Exploring the interplay of ecological and social factors in human-induced disturbance of the African Oystercatcher (*Haematopus moquini*): insights and management recommendations for conservation

A thesis submitted to the Environmental and Geographical Science Department in fulfilment of the requirements for the degree of Master of Social Science

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PLAGIARISM DECLARATION

I hereby declare that the work presented in this thesis is my own, except where otherwise stated. Assistance received by individuals and/or entities during the planning, fieldwork and writing phases of this thesis has been fully acknowledged. This thesis has also not been submitted in whole or in part for a degree at any other university.

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DEDICATION

To my faithful companion and beloved research assistant, Scout. Your hard work helping me gather data over many months under the blazing hot sun will always be fondly remembered and deeply appreciated. Rest easy old friend, you have earned it.

ABSTRACT

It is well-established that nature-based recreation can pose a significant threat to wildlife. However, certain activities may have greater impacts than others, such as dog walking. Estuarine and coastal ecosystems are frequented by dog walkers, and they are also home to shorebird populations that are facing mounting pressure due to human disturbance. African Oystercatchers (*Haematopus moquini*) are vulnerable to human disturbance because they are a ground-nesting species that breeds during the height of the South African holiday and tourist season (October-March). Domestic dogs (*Canis familiaris*) are heavily implicated in the lower breeding success rates evident in mainland African Oystercatcher populations. Therefore, this research focussed on both the ecological (flight initiation distances) and social dimensions (beach user surveys) of human disturbance of African Oystercatchers. The results of the ecological dimension showed that treatment type (dog vs. no dog treatment), location, incubation status, and the interaction between location and incubation status had a significant effect on African Oystercatcher flight initiation distances. Most importantly, African Oystercatchers had longer flight initiation distances on average in response to the dog treatment (a walker approaching with a leashed dog) compared to the no dog treatment. The results of the social dimension revealed 'ambivalence' and 'contradiction' themes. The ambivalence theme centred around the recreationists being uncertain about or disliking the majority of the hypothetical regulations aimed at protecting shorebirds, despite strongly agreeing that shorebird protection and regulations are important. The contradiction theme centred around two sub-themes. Firstly, the species literacy gap that emerged when the recreationists agreed that they were familiar with local shorebirds, while being unable to substantiate this belief by naming the species. Secondly, the cognitive dissonance displayed by the recreationists when they showed good awareness of the threats that human activities pose to shorebirds, while also strongly agreeing that their dogs pose no threat, and many also indicating that larger buffer zones are required to protect shorebirds from dog walkers. Three evidence-based management recommendations were provided, namely implementing buffer zones during the breeding season, tackling the poor leashing compliance rate, and installing signage to educate recreationists and persuade them to adopt pro-social behaviours.

Keywords: African Oystercatcher, buffer zones, dog walking, domestic dogs, flight initiation distance, human disturbance, leashing, management, recreationists, regulations, shorebirds, signage, surveys, threats

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CHAPTER 1. CONTEXTUAL OVERVIEW

1.1. General introduction

1.1.1. Humanity and biodiversity

Human interventions and activities within the biosphere such as recreational disturbance, agricultural expansion and intensification, resource extraction and overexploitation, progressive urbanisation and development, the introduction and spread of alien species, pollution and human-induced climate change, and other activities that cause or exacerbate habitat loss, degradation, modification, and fragmentation collectively have severe and often irreparable effects on biodiversity (Butchart et al., 2010; Wilcove et al., 2013; Gonthier et al., 2014; Conceptión et al., 2015; McCauley et al., 2015; Newbold et al., 2015; Doherty et al., 2016; Maxwell et al., 2016; Nunez et al., 2019; Dueñas et al., 2021; Dulvy et al., 2021). Humanity has significantly altered terrestrial, freshwater and marine ecosystems, which are currently declining in extent and condition (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services [IPBES], 2019). Approximately 75% of terrestrial ecosystems have been transformed through human activity, and 25% or 1 million assessed animal species are currently threatened with extinction (IPBES, 2019). Substantial changes to biodiversity are predicated to occur before the end of the century (Pereira et al., 2010). Global biodiversity change can be thought of as biodiversity loss and biodiversity alteration (Pereira, Navarro & Martins, 2012). Biodiversity loss refers to the decline or extinction of species and genetic diversity, whereas biodiversity alteration refers to the modification of community structure and shifts in species distributions (Pereira, Navarro & Martins, 2012). The consensus of global biodiversity change scenarios is that there will be a steady or rapid decline if ‘business-as-usual’ developmental pathways are followed (Pereira et al., 2010).

Changes to biodiversity at the global scale are mostly attributed to a few drivers, namely changes in land and sea usage, overexploitation, proliferation of invasive species, pollution, and human-induced climate change (IPBES, 2019). Land-use change has the greatest impact on terrestrial and freshwater ecosystems, whereas overexploitation has the greatest impact on marine ecosystems (IPBES, 2019). However, climate change is predicted to become a more prominent driver of global biodiversity change in the coming decades (IPBES, 2019). Synergistic effects produced by the interactions between these drivers, as well as others operating within ecosystems will also influence the magnitude of future changes

(Mantyka-Pringle, Martin & Rhodes, 2012). Changes to biodiversity will have cascading impacts throughout ecosystems because of the integral role that biodiversity plays in crucial ecosystem functions, such as primary production, nutrient cycling and organic matter decomposition (Isbell et al., 2011; Cardinale et al., 2012). There is considerable complexity concerning the role that biodiversity plays in ecosystem functioning (Isbell et al., 2011). Some species are responsible for providing a single function over multiple years, whereas others are responsible for providing multiple functions each year (Isbell et al., 2011). Furthermore, some species may not play a role in ecosystem functioning in certain contexts, but they may play an important role in others, or their roles may be uncertain at present (Isbell et al., 2011). Disruptions or alterations to ecosystem functions due to biodiversity loss will also have cascading impacts throughout society because of the integral role that healthy ecosystem functioning plays in the inner workings of the variety of ecosystem services that are foundational to humanity (Worm et al., 2006; Cardinale et al., 2012).

Biodiversity loss also deprives people of the right to experience and benefit from the full suite of cultural ecosystem services that are uniquely derived from spending time in nature (Milcu et al., 2013). Some derived benefits include recreational and educational opportunities, aesthetic enjoyment and inspiration, improvements to physical health and mental well-being, fostering social relations, and developing a sense of place and identity (Milcu et al., 2013). There is also a possibility that disservices may emerge after landscape transformation, with some common ones being pollution, noise, and fear of personal safety (Plieninger et al., 2013). Some cultural ecosystems services could also be completely lost because services are often clustered in distinct hotspots rather than being evenly distributed throughout landscapes (Plieninger et al., 2013). Hence, it is clear that our current trajectory is not conducive to the preservation of biodiversity or human well-being (Johnson et al., 2017). Humanity is now unequivocally driving a sixth mass extinction, which may prove to be the most devastating mass extinction event because it already significantly exceeds background extinction rates (Ceballos et al., 2015). The magnitude of biodiversity loss will likely increase as the human population grows due to an increase in demand for natural resources, which cannot continue indefinitely because the unabated consumption of resources beyond their regenerative capacities will eventually cause humanity to cross the thresholds that lead to ecological collapses (McBain et al., 2017; Fanning et al., 2022). Making little to no progress towards meeting global biodiversity conservation targets is arguably more untenable than ever before (Buchanan et al., 2020) given that the consequences of inaction can be accurately predicted, and that the window to mitigate future losses is closing (Ceballos et al., 2015).

1.1.2. Invasive alien species and domestic dogs

Invasive alien species are among the main drivers of biodiversity loss (Sala et al., 2000; Butchart et al., 2010; Doherty et al., 2016; Maxwell et al., 2016; Dueñas et al., 2021). These are species that are introduced to ecosystems, naturalise by overcoming barriers that constrain survival, produce fertile offspring, and subsequently proliferate far beyond their initial site of introduction without further human intervention (Richardson et al., 2000). Every country is faced with the difficult task of finding ways to mitigate the impacts associated with invasive alien species from numerous taxa, ranging from plants (Richardson & Rejmánek, 2011), mammals (Tedeschi et al., 2021), birds (Linz et al., 2007), fish (Havel et al., 2015), insects (Bradshaw et al., 2016), and even pathogens (Paini et al., 2016). Furthermore, countries will also be faced with the considerable challenge of preventing the further introduction and spread of alien species in a world that is becoming increasingly connected (Saul et al., 2017). The number of alien species from some of the major taxonomic groups is predicted to increase across continents, and with it so will the magnitude of their impacts (Seebens et al., 2021). Invasive alien species pose a number of threats not only to biodiversity, but also to humanity. They can restructure ecosystems (McNeely, 2001), usurp native species (Bailey et al., 2020), drive extinctions (Bellard, Cassey & Blackburn, 2016), cause major financial losses (Bradshaw et al., 2016), and they can be harbingers of zoonotic diseases (Linz et al., 2007). However, certain taxa and species pose a greater threat to humanity and native biota.

Invasive mammalian predators arguably have the greatest impact on native fauna (Oppel et al., 2011; Doherty et al., 2016; Jones et al., 2016; Dueñas et al., 2021; Tedeschi et al., 2021). The main threats they pose to native fauna are disease transmission, depredation, and competition for space and resources (Tedeschi et al., 2021). Conservative estimates indicate that thirty invasive mammalian predators from 13 families and 8 orders have had an impact on at least 596 threatened and 142 extinct species since AD 1500 (Doherty et al., 2016). Four hundred of the affected species are birds from 78 families, followed by 189 mammals from 45 families, and 149 reptiles from 26 families (Doherty et al., 2016). Rodents, cats, pigs and dogs pose the greatest threat to native fauna, but rodents and cats pose more of a threat, and they are also implicated in the greatest number of extinctions (Doherty et al., 2016). Rodents and cats are linked to the extinction of 138 species, with 92 of these species being birds, which makes them the most affected taxonomic group (Doherty et al., 2016). However, it is suggested that this may be partly attributed to geographical and taxonomic research biases (Meiri & Chapple, 2016). For example, birds are among the most well-studied taxa, whereas only 40% of reptiles have had their conservation statuses assessed, with many of the assessed species coming from a few regions in the northerly latitudes (Meiri & Chapple, 2016).

Domestic dogs (*Canis familiaris*) have received less attention in the literature, but they are increasingly being recognised as a significant threat to native fauna (Doherty et al., 2017). It has become more apparent that previous assessments of dog-wildlife interactions have greatly underestimated the true impacts of these encounters on wildlife (Doherty et al., 2017). Dogs have contributed to the extinction of at least 6 avian species, and they are also a known or potential threat to 78 threatened avian species from 25 families (Doherty et al., 2017). Dogs are deemed an invasive alien species in reviews of the impacts of non-natives on birds (Lees et al., 2022), and wildlife from other major taxonomic groups (Doherty et al., 2017). However, this sentiment is very controversial given that dogs have held a special place in society for millennia, where they have co-evolved with people (Driscoll & Macdonald, 2010). It is roughly estimated that there are between 700 million – 1 billion domestic dogs worldwide (Hughes & Macdonald, 2013; Gompper, 2014). This figure will increase as the human population grows because dogs are an attractive pet option for those seeking companionship, which has been shown to benefit health and well-being (Amiot, Bastian & Martens, 2016). However, growth of the dog population will likely come at a cost because almost all studies show that dog-wildlife interactions are detrimental to wildlife (Hughes & Macdonald, 2013). Relatively few studies have found no impact or positive effects of dog-wildlife interactions (Hughes & Macdonald, 2013). Positive effects only seem to occur when dogs serve as a meal for large carnivores, but there is still the possibility of disease transmission through these encounters (Hughes & Macdonald, 2013). However, the potential exists to reduce the impacts that dogs have on birds and other native taxa because in most instances these impacts occur as a consequence of dog owners disobeying regulations during recreation (Antos et al., 2007; Williams et al., 2009; Jorgensen & Brown, 2014; Maguire, Miller & Weston, 2019).

1.1.3. Shorebirds, human disturbance, and conservation

Estuarine and coastal ecosystems serve as recreational hubs for locals, as well as popular holiday destinations for domestic and foreign tourists (Davenport & Davenport, 2006). However, these ecosystems are being placed under increased pressure due to human activities (Niles et al., 2009; Verhoeven & Setter, 2009; Bulleri & Chapman, 2010), particularly sandy beaches which are used more frequently than any other shore type (Schlacher et al., 2007). These ecosystems provide many ecosystem services, such as raw materials, erosion control, water purification, education, recreation, and research opportunities (Barbier et al., 2011). However, they are also home to resident and migratory shorebird populations (Colwell, 2010). This means that conflicts may emerge between recreationists and management bodies tasked with conservation (McCall, 2007), and between recreationists and wildlife (Catania, 2013). Most of the conflicts that occur between recreationists and wildlife in these ecosystems can be considered asymmetrical, which refers to situations in which one group experiences conflict with another group, but not vice versa (Tynon & Gómez, 2012). This is because recreationists might not believe that their activities pose a threat to wildlife (Williams et al., 2009) and because wildlife usually experience all of the consequences of the encounters (Price, 2008). This is particularly true in the case of shorebirds because they pose no threat to recreationists (Weston et al., 2018), but recreationists pose a considerable threat to them, especially during their breeding seasons (Williams, Ward & Underhill, 2004; Ens & Underhill, 2014; Que et al., 2015; Borneman, Rose & Simons, 2016).

Shorebirds are a diverse group of birds that are predominantly found along the coast (Colwell, 2010). There are *ca.* 215 recognised species that are subdivided into 14 families within the order Charadriiformes (Colwell, 2010). There are many definitions of human disturbance of shorebirds, each with their own limitations and critiques (see Colwell, 2010). Arguably one of the most comprehensive definitions has recently been developed through an iterative process involving a combination of scientists and managers (Mengak & Dayer, 2020). This definition holds that human disturbance is "a human activity that causes an individual or group of shorebirds to alter their normal behaviour, leading to an additional energy expenditure by the birds. It disrupts or prevents shorebirds from effectively using important habitats and from conducting activities of their annual cycle that would occur in the absence of humans. Productivity and survival rates may also be reduced" (Mengak & Dayer, 2020:67). This definition does not cover every facet of the other definitions, and a minority of experts may find it unsatisfactory (Mengak & Dayer, 2020). However, it does cover most facets because it recognises that human disturbance may simply change behaviour, which causes additional and 'unnecessary' energy expenditure, while also recognising that disturbance can affect survival and productivity, and thus population size (Mengak & Dayer, 2020). Hence, it focusses on shorebirds at the individual-level, while acknowledging the potential population-level consequences of human disturbance (Mengak & Dayer, 2020).

Shorebirds are exposed to a variety of anthropogenic stimuli each day, which can affect physiology, behaviour, reproduction, and population size (Steven, Pickering & Castley, 2011). These stimuli differ between locations due to regulations, but they usually involve a combination of consumptive and non-consumptive activities, such as walking, fishing, swimming, boating, kayaking, off-road driving, and spending time with pets in the form of dog walking and horse riding. Some stimuli elicit greater responses from shorebirds than others, but they all possess the potential to impact shorebirds in different ways (Rodgers & Smith, 1995; Williams, Ward & Underhill, 2004; Loewenthal, 2007; Weston & Elgar, 2007; Weston, Ehmke & Maguire, 2011; Mayo, Paton & August, 2015; Jorgensen, Dinan & Brown, 2016). These impacts can occur over short periods of time such as when shorebirds experience elevated heart rates (Charuvi et al., 2020), issue distress calls and perform distraction displays, (Baker & Hockey, 1984), and flush off of their nests (Jorgensen, Dinan & Brown, 2016). These short-term physiological and behavioural responses may appear to be innocuous, but they can have serious consequences. For example, shorebirds that repeatedly flush from their nests leave their eggs and chicks vulnerable to opportunistic predators (Loewenthal, 2007), and possibly exposed to temperatures that can cause developmental defects or kill an embryo in a short period of time under the right conditions (Weston, 2019). Human disturbance during foraging has been shown to reduce the amount of time that adults devote to parental duties, which can negatively affect reproductive outcomes (Verhulst, Oosterbeek & Ens, 2001). Human disturbance has also been shown to force shorebird chicks into habitats with lower food availability and make fewer foraging attempts per minute, which reduces their survival (DeRose-Wilson et al., 2018). Population numbers could eventually decline if human disturbance continues to occur in these cases (Sutherland, 1998), especially if the shorebirds do not habituate to the stimuli, either permanently or over the course of the breeding season (Baudains, 2006).

Understanding the impacts that human disturbance has on wildlife is of critical importance to reserve managers, who are tasked with maintaining and enhancing the ecological integrity of their reserves so that wildlife can prosper, and visitors can continue to benefit. Shorebirds are perhaps the most frequently encountered form of wildlife in coastal locations, which necessitates ecological research on the impact that human disturbance can have either on a particular species of conservation concern (Jorgensen, Dinan & Brown, 2016) or on an entire community (de Blocq van Scheltinga, 2017). However, there is also a need for social research on human disturbance, because management interventions that are implemented without the support or consultation of the relevant stakeholders can cause tension between recreationists and management, and even anger towards the species of conservation concern (McCall, 2007). This is the case in Revere, Massachusetts where sections of Revere Beach were closed to protect incubating Piping Plovers (*Charadrius melodus*). This caused the imperilled species to become the enemy of many recreationists, who responded by creating 'Piping Plovers taste like chicken' bumper stickers for their vehicles (Catania, 2013).

Multi-level stakeholder engagement and the inclusion of recreationists in the decision-making process of management interventions aimed at protecting shorebirds can improve conservation outcomes (Burger & Niles, 2013). This is the case in the surrounds of Plettenberg Bay, South Africa where stakeholder engagement led to the implementation of a beach zonation system for dog walkers, which benefits shorebird populations, as well as recreationists that may want dog-free leisure (Brown, 2018a). White-fronted Plover (*Charadrius marginatus*) numbers increased by 30% on Lookout Beach and 325% in the Nature's Valley in just two breeding seasons after the implementation of the zonation system (Brown, 2018a). However, changes in beach management, multimedia engagement, establishing buffer zones around nesting sites, and increasing awareness through *in situ* education measures such as brochures and signs also helped improve breeding success (Brown 2018a, 2018b). More context-specific research is needed on the ecological and social dimensions of human disturbance of shorebirds (van de Voorde, Witteveen & Brown, 2015). It is clear that a lack of consideration for the social dimension of conservation challenges may not generate successful results. This is particularly true in cases where conservation outcomes are contingent on people, such as on beaches that are heavily trafficked by recreationists who may lack awareness of shorebirds and conservation issues (van Polanen Petel & Bunce, 2012). If the desired 'win-win' solutions are to possibly be achieved, then recreationists need to be viewed as part of nature, not separate entities that have no bearing on conservation outcomes.

1.2. Background and motivation for research

African Oystercatchers (*Haematopus moquini*) are benefitting from a combination of increased protection and food availability due to the spread of the Mediterranean Mussel (*Mytilus galloprovincialis*) around the South African coastline since the 1980s (Loewenthal, 2007). African Oystercatcher numbers have increased substantially in recent years, and now the species is classified as Least Concern (Loewenthal, 2007). However, African Oystercatchers are particularly vulnerable to human disturbance because of where and when they breed (Loewenthal, 2007). There are many documented cases of human disturbance affecting island, protected and unprotected mainland African Oystercatcher populations (Loewenthal, 2007). Protected and unprotected mainland populations are most at risk of human disturbance because they are more accessible to the public, which means that they must contend not only with the elements and natural predators for survival, but also with recreationists (Loewenthal, 2007). Human disturbance lowers African Oystercatcher breeding success rates (Loewenthal, 2007). However, this may not be immediately apparent at the population-level because the African Oystercatchers' longevity can mask the impacts of human disturbance on reproduction (Loewenthal, 2007). This is particularly true in comparison to natural phenomena such as avian cholera or Paralytic Shellfish Poisoning (PSP), which can have an immediate impact at the population-level depending on the magnitude of adult mortality (Loewenthal, 2007). African Oystercatchers are unlikely to become extinct at the global and regional-level (Loewenthal, 2007). However, some mainland populations (16%) at the local-level are declining, and have unsustainable breeding success rates due to human activities (Loewenthal, 2007). This indicates that measures need to be taken to mitigate the type and/or severity of human disturbance facing these populations. Dogs are implicated in many of the known causes of egg loss and chick mortality in mainland African Oystercatcher populations (Loewenthal, 2007). Flight initiation distance research can help reserve managers mitigate the impacts that dogs have on oystercatchers because it has been successfully used to determine buffer zones for incubating shorebirds around the world (Glover et al., 2011). Flight initiation distance refers to the distance at which an animal initiates movement away from an approaching predator or a potential threat, such as a recreationist (Blumstein, 2003). However, reserve managers usually lack this species-specific and context-specific data (Weston et al., 2012a).

A few knowledge gaps were identified in the current body of human disturbance literature, particularly the flight initiation distance literature. Firstly, there is a paucity of literature dedicated to the impact of human disturbance on birds in many regions, including those characterised by high levels of avian diversity and nature-based activities, such as Africa (Steven, Pickering & Castley, 2011). Furthermore, Weston et al. (2021) highlight that relatively few studies have been devoted to the flight initiation distances of African birds. The conflict between humans and birds will likely intensify due to the high rate of urbanisation that is projected for many developing countries (United Nations [UN], 2019). Secondly, there is an abundance of literature devoted to flight initiation distances in response to walkers (Blumstein, 2003; Geist et al., 2005; Baudains, 2006; Møller, 2009; Weston et al., 2012a; Braimoh et al., 2017; Hall et al., 2020). Yet, birds encounter a variety of stimuli in recreational hotspots, including watercraft, vehicles, cyclists, runners, and leashed and unleashed dogs (Rodgers & Smith, 1995; Lord et al., 2001; Glover et al., 2011; Schlacher et al., 2013; Jorgensen, Dinan & Brown, 2016; de Blocq van Scheltinga, 2017; Lethlean et al., 2017;

Bernard et al., 2018). People are often accompanied by their dogs in nature (Antos et al., 2007; Williams et al., 2009; Jorgensen & Brown, 2014; Bowes et al., 2015; Guinness et al., 2020). It is well-established that dogs constitute a major threat to birds (Doherty et al., 2017) and that birds usually perceive dogs as a greater threat than other stimuli that they encounter (Banks & Bryant, 2007; Glover et al., 2011; Faillace & Smith, 2016; Jorgensen, Dinan & Brown, 2016). The only literature on African Oystercatcher flight initiation distances determined their responses to a lone walker (van de Voorde, Witteveen & Brown, 2015; Reynolds et al., 2020). Hence, the need for research that determines flight initiation distances in response to walkers with dogs.

Thirdly, it is important to investigate the human dimension of wildlife management problems (Miller, Ritchie & Weston, 2014). Human dimension research is typically concerned with the knowledge, perceptions, values, and attitudes towards wildlife and their management (Williams et al., 2009; Schlegel & Rupf, 2010; Jorgensen & Brown, 2014; Miller, Ritchie & Weston, 2014; Bowes et al., 2015). However, human dimension research focusing on the conservation of shorebirds has only started to emerge recently (Jorgensen & Brown, 2015). Only a small body of research has been devoted to the human dimension of dog-wildlife interactions despite the fact that people are in control of their dogs, and can thus prevent their dogs from interacting with wildlife during their walks (Miller, Ritchie & Weston, 2014). Furthermore, there is a paucity of flight initiation distance literature dedicated to both the ecological and social dimensions of human disturbance (Glover et al., 2011; Slater et al., 2019). This type of research can prove to be invaluable to shorebird conservation in many ways. For example, it can reveal why people do not comply with regulations (Bowes et al., 2015), which regulations people are more likely to support (Glover et al., 2011), peoples' awareness of the threats facing wildlife (van Polanen Petel & Bunce, 2012), peoples' attitudes towards wildlife (Jorgensen & Brown, 2015), and which type of conservation messages are more likely to persuade people to comply with regulations (Jorgensen & Brown, 2017). Hence, the need for more research that includes the social dimension of human disturbance.

1.3. Thesis structure

The present chapter contextualised this research in the realm of ongoing biodiversity loss. It began at the global scale by broadly highlighting some of the most prominent drivers of biodiversity loss, as well as detailing the potential ramifications of conversation inaction. It then narrowed down to human disturbance and shorebirds, and ultimately the ongoing issues facing the African Oystercatcher, which are largely attributed to recreation with domestic dogs. Chapter 2 represents the ecological component. It provides an overview of the African Oystercatcher and determines their flight initiation distances in response to a dog walker. Chapter 3 represents the social component. It highlights the importance of human dimension research in bird-related conservation efforts and determines recreationists' awareness of threats, and their support for hypothetical regulations aimed at protecting shorebirds. Chapter 4 concludes by combining the findings of the ecological and social components in order to provide evidence-based management recommendations to protect incubating African Oystercatchers.

1.4. Aim and objectives

This thesis aims to couple the ecological and social dimensions of human disturbance of the African Oystercatcher in order to improve our understanding of the ways in which the species can be further protected. The objectives are to:

I. Determine incubating (breeding) and non-incubating (non-breeding) African Oystercatcher flight initiation distances in response to a walker with a leashed dog (dog treatment) and without a leashed dog (walking treatment).
   - This is done to provide the relevant conservation bodies with further insight into the appropriate buffer distances to minimise the impact of human disturbance during the breeding season (van de Voorde, Witteveen & Brown, 2015).

II. Determine recreationists' awareness of the threats that human activities pose to shorebirds.
   - This is because research has shown there may be a poor understanding among recreationists of the threat that they (Le Corre et al., 2013) and/or their dogs pose to shorebirds (Williams et al., 2009). It is possible that *in situ* education can induce behavioural change, which is why it is often recommended as a conservation tool (Bridson, 2000; Williams et al., 2009; Jorgensen & Brown, 2014).

III. Determine recreationists' attitudes towards hypothetical regulations aimed at protecting shorebirds.
   - This is because research has shown that recreationists indicate greater support for certain regulations than others (Glover et al., 2011), which may affect compliance (Maguire, Miller & Weston, 2019). It is important to identify which regulations recreationists will support, especially when it is not possible for reserve personnel to patrol and issue fines on a daily basis (Jorgensen & Brown, 2014).

CHAPTER 2. AFRICAN OYSTERCATCHER (*HAEMATOPUS MOQUINI*) FLIGHT INITIATION DISTANCES IN RESPONSE TO A KNOWN THREAT, DOMESTIC DOGS (*CANIS FAMILIARIS*)

2.1. Introduction

Birds are among the most well-studied taxa, with 11162 (92%) species having been assessed and included in the most recent IUCN Red List of Threatened Species Report (IUCN, 2021). A total of 225 species are classified as Critically Endangered, 447 as Endangered, and 773 as Vulnerable, which means that 1445 (13%) species are threatened with extinction (IUCN, 2021). Avian populations are declining around the world (Cooper, Wannenburgh & Cherry, 2017; Rosenberg et al., 2019; Şekercioğlu et al., 2019; Burns et al., 2021; Lees et al., 2022). Approximately 5245 (48%) species are known or suspected to be undergoing population declines, whereas only 676 (6%) are experiencing population increases (Lees et al., 2022). Humanity is responsible for driving these population declines through agriculture, logging, development, energy production, hunting, fishing, illegal wildlife trade, climate change, pollution, and aiding in the introduction and spread of non-native species (Lees et al., 2022). South Africa has rich avian diversity (Taylor & Peacock, 2018). A total of 856 species have been recorded on the mainland, as well as on sub-Antarctic islands (Taylor & Peacock, 2018). Approximately 132 (15%) of these species are regionally threatened with extinction (Taylor & Peacock, 2018). While there is ample cause for concern, it is important to note that global conservation efforts have helped at least 25 Critically Endangered avian species stave off extinction over the last 20 years (BirdLife International, 2018). Furthermore, conservation efforts have also led to the downlisting of many other lesser threatened species (BirdLife International, 2021). For example, 78 species were downlisted to a lower threat category between 2020/21, whereas 40 species were uplisted (BirdLife International, 2021).

It is clear that the potential exists to prevent the further decline of avian populations through a myriad of conservation strategies, including educating the public to increase awareness of the threats facing avian populations in general or certain species in particular (Ormsby & Forys, 2010), finding ways to decrease overexploitation (Gilman, 2011), captive breeding certain species for future reintroduction (Collar & Butchart, 2014), controlling invasive alien species (de Villiers et al., 2010), ecosystem restoration (Strassburg et al., 2020), identifying Important Bird Areas (Buchanan, Donald & Butchart, 2011), and influencing policy (BirdLife International, 2018). However, more species and context-specific information is needed to successfully implement conservation-minded interventions. Conservation is not only beneficial to birds, but it is also beneficial to people because birds play an important role in maintaining ecosystem functions, and thereby provide many ecosystem services to society (Whelan, Wenny & Marquis 2008). For example, many species pollinate, disperse seeds, and control weed and pest populations in agricultural systems (Whelan, Wenny & Marquis, 2008). Moreover, other species help society by scavenging on carcasses, which regulates the spread of zoonotic diseases that kill tens of thousands of people a year and burden healthcare systems (Jalihal, Rana & Sharma, 2022). Birds also provide jobs to local individuals and communities because many tourists flock to destinations around the world specifically for birding purposes (BirdLife International, 2018). For example, 21000-41000 avitourists visit South Africa each year, and they contribute R927-1725 million to the economy annually (Taylor & Peacock, 2018).

2.2. The African Oystercatcher

2.2.1. Distribution and movement patterns

The African Oystercatcher (*H. moquini*) (hereafter 'oystercatcher(s)') is one of only 11 extant oystercatcher species belonging to the Haematopodidae family within the Charadriiform order (Colwell, 2010). It is the only endemic oystercatcher species that is found in Africa since the Canary Island Oystercatcher (*Haematopus meadewaldoi*) went extinct (Hockey, 1987), and is now considered to be a melanistic morph or subspecies of the Eurasian Oystercatcher (*Haematopus ostralegus*) (Senfeld, 2020). Oystercatchers are found and breed almost exclusively on the sandy, rocky, and mixed mainland coastlines, as well as offshore islands between Lüderitz, Namibia and Port Edward, South Africa (Fig. 1) (Hockey, 1983a). Oystercatchers have also been spotted as far as Lobito, Angola (Summers & Cooper, 1977) and Inhaca Island, Mozambique (de Boer & Bento, 1999). However, these sightings are rare, with the exception of the non-breeding populations (Simmons, Mills & Dean, 2009) that were recorded along the southern Angolan coastline between Tombua, Baia dos Tigres, and Ilha dos Tigres (Simmons et al., 2006).

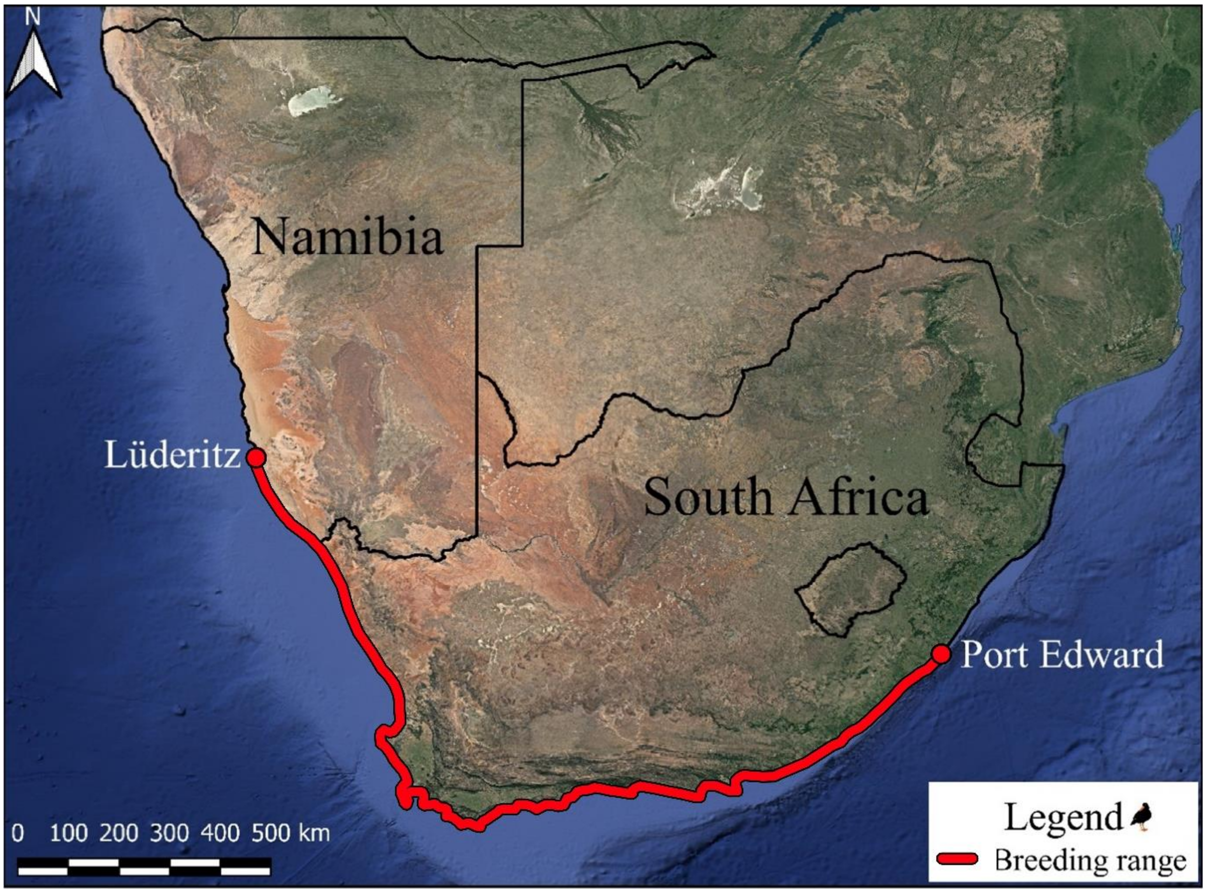

Fig. 1. Oystercatcher breeding range along the mainland coast (sandy, rocky and mixed shores) between Lüderitz, Namibia and Port Edward, South Africa (QGIS, 2022).

There are some records of extralimital breeding attempts, such as the two clutches that were found 2 km south of the Hoanib River mouth, which is *ca.* 800 km north of Lüderitz (Braine, 1987). These clutches likely belonged to the same pair because they were found in close proximity to each other less than a month after the first clutch failed (Braine, 1987). Oystercatchers have also extended their breeding range further east into KwaZulu-Natal. (Brown & Hockey, 2007). A number of individuals have been spotted in the province, with most coming from locations further south, closer to the Eastern Cape (Brown & Hockey, 2007). However, it is unlikely that the province will become a regular breeding locale because the carrying capacity for breeding oystercatchers is arguably quite low (Brown & Hockey, 2007). Only two instances of breeding have been recorded in the province, and most of the individuals appear to be pre-breeding birds that have yet to establish territories in their natal sites outside of the province (Brown & Hockey, 2007). Despite this, oystercatchers have continued to expand their range further into the province, with a significant increase in reporting rates having occurred between the first (1987-1991) and second (2007-ongoing) Southern African Bird Atlas Projects (Brown et al., 2019).

Oystercatchers spotted outside of the breeding range are usually juveniles that have migrated to 'nursery' grounds (sites that support aggregations of juvenile oystercatchers) where they will develop their foraging skills in the absence of adult competition for a few years before returning to their natal sites to try and establish a territory, attract a mate, and begin breeding (Leseberg, 2001; Hockey, Leseberg & Loewenthal, 2003; Rao, 2005). Adults are non-migratory, but they may engage in short local movements (Hockey, 1983a). In comparison, between 36-46% of the juvenile oystercatchers that are born in South Africa migrate to one of five nursery grounds in central and northern Namibia, and southern Angola (Hockey, Leseberg & Loewenthal, 2003). Juveniles move over 1500-2000 km in a few months, with the longest recorded movement being 2800 km from a bird in East London, Eastern Cape (Hockey, Leseberg & Loewenthal, 2003). However, there are differences between the juveniles on the south/east and west coast, and some juveniles remain within 150 km of their natal sites (Hockey, Leseberg & Loewenthal, 2003). Juveniles from the south and east coasts typically embark on shorter 'dispersals' and conclude their journeys within the breeding range, whereas juveniles from the west coast typically embark on longer 'migrations' that conclude in one of the Namibian and Angolan nursery grounds (Hockey, Leseberg & Loewenthal, 2003).

2.2.2. Population size and conservation status

A near-complete global population survey conducted in the late 1970s and early 1980s estimated that there were *ca.* 4781 adult oystercatchers in the breeding range (Hockey, 1983a). A total of 4159 (87%) of the oystercatchers were found in South Africa and 662 (13%) in Namibia (Hockey, 1983a). A total of 3375 (71%) of the oystercatchers were found on the mainland coast and 1406 (29%) on offshore islands (Hockey, 1983a). Oystercatchers were classified as Near Threatened during this period due to their small population size, as well as numbers that were either decreasing or had previously decreased (Loewenthal, 2007). The most recent near-complete global population survey conducted in the late 1990s and early 2000s estimated that there were *ca.* 6670 adult oystercatchers in the breeding range, which is an increase of *ca.* 46% (Loewenthal, 2007). The majority of the population is still found on the mainland coast, including coastal wetlands (Loewenthal, 2007). However, offshore islands are home to a large share of the population relative to the area that they occupy in the breeding range, and they are also disproportionately important breeding grounds (Loewenthal, 2007). For example, Robben Island, Western Cape is home to 8% of the global population despite having a coastline of *ca.* 10 km (Quintana, Button & Underhill, 2021).

Oystercatcher numbers increased across all habitat types between the Olifants and Kei Rivers, South Africa (Loewenthal, 2007). Mixed, sandy and rocky shores respectively support 42%, 31% and 24% of the global population (Loewenthal, 2007). The Eastern Cape experienced the greatest absolute and proportional increase, but the Western Cape remains the most important region because it supports 54% of the global population (Loewenthal, 2007). The oystercatcher population in the 278 km stretch between the Berg River and De Hoop Nature Reserve, Western Cape more than doubled between 1980/81 and 2010/11 (Ryan, 2012). The significant growth of the oystercatcher population is attributed to the improved management of island populations, increased protection following a ban on off-road vehicles on South African beaches in the early 2000s, and the spread of the invasive Mediterranean Mussel (*Mytilus galloprovincialis*) around the South African coastline (Loewenthal, 2007). Oystercatchers no longer represent a conservation plight at the global or regional scale (Loewenthal, 2007), which is why their status has recently been reclassified to Least Concern (BirdLife International, 2017). Oystercatchers are considered a rare conservation success story (Brown et al., 2019) in a time where the global, regional and local outlook for avifauna is particularly concerning (BirdLife International, 2018; Taylor & Peacock, 2018).

2.2.3. Diet and sexual dimorphism

There is a biogeographic pattern to oystercatcher diets, but they are usually dominated by mussels and limpets (Hockey & Underhill, 1984; Kohler et al., 2011). Their diets generally reflect the relative abundance of prey items in a given location (Hockey & Underhill, 1984). Oystercatchers are opportunistic foragers because they are known to consume sea anemones, sea cucumbers, sea squirts, bristle worms, barnacles, gastropods, amphipods and isopods (Hockey & Underhill, 1984). Over 50 different species have been recorded in oystercatcher middens (piles of empty mollusc shells) in mainland rocky shores (Hockey & Underhill, 1984). Oystercatcher diets have changed to a degree since the early 1980s (Loewenthal, 2007). The Mediterranean Mussel was only positively identified on the South African coast in 1985, but it may have been present as early as the 1970s (Fig. 2) (Grant & Cherry, 1985). *Mytilus galloprovincialis* was likely unintentionally introduced to the South African coast through hull fouling (Grant & Cherry, 1985). It has since become the most successful marine invader, occupies all of the environmentally suitable habitats, and outcompetes many indigenous mussel and limpet species on the South African coast (Assis et al., 2015). Oystercatcher diets reflect the invasion of *M. galloprovincialis*, but some diets are still dominated by native species, such as in Kenton, Eastern Cape (Kohler et al., 2011). Oystercatcher diets on the west coast are now dominated by *M. galloprovincialis*, where the invader is most abundant (Hockey & van Erkom Schurink, 1992; Coleman & Hockey, 2008; Kohler et al., 2011).

Fig. 2. An oystercatcher on Scarborough Beach, Western Cape foraging on a washed-up mussel, which is either the native Black Mussel (*Choromytilus meridionalis*) or the invasive Mediterranean Mussel (*M. galloprovincialis*) because both are abundant in the intertidal zone, and are similar in appearance.

Oystercatcher diets also differ temporally (Hockey & Underhill, 1984). Oystercatchers consume more food during the day and show preference for certain species during the night (Hockey & Underhill, 1984). Oystercatcher diets can vary according to the sex of the individual, with females showing a preference for mussels and polychaetes, and males a showing preference for limpets (Hockey & Underhill, 1984). Oystercatchers are a sexually dimorphic species, but differences are not apparent through observation (Hockey, 1981). Bill dimorphism is the suggested reason for the difference in prey selection between males and females (Hockey & Underhill, 1984). Males have shorter, stouter bills that appear to bend upward in the lower mandible at the gonys, whereas females have longer, pointier bills that appear to bend downwards at the tip (Hockey, 1981). Stouter bills may aid in limpet removal, whereas longer, pointier bills appear to provide an advantage when probing for polychaetes (Fig. 3) (Hockey & Underhill, 1984). It is suggested that these subtle differences may improve resource exploitation within a territory by reducing the intersexual competition for food (Hockey & Underhill, 1984). More recent studies have shown that there is minimal sex-related dietary variation (Coleman & Hockey, 2008; Kohler et al., 2011; Kohler et al., 2014). Rather, there appears to be an intersexual dietary convergence that occurred sometime after the invasion and spread of *M. galloprovincialis* (Coleman & Hockey 2008). However, there are still instances of sex-related dietary variation on the south-east coast, such as in Kenton and

Port Elizabeth, Eastern Cape where bill dimorphism is most pronounced (Kohler et al., 2014) and where *M. galloprovincialis* is uncommon (Kohler et al., 2011).

Fig. 3. A pair of oystercatchers foraging along the shoreline of Scarborough Beach. The individual on the left is probing the sand, potentially in search of polychaetes, whereas the individual on the right is holding a mussel in its bill.

2.2.4. Human disturbance and impacts

Oystercatchers are affected by a wide variety of human-related activities (Underhill, 2014). Some of the more common human-related activities and impacts include habitat loss and degradation due to coastal development and mining, egg loss and chick mortality due to depredation by natural predators that gain access to them for a period of time after parents are flushed from their nests, egg loss and chick mortality due to depredation by unleashed dogs, chick injury or mortality that occurs while hiding under rocks in the intertidal zone or in washed-up kelp during incoming tides (Fig. 4), and nest destruction due to walkers, horse riders, and off-road vehicles (Figs. 5 & 6) (Summers & Cooper, 1977; Hockey, 1983b; Calf & Underhill, 2002; Jeffrey & Scott, 2005; Rao, 2005; Loewenthal, 2007; Paijmans, 2016). An off-road vehicle ban was implemented on South African beaches on 21 December 2001 (Williams, Ward & Underhill, 2004). Vehicles are now only allowed on beaches with a permit or written exemption, which are only issued in select instances (*National Environmental Management: Integrated Coastal Management Act, No. 24 of 2008. Regulations, 2014*). Evidence suggests that oystercatchers and many other coastal avian species responded quickly and positively to the ban (Williams, Ward & Underhill, 2004). The number of juvenile birds, breeding pairs, and chicks raised to fledgling substantially increased in the first breeding season after the ban in two popular holiday destinations in the Western Cape that were previously associated with frequent and extensive vehicular disturbance, namely Lambert's Bay and Struisbaai (Williams, Ward & Underhill, 2004).

However, there are still people who ignore these regulations and illegally drive their vehicles on beaches (Fig. 7) (Jeffrey & Scott, 2005; Rao, 2005; Loewenthal, 2007).

Fig. 4. A parent and chick seen standing amongst a small aggregation of washed-up kelp in the Blaauwberg Nature Reserve, Western Cape during the 2021/22 breeding season.

Fig. 5. A horse rider seen adjacent to a pair of incubating oystercatchers during the 2021/22 breeding season on Noordhoek Beach, Western Cape. The non-incubating bird (bottom left) can be seen preparing to lure the rider away from its incubating partner (bottom centre).

Fig. 6. An unleashed dog chasing a flock of Kelp Gulls (*Larus dominicanus vetula*) (seabirds) in an oystercatcher breeding hotspot (Haakgat Beach) in the Blaauwberg Nature Reserve.

Fig. 7. Vehicle tracks seen during the 2021/22 breeding season on Haakgat Beach in the Blaauwberg Nature Reserve. Tracks were seen on a number of occasions during fieldwork. This set stretched across the entire breeding range (Kreeftebaai – Holbaai).

Some of the less common impacts include egg loss and chick mortality due to heat exposure that occurs when parents are flushed from their nests, and possible chick starvation that occurs when adult foraging time is impeded (Adams, Kerley & Watson, 1999; Leseberg, Hockey & Loewenthal, 2000). Climate change, which is induced by human-related activities, is also predicted to affect oystercatchers (Underhill, 2014). This will likely occur through an increase in the frequency and duration of temperature and tidal extremes (Underhill, 2014). Temperature extremes could affect embryogenesis or cause chicks to die, whereas tidal extremes may increase the prevalence of nest flooding (Loewenthal, 2007), especially if coupled with spring high tides (Underhill, 2014). Sea level rise will also likely affect oystercatchers because they mostly forage in the rocky intertidal zone on invertebrates (Hockey & Underhill, 1984). Sea level rise is an inevitable consequence of climate change, which is predicted to cause a considerable reduction in the total intertidal habitat area (Shaefer et al., 2020), and abundance of sessile and mobile invertebrates in coastal areas around the world (Kaplanis et al., 2020).

Pollution is another human-related activity that can also affect oystercatchers. Coastal ecosystems are known repositories of many pollutants (Vikas & Dwarakish, 2015). Pollutants can have adverse effects on shorebird health (Tang, Huang, Nie & Yang, 2015). Heavy metals may occur in water and sediment, and they also bioaccumulate in prey species (Tsipoura et al., 2017; Pandiyan et al., 2020). Heavy metals have been recorded in the blood and feather samples of many shorebird species (Tsipoura et al., 2017; Pandiyan et al., 2020). Heavy metals have also been recorded locally in favoured oystercatcher prey species such as *M. galloprovincialis*, albeit usually within permissible concentrations (Sparks et al., 2018).

Plastic pollutants may be a more pertinent threat to oystercatchers than heavy metals (Fig. 8). There is a relative lack of understanding surrounding shorebirds and plastic exposure, frequency of ingestion, and the potential impacts of ingestion (Flemming et al., 2022). However, a recent review found that plastic ingestion is fairly common among shorebirds (Flemming et al., 2022). The Haematopodidae family (oystercatcher) was found to have the highest frequency of plastic ingestion (Flemming et al., 2022). The necropsied carcasses of the American Oystercatcher (*H. palliatus*) contained an average of 29.1 pieces of plastic per bird (Flemming et al., 2022). Fishing line from commercial or recreational anglers can also injure or kill shorebirds. Local seabirds appear to be more at risk (Fig. 9), but there are records of oystercatcher injuries and deaths due to fishing line entanglements (Paijmans & Stewart, 2016).

Fig. 8. Plastic pollution seen in the Blaauwberg Nature Reserve. Plastic lodged inside of the carcass of a dead whale, which likely accumulated post-mortem due to turbulence associated with rough waves (left). Plastic seen strewn amongst washed-up kelp and seaweed (right).

Fig. 9. A juvenile Kelp Gull seen in the Blaauwberg Nature Reserve with a piece of fishing line wrapped around both legs.

2.2.5. Breeding biology and causes of reproductive failure

Oystercatchers select their nesting sites according to the macrohabitat type, local substratum, and the presence of vegetation, and other objects that will enhance crypsis (Hockey, 1982). Oystercatchers lay their eggs in a shallow scrape in the ground (depending on the substrate) above the high-water mark, usually in sheltered nesting sites that are adjacent to vegetation (Fig. 10) (Hockey, 1982). For example, fewer oystercatchers in Robben Island nest in the western region because the shoreline is exposed and frequently experiences rough oceanic conditions (Quintana, Button & Underhill, 2021). However, sites adjacent to or within vegetation provide poor visibility of approaching predators (Calf & Underhill, 2005). Therefore, oystercatchers have to compromise between the higher predation risk associated with sites in the surrounds of vegetation or the higher chance of nests being washed away during anomalous tidal events when they nest closer to the ocean (Calf & Underhill, 2005). Hence, oystercatchers carefully choose their nesting sites, and they may make several nest scrapes in their territories before choosing a spot and laying their first clutch (Hockey, 1982). Oystercatcher nesting sites are usually in close proximity (± 50 m) to their feeding grounds (Hockey, 1982). However, 'leapfrog' populations have breeding and feeding grounds that can be several hundreds of meters away from each other (Loewenthal, 2007).

Fig. 10. An oystercatcher incubating amongst vegetation in the Blaauwberg Nature Reserve. This bird was very inconspicuous despite its jet-black colouration.

Oystercatchers are territorial and they will only begin breeding once they have secured a territory, which can take many years, especially on islands (Loewenthal, 2007). Oystercatchers will defend their territories year-round, which are usually between 5-20 m wide, but this depends on the width of the intertidal zone (Calf & Underhill, 2005). Territory length varies, but it is usually much larger on the mainland coast due to the fact that there is a lower density of oystercatchers, and thus less competition for resources and space

(Parsons, 2006; Loewenthal, 2007). Territories can be smaller than 50 m or they can be as large as 1 km in some locations, such as in the Koeberg Nuclear Power Station, Western Cape (Parsons, 2006). Females sexually mature at three years old and males at four years old, but both may take a few more years to attract a mate and secure a territory (Loewenthal, 2007). Oystercatchers are mate-faithful and display a high level of adult site fidelity, which means that they will breed in the same territory with the same partner each year (Loewenthal, 2007). However, there are some observations of ‘divorce’ amongst oystercatchers (Parsons, 2006). For example, an unconfirmed female in the Koeberg Nuclear Power Station appeared to leave her partner and pair with a widowed banded male (Parsons, 2006). Oystercatchers are known to abandon their territories due to high levels of human disturbance (Loewenthal, 2007), but they may return when disturbance rates decline (Williams, Ward & Underhill, 2004).

Oystercatchers are particularly vulnerable to human disturbance because they breed during the austral summer at the height of the holiday season (Summers & Cooper, 1977). Oystercatchers typically start breeding during October and end in March (Hockey, 1983b). However, the onset of egg laying differs spatio-temporally (Hockey, 1983b; Parsons, 2006). There are some instances of pairs breeding in late September and producing chicks by early October, but this is uncommon (Parsons, 2006). Oystercatchers produce most of their eggs between November and February, with peak breeding productivity occurring between mid-December to mid-January (Hockey, 1983b; Calf & Underhill, 2002; Parsons, 2006). Oystercatchers incubate their clutches for 27-39 days, with the average being 32.1 days (Hockey, 1983b). Clutches contain either one, two or three eggs, with two-egg clutches being the most common and three-egg clutches being the least common (Fig. 11) (Hockey, 1983b). Three-egg clutches have started to become more common in recent decades, but they offer no benefit to fitness because they do not result in greater fledgling output (Paijmans, 2014). Oystercatchers spend more time on average incubating the first egg that they lay in comparison to the second (Hockey, 1983b). Replacement clutches are typically laid 22.2 ± 8.3 days after the loss of the first clutch, and some pairs are known to produce three (Hockey, 1983b) or even four replacement clutches (Parsons, 2006). Replacement clutches are laid in close proximity to the initial clutch, sometimes in the same nest, but usually between 2.5–25.5 m apart (Hockey, 1983b). While it is uncommon, oystercatchers may also re-lay clutches after successfully rearing chicks to fledgling (Parsons, 2006).

Fig. 11. A two-egg clutch seen on Noordhoek Beach during the 2021/22 breeding season.

Oystercatcher breeding success rates are characteristically low, and they also differ spatio-temporally (Loewenthal, 2007). Breeding success differs significantly between island populations, protected mainland populations and unprotected mainland populations (Loewenthal, 2007). Island populations are associated with significantly higher breeding success rates than protected and unprotected mainland populations because they experience much lower levels of depredation (Loewenthal, 2007). The majority of islands have relatively few natural predators outside of seabirds, except for Robben Island (Tjørve & Underhill, 2008). Islands also experience minimal or no human disturbance, which is not the case for protected and unprotected mainland populations (Loewenthal, 2007). Island populations have been shown to produce 0.91 fledglings per pair per year, whereas the protected and unprotected mainland populations produce less than half that number, at 0.42 and 0.34 fledglings per pair per year respectively (Loewenthal, 2007). Island populations greatly exceed the estimated 0.33 fledgling per pair per year threshold that is required to maintain a stable population, whereas the protected and unprotected mainland populations barely exceed it (Loewenthal, 2007). Loewenthal (2007:79) states that "human disturbance, in whatever form, does lower the breeding success of oystercatcher populations".

Between 44-62% of the egg losses and 60-80% of the chick mortalities across the three aforementioned population categories are attributed to unknown causes (Loewenthal, 2007). Human disturbance accounts for a moderate percentage of the known causes of egg loss and chick mortality in protected and unprotected mainland populations (Loewenthal, 2007). For example, human interference (the deliberate/accidental crushing or removal of eggs) accounts for 8% of the egg losses and dog predation accounts for 16% of the chick mortalities in protected mainland populations (Loewenthal, 2007). Unprotected mainland populations are likely exposed to a greater number, higher density, and wider variety of human-related activities than protected mainland populations. This assumption is reflected in the known causes of egg loss and chick mortality in these populations (Loewenthal, 2007). Human interference and dogs each account for 10% of the egg losses in unprotected mainland populations (Loewenthal, 2007). However, dogs are attributed to a disproportionate number of the chick mortalities in unprotected mainland populations (Loewenthal, 2007). They account for 41% of the chick mortalities, which is concerning because the majority (71%) of the oystercatcher population is found in unprotected stretches of the mainland coast (Loewenthal, 2007). The difference in breeding success between protected and unprotected mainland populations is attributed to chick mortalities rather than egg losses (Loewenthal, 2007). This means that dogs are one of the main reasons for the difference in breeding success between protected and unprotected mainland populations (Loewenthal, 2007). Loewenthal (2007:85) states that "fledging success is lowest in unprotected sites, where depredation of small chicks by dogs is the primary cause of failure, suggesting that mortality levels caused by uncontrolled dogs are more severe than those resulting from natural predators".

Human disturbance is also likely contributing in other ways to the egg losses and chick mortalities in unprotected mainland populations (Loewenthal, 2007). Clutch abandonment and drowning are markedly higher in unprotected mainland populations (Loewenthal, 2007). Clutch abandonment accounts for 23% of the egg losses and drowning accounts for 24% of the chick mortalities (Loewenthal, 2007). In regards to clutch abandonment, it is suggested that parents in unprotected mainland populations may be more stressed due to a higher degree of exposure to human disturbance, which is causing them to abandon their unhatched egg(s) in favour of rearing their chick(s) that have already hatched (Loewenthal, 2007). The higher prevalence of drowning is likely attributed to chicks responding to their parents' distress calls and hiding underneath or in-between rocks when recreationists are nearby (Loewenthal, 2007). Oystercatchers are now unlikely to become extinct at the global or regional level, but certain populations may be vulnerable at the local level (Loewenthal, 2007). For example, some unprotected mainland populations display negative intrinsic population growth rates (Loewenthal, 2007). Oystercatchers are a long-lived species, with individuals being capable of living between 20-30 years, and sometimes even longer (Loewenthal, 2007). Their longevity can mask the population-level impact of unsustainable reproductive rates that are either caused or exacerbated by human disturbance (Loewenthal, 2007). Their high-level of adult site fidelity may also leave them susceptible to poor breeding success rates each year or even local extinctions in the worst-case scenario if measures are not taken to reduce the type and/or severity of human disturbance that is occurring in some locations. One way to mitigate human disturbance is to determine the flight initiation distances of a species in response to the stimuli that it frequently encounters and/or the stimuli that pose a significant threat, such as dogs in the case of oystercatchers. This information can be used by reserve managers and other conservation bodies to inform strategies for minimising the impacts of recreational activities on a particular species or community (Guay et al., 2016).

2.3. Flight initiation distance

2.3.1. Overview and application

Flight initiation distance or flush distance is an antipredator behaviour and a proxy of fearfulness (Stankowich & Blumstein, 2005) that concerns the distance at which an animal initiates movement away from an approaching predator or a potential threat (Blumstein, 2003). Scientific databases are replete with literature on avian flight initiation distances (Livezey, Fernández-Juricic & Blumstein, 2016). However, flight initiation distances have also been determined for species from a variety of taxa, including lizards (Cooper & Whiting, 2007), wolves (Karlsson, Eriksson & Liberg, 2007), kangaroos (Wolf & Croft, 2010), squirrels (Engelhardt & Weladji, 2011), seals (Andersen et al., 2012), horses (Cabrera et al., 2017), monkeys (Mikula et al., 2018), dragonflies (Bell et al., 2019) and bears (Ordiz et al., 2019). Flight initiation distance research is important for conservation efforts because it can be used by reserve managers to inform decision making when determining buffer zones or set-back distances to reduce the impact of human disturbance on wildlife (Rodgers & Smith, 1995; Blumstein et al., 2003; Ikuta & Blumstein, 2003; Geist et al., 2005; Glover et al., 2011; Weston et al., 2012a; Schlacher et al., 2013; Jorgensen, Dinan & Brown, 2016; Braimoh et al., 2017). Although, it is important to note that flight initiation distance data has many different applications (see Guay et al., 2016). Evidence shows that spatial restrictions like buffer zones can reduce the impact of human disturbance on wildlife, such as birds (Ikuta & Blumstein, 2003; Lafferty, Goodman & Sandoval, 2006; Weston et al., 2012b). However, reserve managers and other conservation bodies usually lack the flight data that is required to inform the establishment of buffer zones (Glover et al., 2011; Weston et al., 2012a; Guay et al., 2016). Buffer zones that are established without the backing of species and context-specific data would likely be less effective because they may be too small to fulfil their intended purpose. Expert opinion has been shown to be fairly reliable in terms of predicting flight initiation distances, but it should not be used as a replacement for the empirical measures of human disturbance (Whitfield, Ruddock & Bullman, 2008).

2.3.2. Factors affecting flight initiation distances

Flight initiation distance is a species-specific trait that can be influenced by context-specific characteristics (Blumstein et al., 2003). Researchers have identified a number of species-specific and context-specific factors that influence avian flight initiation distances. Some species-specific factors found to affect flight initiation distance include: age, sex, body size, body condition, stress responsiveness, stage of life cycle, basal metabolic rate, camouflage, and relative eye and brain size (Holmes et al., 1993; Fernández-Juricic, Jimenez & Lucas, 2002; Beale & Monaghan, 2004; Blumstein, 2006; Møller, 2009; Glover et al., 2011; Seltmann et al., 2012; Guay et al., 2013; Møller, 2014; Møller & Erritzøe, 2014; Symonds et al., 2014; van de Voorde, Witteveen & Brown, 2015; Møller, Liang & Samia, 2019; Reynolds et al., 2020). Some context-specific factors found to affect flight initiation distance include: stimulus type, stimulus starting distance, stimulus approach direction, stimulus approach speed, stimulus group size, flock size, researcher clothing colour, degree of exposure to humans, distance to refuge, vegetation characteristics, weather conditions, time of day, and season (Burger & Gochfeld, 1981; Burger et al., 1989; Holmes et al., 1993; Rodgers & Smith, 1995; Fernández-Juricic, Jimenez & Lucas, 2002; Blumstein, 2003; Gould et al., 2004; Geist et al., 2005; Burger et al., 2010; Glover et al., 2011; Guay et al., 2013; Jorgensen, Dinan & Brown, 2016; Braimoh et al., 2017; Morelli et al., 2019; García-Arroyo & MacGregor-Fors, 2020; Hall et al., 2020; Reynolds et al., 2020; Zhou & Liang, 2020; Hammer et al., 2022).

It is well-established that many factors can influence flight initiation distances. However, some factors consistently influence flight initiation distances (Blumstein, 2003), whereas others seldom play a role, or they only play a role in very particular circumstances (Guay et al., 2013). There is a strong positive correlation between stimulus starting distance and flight initiation distance for most species, which indicates that most birds will take flight earlier so that they can escape while the costs to fitness are much lower (Blumstein, 2003). Body size is also one of the main determinants of flight initiation distance (Blumstein, 2006). Large-bodied species tend to have longer flight initiation distances than small-bodied species (Blumstein, 2006). It is suggested that large-bodied species have longer flight initiation distances because they are less agile, and thus require more time and space to escape (Fernández-Juricic, Jimenez & Lucas, 2002). Large-bodied species may also be flightier because they are easier to see, and consequently are more vulnerable to hunting (Gnanapragasam et al., 2021) and persecution (Cooke, 1980). Relative eye and brain size (cerebellum size) also offers an explanation as to why large-bodied species tend to be flightier.

For example, relative eye size positively correlates with flight initiation distance, which is possibly because species or individuals with larger eyes are able to detect predators earlier (Møller & Erritzøe, 2014). It is also suggested that small-bodied species have shorter flight initiation distances because they have greater energy requirements (Bennett & Harvey, 1987). Frequently taking flight can be detrimental to fitness because it wastes energy and time that could be spent foraging (DeRose-Wilson et al., 2018), which is why small-bodied species may minimise energy expenditure by allowing closer approaches (Holmes et al., 1993).

Research has shown that flock size can positively or negatively correlate with flight initiation distance (Morelli et al., 2019). A positive effect refers to situations in which birds have longer flight initiation distances due to increased vigilance, whereas a negative effect refers to situations in which birds have shorter flight initiation distances due to risk dilution (Morelli et al., 2019). Hence, birds will react in accordance with the most alert, sensitive or risk-averse individual in a flock (Weston et al., 2012a). However, flock composition can also affect when birds take flight. For example, species that are typically flightier can have shorter flight initiation distances when in mixed-species flocks compared to single-species flocks (Linley, Guay & Weston, 2019). Three different models have been proposed to explain why flight initiation distances may differ between single and mixed-species flocks, namely the 'sentinel model', 'recalcitrant model', and 'consensus model' (Linley, Guay & Weston, 2019). The sentinel model holds that the most sensitive species in a mixed-species flock will be the first to initiate an escape, which causes a 'social contagion' to spread throughout the flock, and thus the less sensitive species take flight earlier (Linley, Guay & Weston, 2019). In comparison, the recalcitrant model holds that the less sensitive species in a mixed-species flock suppress the response of the more sensitive species through social contagion, whereas the 'middle-of-the-road' consensus model holds that the decision to escape is negotiated between the more tolerant and sensitive species in the flock (Linley, Guay & Weston, 2019).

Tolerance or sensitivity to a potential threat can be explained by life history traits (Blumstein, 2006), such as whether a bird is breeding or non-breeding (Weston et al., 2018). Certain species may be more sensitive and take flight earlier when they are incubating, which is done to avoid revealing the location of their clutches to predators (Weston et al., 2018). Alternatively, sensitivity may decrease during the incubation phase as the eggs get older, which may be because of habituation, due to an increase in parental investment, or both (Jorgensen, Dinan & Brown, 2016). However, egg age has no effect on the flight initiation distances of some species (van de Voorde, Witteveen & Brown, 2015), and some species have comparable flight initiation distances between breeding and non-breeding seasons

(Weston et al., 2018). Approach direction also affects flight initiation distances. Birds generally take flight earlier in response to direct approaches in comparison to tangential approaches (Burger & Gochfeld, 1981; Burger et al., 2010), but this is not always the case (Fernández-Juricic et al., 2005). Clothing colour can also affect flight initiation distances. Zhou and Liang (2020) found that clothing colour only had a significant effect on flight initiation distances in rural contexts, with their focal species having longer flight initiation distances in response to red clothing in comparison to black, white and dark green clothing. This may be because colours such as red are more conspicuous (Gutzwiller & Marcum, 1993) or it could be attributed to the fact that some species have been shown to be less responsive to colours that match their plumage (Gould et al., 2004; Lin, Cheng & Chen, 2013). Regardless, it is advised that researchers should wear clothing that is not colourful or bright during approaches because it may generate inaccurate assessments of behaviour, habitat use and abundance (Gutzwiller & Marcum, 1993; Lin, Cheng & Chen, 2013).

The effect of stimulus type on flight initiation distance has been frequently investigated, which is mainly due to its importance to conservation efforts. Numerous studies have determined flight initiation distances in response to walkers (Cooke, 1980; Blumstein, 2003; Ikuta & Blumstein, 2003; Geist et al., 2005; Baudains, 2006; Møller, 2009; Smith-Castro & Rodewald, 2010; Seltmann et al., 2012; Møller & Erritzøe, 2014; Braimoh et al., 2017; Hall et al., 2020; Zhou & Liang, 2020). However, birds are exposed to a wide variety of anthropogenic stimuli on a daily basis, which is why researchers have determined flight initiation distances and other proxies of fearfulness such as alert distance, return times, and vigilance in response to non-motorised watercraft (kayaks and canoes), motorised watercraft, aircraft, vehicles, cyclists, runners, dog walkers and horse riders (Brown, 1990; Holmes et al., 1993; Rodgers & Smith 1995; Lafferty, 2001a; Lord et al., 2001; Randler, 2006; Weston & Elgar, 2007; Glover et al., 2011; Mayo, Paton & August, 2015; Cavalli et al., 2016; Faillace & Smith, 2016; Jorgensen, Dinan & Brown, 2016; de Blocq van Scheltinga, 2017; Bernard et al., 2018; Guinness et al., 2019; Mayer, Natusch & Frank, 2019; McBlain, Jones & Shannon, 2020). Studies investigating the effect of different stimuli on flight initiation distance usually find that birds take flight earlier in response to stimuli other than walkers (Glover et al., 2011), but this is not always the case (Holmes et al., 1993; Rodgers & Smith, 1995).

Birds usually perceive dogs as a greater threat than the other stimuli that they encounter (Lafferty, 2001a; Lord et al., 2001; Banks & Bryant, 2007; Weston & Elgar, 2007; Glover et al., 2011; Cavalli et al., 2016; Jorgensen, Dinan & Brown, 2016; Gómez-Serrano, 2021). Jorgensen, Dinan and Brown (2016) found that dogs and walkers with dogs caused Piping

Plovers (*C. melodus*) to flush from their nests far more frequently than walkers without dogs. Furthermore, the Piping Plovers also spent significantly more time off their nests after encounters with the dogs and the walkers with dogs (Jorgensen, Dinan & Brown, 2016). Lafferty (2001a) found that Western Snowy Plovers (*Charadrius alexandrinus nivosus*) were more likely to take flight in response to dogs, horses, and crows than people without dogs. Glover et al. (2011) found that the Pied Oystercatcher (*Haematopus longirostris*), Masked Lapwing (*Vanellus miles*), and Latham's Snipe (*Gallinago harwickii*) had longer flight initiation distances in response to joggers and leashed dogs than walkers without dogs. Lord et al. (2001) found that stimulus speed had no effect on northern New Zealand Dotterel (*Charadrius obscurus aquilonius*) flight initiation distances. The jogging and walking approaches elicited similar flight responses, whereas the leashed dog walking approach caused the dotterels to take flight much earlier and spend more time off their nests (Lord et al., 2001). In addition to longer flight initiation distances, dogs can also cause birds to become more vigilant and aggressive. For example, McBlain, Jones and Shannon (2020) found that Eurasian Oystercatchers (*H. ostralegus*) were more vigilant in response to dog walkers than watercraft. Cavalli et al. (2016) found that male Burrowing Owls (*Athene cunicularia*) in urban environments had longer flight initiation distances and displayed more aggressive behaviours in response to a walker with a leashed dog than a walker without a dog.

The behaviour of dogs rather than the dogs themselves may influence the decision to stay or flush from an area, or to flush earlier or later from an area (Weston & Elgar, 2007). Weston and Elgar (2007) found that Hooded Plovers (*Thinornis rubricollis*) were equally likely to flush from their nests in response to walkers with leashed dogs and walkers without dogs. However, the Hooded Plovers were almost twice as likely to flush from their nests in response to walkers with unleashed dogs (Weston & Elgar, 2007). This may be because unleashed dogs move in an unpredictable manner, akin to a natural predator (Weston & Stankowich, 2014). Unleashed dogs are free to roam in any direction, and they are also able to modulate their own speeds, which may make them appear more threatening (Weston & Stankowich, 2014). Gómez-Serrano (2021) found that Kentish Plovers (*Charadrius alexandrinus*) were more likely to flush from their nests in response to dogs and walkers with dogs than walkers without dogs. However, the Kentish Plovers were more likely to flush from their nests in response to dogs that were not accompanied by their owners, i.e. the unleashed dogs that were free to roam. Guinness et al. (2019) found that none of the shorebirds in their study changed their flight initiation distances in response to a walker with one or two leashed dogs. However, the authors allude to the importance of dog behaviour in their recommendation for future research by suggesting that unleashed and/or barking dogs may elicit greater responses from shorebirds.

2.4. Methodology

2.4.1. Study sites

2.4.1.1. Blaauwberg Nature Reserve

The Blaauwberg Nature Reserve (33°46'39.57"S, 18°26'56.50"E) was declared a local and provincial nature reserve in 2007, and it is located *ca.* 25 km from the City of Cape Town (Küyler, 2011). The reserve forms part of the southern area of the larger Cape West Coast Biosphere Reserve, and it currently occupies 1445 ha of an envisaged 2000 ha (Küyler, 2011). The reserve is comprised of an inland and a coastal component (*ca*. 7-8 km) (Küyler, 2011). However, this research was only concerned with the coastal component, more specifically the area between Kreeftebaai and the Melkbos Cultural Centre because this stretch is home to the majority of the oystercatcher population, and all of the nesting hotspots (Fig. 12) (Retief, 2020). The reserve has the largest oystercatcher population of the three study sites. Oystercatchers returned to the reserve after concrete blockades were erected to inhibit off-road driving (Küyler, 2011). However, some people still illegally drive on the reserve beaches (pers. obs.), and the oystercatcher population is still relatively small and vulnerable to human disturbance (Retief, 2020). The 2018/19 and 2019/20 oystercatcher population surveys showed that there were between 20-72 birds per count (Küyler, 2019; Retief, 2020). The number of breeding pairs is far lower than the total number of birds, with a maximum of 11 recorded during one count in 2018/19, and 18 recorded during one count in 2019/20 (Küyler, 2019; Retief, 2020). The 2019/20 survey also showed that some clutches were possibly damaged by people and their dogs (Retief, 2020), which are almost always unleashed (pers. obs.).

2.4.1.2. Noordhoek Beach

Noordhoek Beach (Fig. 13) (34°07'29.07"S, 18°20'56.21"E) is situated between Hout Bay and Kommetjie. The area surrounding the beach has undergone extensive development over the last few decades, which has likely resulted in increased beach usage (Loewenthal, 2007). Oystercatchers are exposed to a wide variety of anthropogenic stimuli, including horse riders and dog walkers. The majority of the oystercatcher population appears to congregate in the southern section of the beach, possibly because it is closer to the only rocky intertidal zone. This area is also heavily trafficked because it is the start of the horse-riding route, and it is the interface between Noordhoek and Kommetjie, which is a popular beach (Baudains, 2006). Noordhoek Beach is a very dynamic system that is associated with strong winds and seasonal flooding over vast areas (Heinecken, 1985).

Flooding appears to occur more frequently in the northern section of the beach, but it also occurs in the southern section, which is fed by the heavily polluted Wildevoëlvlei (Day et al., 2020), which is situated in Imhoff's Gift (Heinecken, 1985). These abiotic factors are likely the main reason for the relatively small population and low breeding success rate (Pond, 1999) because nest flooding, sand burials, and drowning are among the most common known causes of egg loss and chick mortality in oystercatcher populations (Paijmans, 2014), particularly unprotected mainland populations (Loewenthal, 2007). However, it is suggested that human disturbance (housing development and recreational activities) forced the oystercatcher population out of the ideal breeding ground immediately adjacent to the rocky intertidal zone, and into these relatively less disturbed, wind-blown, and flood-prone areas (Pond, 1999; Loewenthal, 2007). The Noordhoek population is known as a 'leapfrog' population because they have a disjunct breeding and feeding ground (Loewenthal, 2007). Parents fly hundreds of meters to provision for their chicks, which may affect breeding success rates due to increased energy expenditure and decreased vigilance (Loewenthal, 2007).

Unleashed dogs have been shown to harass the oystercatcher population and prey upon their chicks (Paijmans, 2016), whereas horse-riders flush oystercatchers from their nests and may also trample their eggs and/or chicks (Pond, 1999). Horse riders also frequently venture above the high-water mark between Klein Slangkop and the Kakapo shipwreck (pers. obs.). This large section of the beach has been proclaimed a restricted area in order to reduce human disturbance, and consequently improve breeding success rates (Paijmans, 2016). Furthermore, additional conservation measures require people to have a permit to walk their leashed dogs on the beach, but people usually do not comply with the leashing regulation (Paijmans, 2016). Non-compliance is likely due to a combination of factors, such as the lack of a fence around the 'protected' breeding ground, the lack of law enforcement to issue fines, poor visibility of signage, and people not knowing about the plight of oystercatchers on the beach (Williams et al., 2009; Bowes et al., 2015; Paijmans, 2016).

2.4.1.3. Scarborough Beach

Scarborough Beach (Fig. 14) (34°11'56.69"S, 18°22'18.73"E) is located south of Noordhoek. It is the smallest and most ‘remote’ of the three study sites. However, it is frequented by a wide variety of recreationists, including resident dog walkers who rarely leash their dogs (pers. obs.). The oystercatcher population is also the smallest of the three study sites, and relatively few birds breed each year (Scarborough Environmental Group [SEG], 2021 unpubl. data). However, the oystercatchers are fairly well protected on the beach, which is due to residents from the SEG who erect makeshift buffer zones (rope fences or “symbolic fences”) around oystercatcher territories during the breeding season. These fences may prevent some recreationists from mistakenly entering their territories, but they do not prevent incubating oystercatchers from flushing off their nests because most of them are much smaller (pers. obs.) than the flight initiation distances that were recorded for incubating oystercatchers along the south coast in response to walkers (30-60 m) (van de Voorde, Witteveen & Brown, 2015). Furthermore, the fences do not prevent unleashed dogs from entering the breeding territories, nor do they stop recreationists from entering to take a look around or the residents who walk through the territories to get onto shortcut paths that lead home (pers. obs.).

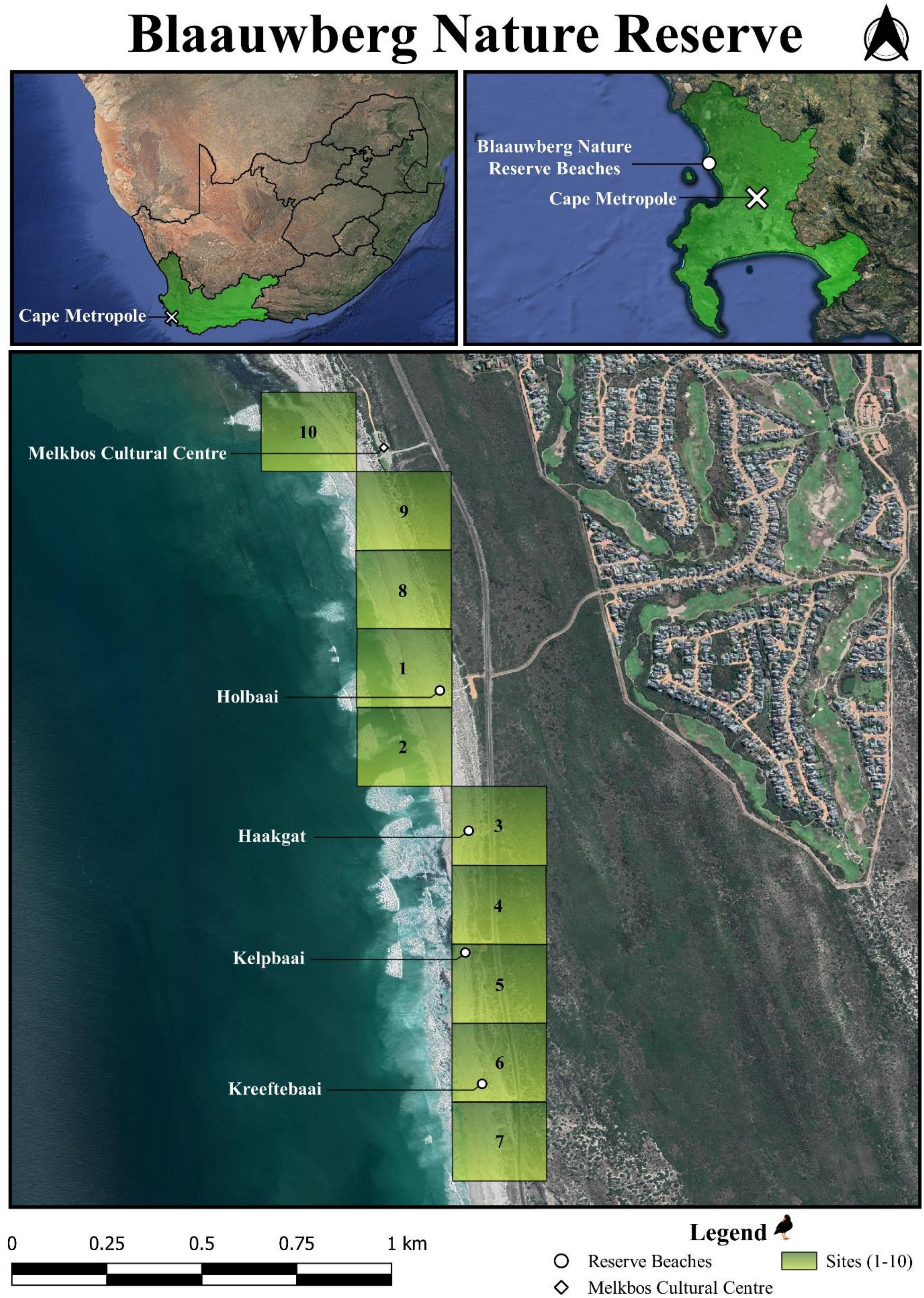

Fig. 12. Map of the sampling sites (250 x 250 m) within a section of the coastal component of the Blaauwberg Nature Reserve (QGIS, 2022).

Fig. 13. Map of the sampling sites (250 x 250 m) within the southern section of Noordhoek (QGIS, 2022).

Fig. 14. Map of the sampling sites (250 x 250 m) in Scarborough (QGIS, 2022).

2.4.2. Sampling

2.4.2.1. Study design

A randomised block study design was adopted in this research. Each study site was divided into a number of 250 x 250 m sampling sites or 'blocks' with GEPath V1.4.6. (Sgrillo, 2013). This was done in order to minimise pseudoreplication for the non-incubating oystercatchers (adult birds that were not breeding during sampling). Despite this precautionary measure, Runyan and Blumstein (2004) found that a moderate degree of pseudoreplication did not significantly affect the results of most of their analyses. Each 250 x 250 m block was given a number, and they exported to Google Maps, which was used as a guide during fieldwork. In comparison to the non-incubating oystercatchers, each pair of incubating oystercatchers (adult birds that were breeding during sampling) was numbered and treated as a 'block'. This paired design allowed the researcher to account for differences in flight initiation distance among the incubating pairs. Implementing a similar paired design was not possible for the non-incubating oystercatchers because they are not tied to a specific place like their incubating counterparts are during the breeding season, and because the same individuals could not be clearly identified due to their identical appearances (see Hockey, 1981).

2.4.2.2. Approach procedure

Incubating and non-incubating oystercatcher flight initiation distances were determined during the 2021/22 breeding season (October-March) in the Blaauwberg Nature Reserve, Noordhoek Beach and Scarborough Beach. Both the incubating and non-incubating oystercatchers were approached with (dog treatment) and without a dog (walking treatment). The same procedure was followed for both treatments, except for the fact that a well-trained, leashed and non-barking basset hound (medium-sized dog) was used in the dog treatment. The same inconspicuous, grey/cream-coloured clothes were worn throughout the fieldwork period in order to control for the effect that clothing colour can have on flight initiation distances (Gutzwiller & Marcum, 1993; Gould et al., 2004; Zhou & Liang, 2020). Firstly, an oystercatcher was identified (focal bird) either by eye or with a pair of binoculars. Secondly, the number of heterospecifics and conspecifics within *ca.* 10 m of the focal oystercatcher was recorded with a Bushnell Prime 1300 rangefinder (Weston et al., 2012a) because flock size can affect flight initiation distances (Morelli et al., 2019). However, the flock size data were not used because the majority of the oystercatchers were alone or had a partner in close proximity (≥ 10 m) (see Hockey, 1985).

Thirdly, the rangefinder was used to record the starting distance, which was kept at *ca*. 100 m for every approach (Blumstein, 2003). Fourthly, the focal oystercatcher was directly approached at a constant speed of *ca*. 1 m/s while maintaining eye contact (Blumstein, 2003). A flight initiation distance was only recorded if the focal oystercatcher ceased its activity and walked, ran or flew away (Blumstein, 2003). An obvious change in direction of movement or gate was used to determine a flight initiation distance if the focal oystercatcher was already moving, but interpretation was rarely necessary because most oystercatchers were stationary (Blumstein, 2003). Once a flight response was issued, the researcher did not approach another oystercatcher on that day that was within *ca*. 100 m of the bird that had been sampled, which was done in order to further minimise the potential for pseudoreplication (Reynolds et al., 2020). Lastly, the time it took for the incubating oystercatchers to resume incubation after issuing a flight response was also recorded (return time) (Baudains, 2006). This was done by immediately starting a stopwatch when the incubating oystercatcher was flushed from the nest, and then retreating back to the approach starting point (*ca*. 100 m). The focal oystercatcher was observed from the starting point through binoculars until it not only returned to the vicinity, but also resumed incubation, i.e. assumed a prone position over the clutch.

2.4.2.3. Ethical considerations

Oystercatchers were only exposed to one treatment per day in order to minimise disturbance, and the incubating pairs were only exposed to each treatment once (two approaches in total). Approaches were only made to oystercatchers that were in a relaxed state (Blumstein, 2003). In other words, the oystercatchers that were not highly vigilant or that had been disturbed by any natural and/or anthropogenic stimuli that were in the vicinity (Blumstein, 2003). Oystercatchers that had been disturbed were either not approached or were only approached *ca*. 10-15 minutes after they had resumed their normal activities (Baudains, 2006), such as foraging, preening and roosting (Blumstein, 2003). No approaches were made if corvids (crows and ravens), seabirds (gulls) or small mammals (mongooses and genets) were seen within *ca*. 100 m of incubating oystercatchers because all of which are known egg predators (Loewenthal, 2007; Paijmans, 2016).

2.4.3. Data analysis

Fifty-seven non-incubating oystercatchers were approached without a dog, 38 non-incubating oystercatchers with a dog, and 11 incubating oystercatchers (pairs) with and without a dog. Firstly, a linear model with all of the aforementioned data was ran in Programme R V4.1.0 (R Core Team, 2022). In this model, "location" referred to the study sites, "stimulus type" referred to the dog and walking treatments, and "incubation status" referred to whether the oystercatchers were classified as incubating or non-incubating. Diagnostic plots were checked to ensure that the assumptions of normality and homoscedasticity were not violated. All of the non-significant interaction effects were removed and then a second model was run. Hence, the interaction effects were not reported in the results if they were non-significant. Figures were created using the 'visreg' package, which is used to visualise regression models (Breheny & Burchett, 2017). The effects of two factors were plotted at a time for ease of interpretation. The visreg package calculates the means and confidence intervals while keeping the third factor fixed at the most common level, i.e. the level with the most data. These can differ slightly from the marginal means presented in the text in the results section, where the 'emmeans' package was used (Russell et al., 2022). Secondly, the researcher was unable to account for the fact that a paired design was used for the incubating oystercatchers in the analysis described above. Therefore, the data for the incubating oystercatchers was also analysed separately in order to account for this design feature. The 'nlme' package (Pinheiro et al., 2021) was used to run two linear mixed-effects models, one for the incubating oystercatcher flight initiation distances and the other for their return times. Location and stimulus type were treated as fixed effects, whereas the incubating pairs were treated as random effects in both models. The same procedure described above for linear model was followed for both of the linear mixed-effects models.

2.5. Results

2.5.1. Incubating and non-incubating oystercatchers

Two hypotheses were tested: (I) oystercatchers will have longer flight initiation distances when approached by a walker with a leashed dog compared to a walker without a dog, and (II) incubating oystercatchers will have longer flight initiation distances than non-incubating oystercatchers. The linear model ($R^2 = 0.54$) showed that stimulus type ($F_{(1,110)} = 48.49$, $p < .001$), location ($F_{(2,110)} = 20.033$, $p < .001$), incubation status ($F_{(1,110)} = 22.722$, $p < .001$), and the interaction between location and incubation status ($F_{(2,110)} = 9.936$, $p < .001$) all had a significant effect on flight initiation distances. Oystercatchers had longer flight initiation distances at each location in response to the dog treatment, which indicates that they perceived the walker with the leashed dog as a greater threat than the walker without the dog (Fig. 15). Flight initiation distances were 14.3 m longer on average in response to the dog treatment, which was significantly greater than the no dog treatment ($t_{(110)} = 6.506$, $p < .001$). Oystercatchers in Noordhoek had the longest flight initiation distances (dog: 67.9 m ± 2.42 SE, 95% C.I. [63.2, 72.7]; no dog: 53.7 m ± 2.27 SE, 95% C.I. [49.2, 58.2]), followed by those in Blaauwberg (dog: 48.3 m ± 2.84 SE, 95% C.I. [42.6, 53.9]; no dog: 34.0 m ± 2.72 SE, 95% C.I. [28.6, 39.4]), and then Scarborough (dog: 47.9 m ± 2.86 SE, 95% C.I. [42.3, 53.6]; no dog: 33.7 m ± 2.88 SE, 95% C.I. [27.9, 39.4]).

Incubating oystercatchers had longer flight initiation distances than the non-incubating oystercatchers in response to both treatments (Fig. 16). Flight initiation distances were 10.5 m longer on average for the incubating oystercatchers (52.8 m ± 2.54 SE, 95% C.I. [47.8, 57.9]) than the non-incubating oystercatchers (42.3 m ± 1.23 SE, 95% C.I. [39.9, 44.8]). However, the difference between the incubating and non-incubating oystercatchers was location dependent (Fig. 17). Incubating oystercatchers (44.8 m ± 4.73 SE, 95% C.I. [35.5, 54.2]) in Blaauwberg had flight initiation distances that were 7.4 m longer on average than the non-incubating oystercatchers (37.5 m ± 1.95 SE, 95% C.I. [33.6, 41.3]), but this difference was non-significant ($t_{(110)} = 1.443$, $p = .152$). Incubating oystercatchers (39.7 m ± 4.73 SE, 95% C.I. [30.3, 49.0]) in Scarborough had flight initiation distances that were 2.2 m shorter on average than the non-incubating oystercatchers (41.9 m ± 2.41 SE, 95% C.I. [37.1, 46.7]), but this difference was also non-significant ($t_{(110)} = -1.305$, $p = .195$). Incubating oystercatchers (74.0 m ± 3.66 SE, 95% C.I. [66.7, 81.3]) in Noordhoek had flight initiation distances that were 26.3 m longer on average than the non-incubating oystercatchers (47.6 m ± 1.95 SE, 95% C.I. [43.7, 51.5]), which was significant ($t_{(110)}$ = 2.891, p = .005).

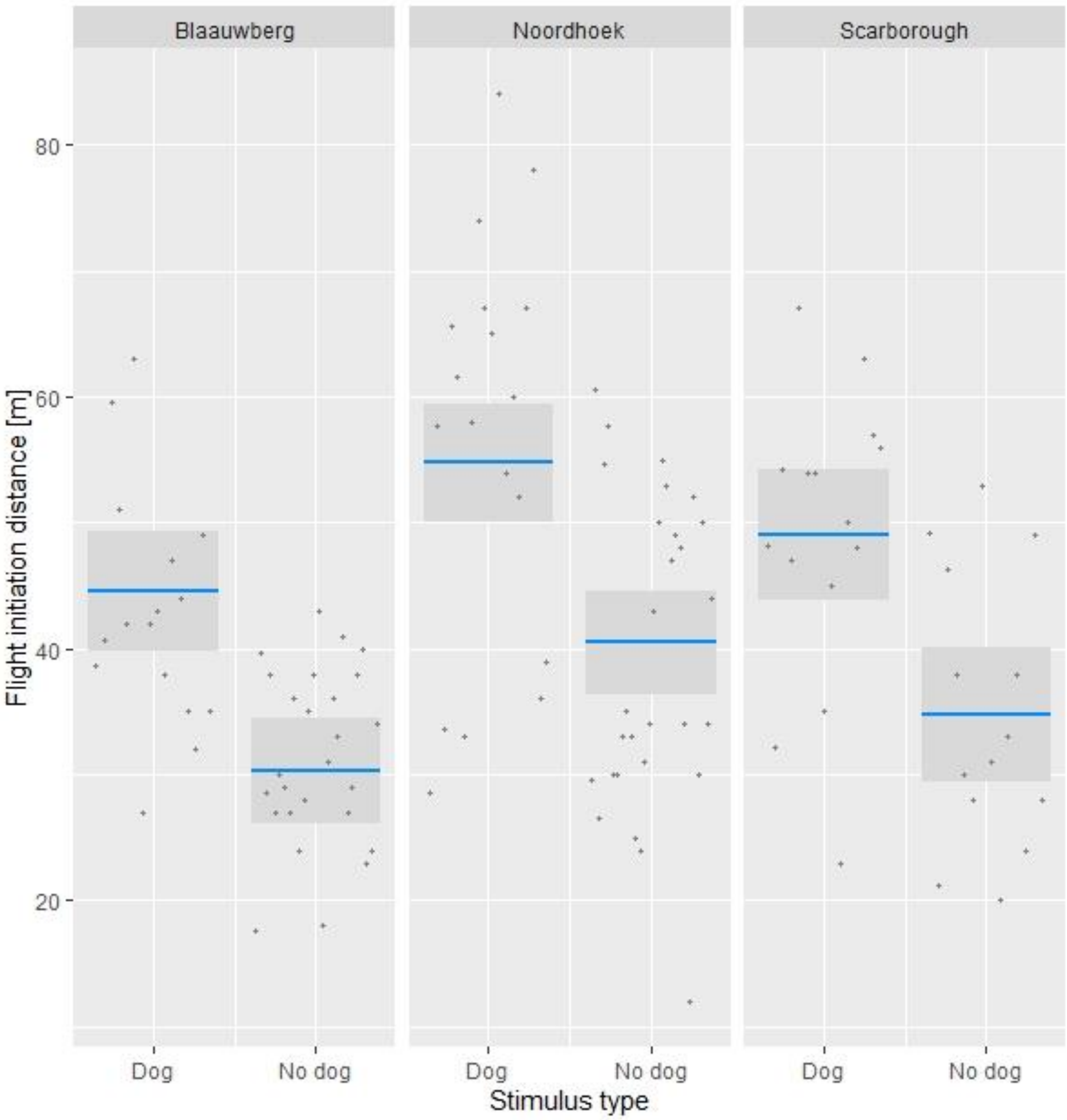

Fig. 15. Oystercatcher flight initiation distances in response to the dog and walking treatments at each beach. The plot shows the flight initiation distances for all oystercatchers (grey dots), fitted means (blue lines), and 95% confidence intervals for each treatment at each location (grey box above and below blue lines). The fitted means are for the non-incubating oystercatchers (which is the most frequently observed or data rich level), and therefore may differ slightly from the marginal means provided in the text.

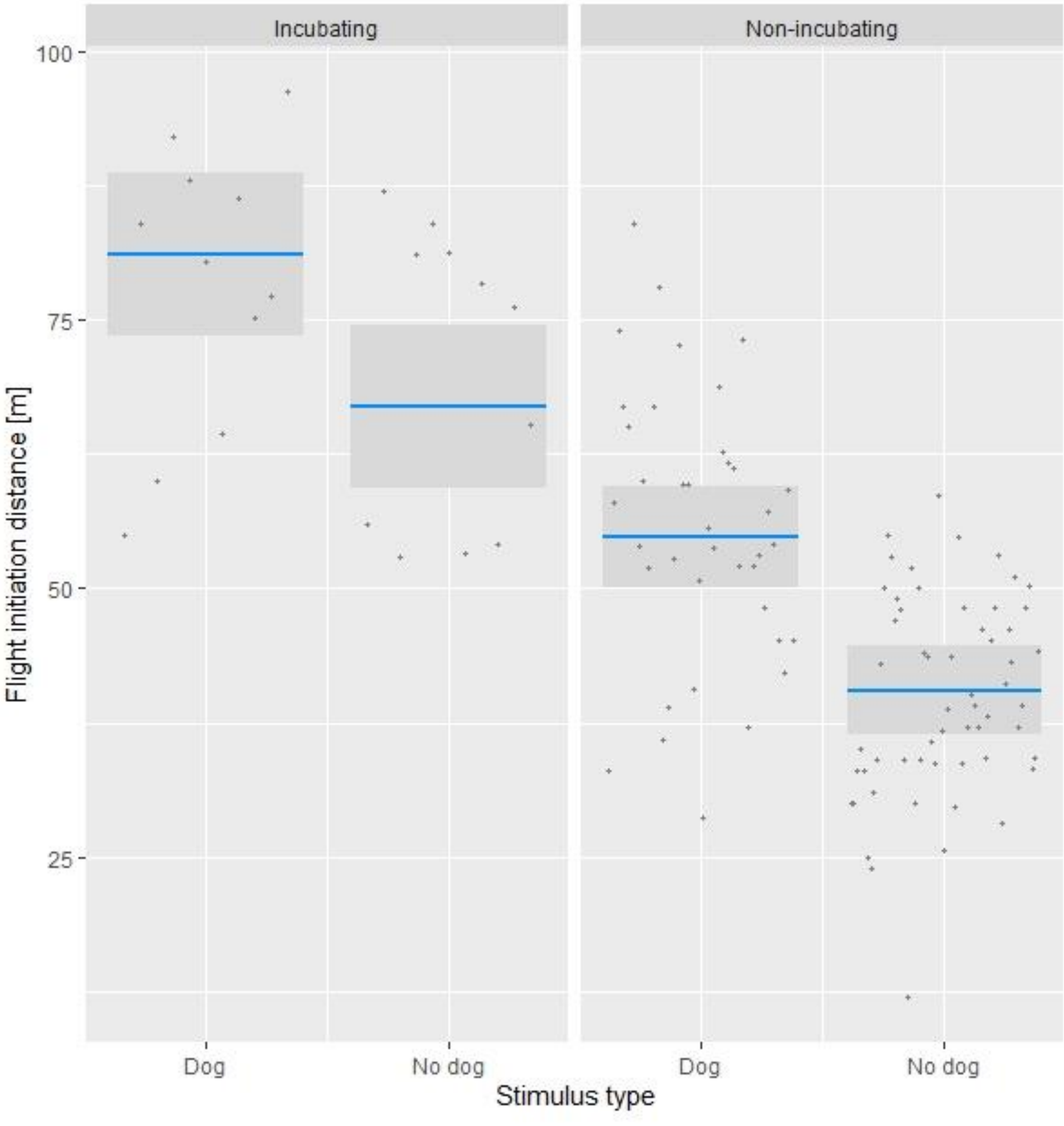

Fig. 16. Incubating and non-incubating oystercatcher flight initiation distances in response to the dog and walking treatments. The plot shows the flight initiation distances (grey dots), fitted means (blue lines), and 95% confidence intervals for the incubating and non-incubating oystercatchers in response to both treatments (grey box above and below blue lines). The fitted means are for Noordhoek (which is the most frequently observed or data rich level), and therefore may differ slightly from the marginal means provided in the text.

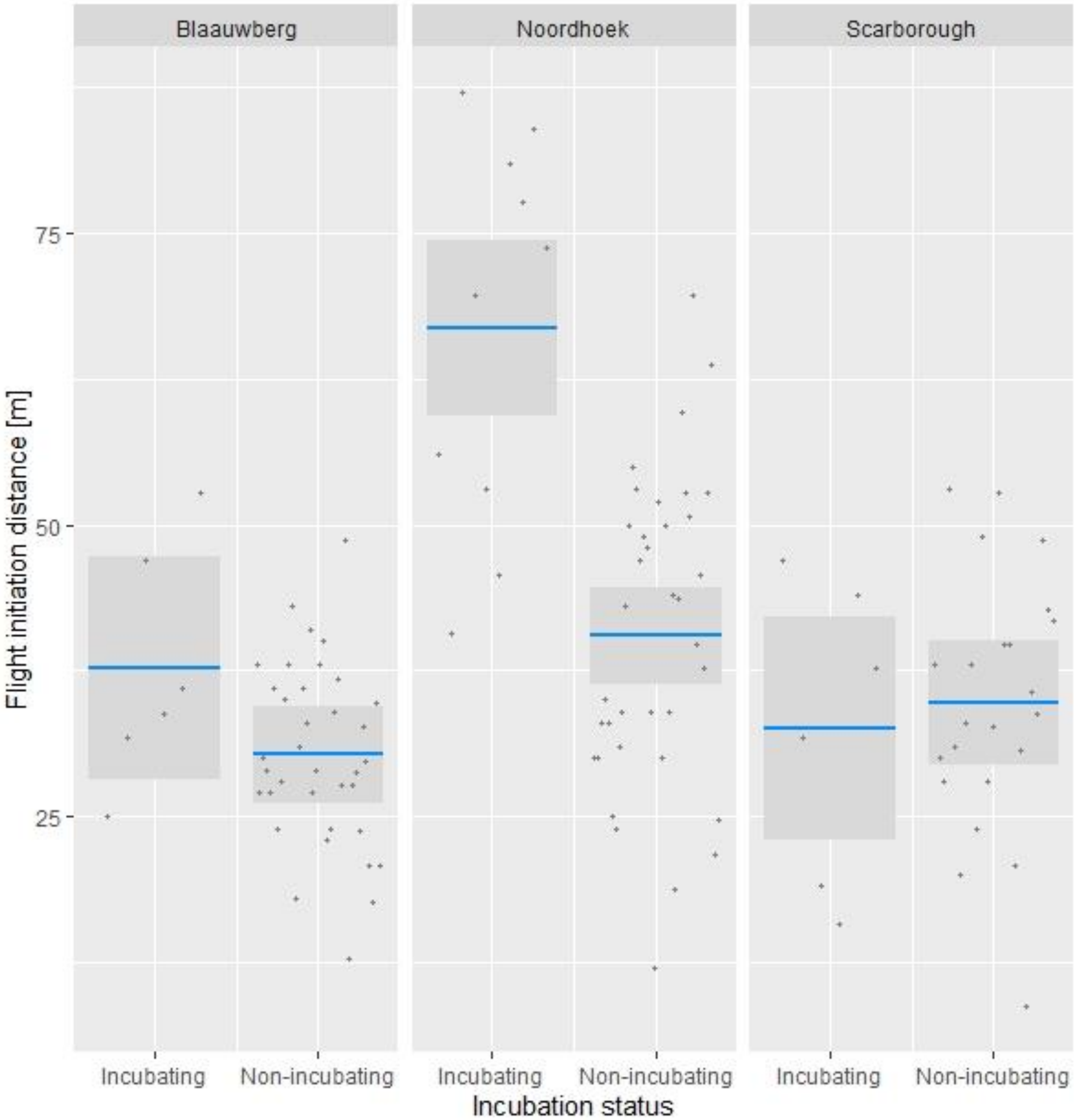

Fig. 17. Incubating and non-incubating oystercatcher flight initiation distances at each beach. The plot shows the flight initiation distances (grey dots), fitted means (blue lines), and 95% confidence intervals for the incubating and non-incubating oystercatchers at each beach (grey box above and below blue lines). The fitted means are for the walking treatment (which is the most frequently observed or data rich level), and therefore may differ slightly from the marginal means provided in the text.

2.5.2. Incubating oystercatchers

2.5.2.1. Flight initiation distances

One hypothesis was tested: incubating oystercatchers will have longer flight initiation distances when approached by a walker with a leashed dog compared to a walker without a dog. The linear mixed-effects model showed that only stimulus type ($F_{(1,10)} = 6.762$, $p = .027$) and location ($F_{(2,8)} = 7.125$, $p = .017$) had a significant effect on flight initiation distances. The incubating oystercatchers had longer flight initiation distances at each location in response to the dog treatment, which indicates that they perceived the walker with the leashed dog as a greater threat than the walker without the dog. Flight initiation distances were 8.1 m longer on average when the incubating oystercatchers were approached by the walker with the leashed dog, which was significantly greater than the no dog treatment ($t_{(10)} = 2.6$, $p = .027$). Flight initiation distances differed significantly between locations. However, this was due to the longer flight initiation distances in Noordhoek because flight initiation distances were very similar between Scarborough and Blaauwberg. For example, the incubating oystercatchers in Noordhoek (78.0 m ± 6.45 SE, 95% C.I. [63.2, 92.9]) had flight initiation distances that were 29.17 m longer on average than those in Blaauwberg (48.9 m ± 8.23 SE, 95% C.I. [30.6, 67.2]) in response to the dog treatment, which was a significant difference ($t_{(8)} = 2.855$, $p = .021$). Whereas, incubating oystercatchers in Scarborough (43.7 m ± 8.23 SE, 95% C.I. [24.7, 62.7]) had flight initiation distances that were 5.17 m shorter on average than those in Blaauwberg in response to the dog treatment, but this was non-significant ($t_{(8)} = -.452$, $p = .663$).

2.5.2.2. Return times

One hypothesis was tested: the incubating oystercatchers will spend more time off their nests after being approached by the walker with a leashed dog compared to the walker without a dog. The linear mixed-effects model showed that stimulus type had a significant effect on return times ($F_{(1,10)} = 6.911$, $p = .025$), but location did not ($F_{(2,8)} = 2.712$, $p = .126$). Incubating oystercatchers spent more time off of their nests in response to the dog treatment, which indicates that they perceived the walker with the leashed dog as a greater threat than the walker without the dog. Return times were 29.43 seconds longer on average when the incubating oystercatchers were approached by the walker with the leashed dog, which was significantly greater than the no dog treatment ($t_{(10)} = 2.629$, $p = .025$). Incubating oystercatchers in Blaauwberg spent the most time off their nests (dog: 123.1 sec ± 16.4 SE, 95% C.I. [86.55, 159.7]; no dog: 93.7 sec ± 16.4 SE, 95% C.I. [57.12, 130.2]), followed by those in Noordhoek (dog: 111.6 sec ± 13.2 SE, 95% C.I. [81.14, 142.0]; no dog: 82.1 sec ± 13.2 SE, 95% C.I. [51.71, 112.6]), and then Scarborough (dog: 75.2 sec ± 16.4 SE, 95% C.I. [37.33, 113.0]; no dog: 45.7 sec ± 16.4 SE, 95% C.I. [7.89, 83.6]). A Pearson's correlation analysis was also conducted to examine the relationship between flight initiation distance and return time for the incubating oystercatchers. The analysis revealed a weak positive correlation (r = .302), but this was non-significant ($t_{(20)}$ = 1.415, p = .173, 95% C.I. [-0.137, 0.642]).

2.5.3. Pair flight initiation distance map

A map was created with QGIS V3.22.2. to show the incubating oystercatcher flight initiation distances in response to the dog treatment (Fig. 18). The map also highlights the difference in beach morphology, which likely affects flight initiation distance (see Discussion).

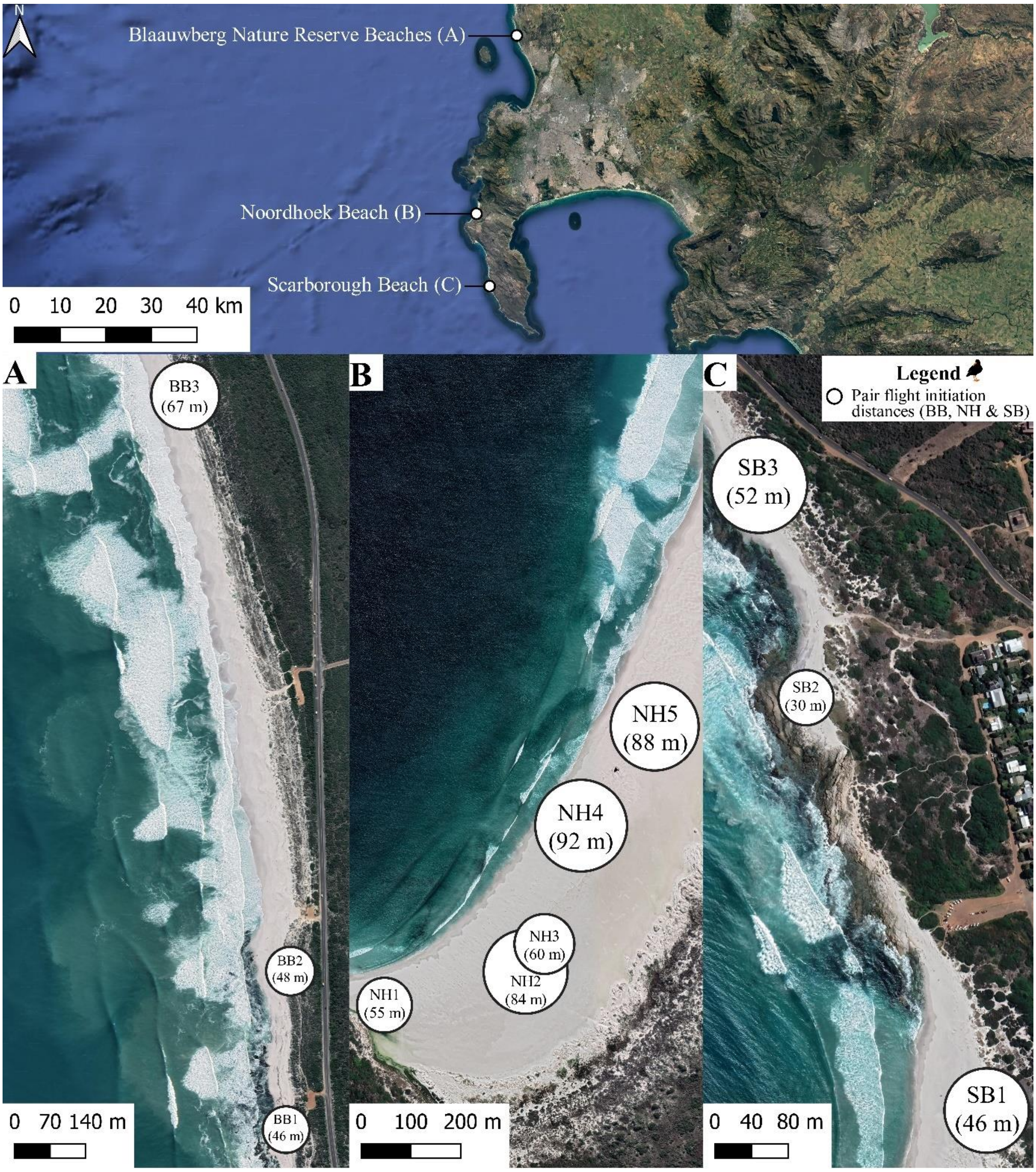

Fig. 18. A map showing the location and flight initiation distances (dog treatment) of the incubating pairs (N = 11) in the Blaauwberg Nature Reserve (BB1, 2 & 3), Noordhoek Beach (NH1, 2, 3, 4 & 5) and Scarborough Beach (SB1, 2 & 3). The pairs in Noordhoek (B) nested in the middle of this comparatively wide beach, far from protective cover near the dune belt, whereas the pairs in Blaauwberg (A) and Scarborough (C) all nested within or in close proximity to protective cover.

2.6. Discussion

It is well-established that human disturbance poses a considerable threat to birds, including seemingly benign nature-based recreational activities (Steven, Pickering & Castley, 2011). Oystercatchers are particularly vulnerable to human disturbance (Summers & Cooper, 1977). Dogs are a prominent cause of egg and chick loss, which contributes to the lower breeding success rates that are evident in mainland oystercatcher populations (Loewenthal, 2007). Flight initiation distance research is valuable to conservation because it can be used to develop buffer zones to protect wildlife from human disturbance (Rodgers & Smith, 1995; Blumstein et al., 2003; Ikuta & Blumstein, 2003; Geist et al., 2005; Glover et al., 2011). Until now, no research has been conducted on oystercatcher flight initiation distances in response to dog walkers (van de Voorde, Witteveen & Brown, 2015; Reynolds et al., 2020). Therefore, this research determined incubating and non-incubating oystercatcher flight initiation distances in response to a walker with and without a leashed dog at three locations. The two central hypotheses tested were that (I) oystercatchers would have longer flight initiation distances in response to the dog treatment, and (II) incubating oystercatchers would longer flight initiation distances than the non-incubating oystercatchers.

Oystercatchers had significantly longer flight initiation distances in response to the walker with the leashed dog, which supports the finding that birds usually perceive dogs as a greater threat (Lafferty, 2001a; Lord et al., 2001; Glover et al., 2011; Cavalli et al., 2016; Faillace & Smith, 2016; Jorgensen, Dinan & Brown, 2016; McBlain, Jones & Shannon, 2020). However, there were differences between the three study sites, with the oystercatchers in Noordhoek having significantly longer flight initiation distances than the oystercatchers in Scarborough and Blaauwberg. There are a few possible explanations for this finding. Oystercatchers in Noordhoek may be less habituated to human disturbance (Baudains, 2006). Noordhoek is a very wide beach, especially in comparison to Scarborough and Blaauwberg. The sampling area between the dunes and shoreline is well over 300 m wide, and most people tend to stick to the shoreline because Noordhoek is known for violent crime near the dunes (Palm, 2018; Smith, 2018; Bezuidenhout, 2022). In comparison, Scarborough and Blaauwberg are much narrower, which means that human-oystercatcher contact is largely unavoidable for the oystercatchers, and consequently they may be more habituated to human disturbance. Baudains (2006) found that the incubating White-fronted Plovers (*C. marginatus*) in a heavily trafficked location issued less intense behavioural responses to a walking stimulus than those in a relatively undisturbed reserve, which suggests that they habituated to human disturbance.

A meta-analysis found that birds, lizards and mammals become more tolerant to human disturbance as their exposure to anthropogenic stimuli increases (Samia et al., 2015). Further research would need to be conducted to determine if the oystercatchers in Noordhoek experience lower levels of disturbance than those in Scarborough and Blaauwberg (see Baudains, 2006).

Oystercatchers in Noordhoek may also have longer flight initiation distances because they may have more time to evaluate threats than the birds in Scarborough and Blaauwberg. The oystercatchers in Noordhoek likely saw the researcher from further away due to the wide, flat morphology of the beach. The researcher was also usually the only stimulus that they had to monitor because most of the oystercatchers were approached above the high-water mark where relatively few people ventured, other than the occasional dog walker or horse rider. Thus, it is possible that the oystercatchers detected the researcher well before the approaches began, which would have given them more time to 'dynamically' assess the threat, and escape while the costs to fitness were still low (Blumstein, 2003). Mayer, Natusch and Frank (2019) found that their ten focal waterbird species usually had longer flight initiation distances on lakes (than rivers) in response to a boat approach. The waterbirds that were approached on lakes were significantly further from the shore, and they were also approached from a significantly greater distance (Mayer, Natusch & Frank, 2019). The waterbirds on lakes likely took flight much sooner because they detected the boat earlier and had more time to monitor the threat due to the wide, open morphology of the lakes (Mayer, Natusch & Frank, 2019). Blumstein, Samia and Cooper (2016) note that there is a ubiquitous positive correlation between flight initiation distance and alert distance, which is the distance at which an animal first detects a potential threat. The Flush Early and Avoid the Rush (FEAR) hypothesis holds that animals will usually initiate an escape soon after they detect a potential threat in order to minimise the costs associated with continuing to monitor the threat (Samia & Blumstein, 2015). Samia and Blumstein (2015) found that the FEAR hypothesis explained the escape behaviour of 79% of the 78 bird species from 67 families that were included in their study.

Another possible explanation for the longer flight initiation distances in Noordhoek is distance from refuge or protective cover. Dear et al. (2014) determined alert distances for a few terrestrially-foraging waterbirds and found that they became alert significantly earlier when they were further away from water. Oystercatchers are also terrestrial foragers that conduct much of their foraging on rocks where their prey items are abundant and easily accessible (Hockey & Underhill, 1984). Hence, it is possible that the oystercatchers in Noordhoek had longer flight initiation distances because they were further away from the rocky intertidal zone.

Noordhoek differs from Scarborough and Blaauwberg in terms of rocky intertidal zone coverage, with the latter two beaches having a vast network of rocks for the oystercatchers. Almost all of the oystercatchers in Scarborough and Blaauwberg were approached while they were in close proximity to the rocky intertidal zone. In comparison, Noordhoek has one relatively small rocky intertidal zone that appears to experience high levels of human disturbance (Pond, 1999; Loewenthal, 2007) because it is situated at the interface between Noordhoek and Kommetjie, which is a popular and heavily trafficked beach (Baudains, 2006). Thus, the oystercatchers appear to spend much of their time in the flood-prone flats that are located a few hundred meters away from the rocky intertidal zone when they are not foraging. Guay et al. (2013), Lomas et al. (2014), and Braimoh et al. (2017) also report longer flight initiation distances for birds that are further away from protective cover. This lends further credence to the hypothesis that the oystercatchers in Noordhoek may have taken flight earlier because they were further away from refuge (rocks) and protective cover (vegetation).

The incubating oystercatchers had longer flight initiation distances on average than non-incubating oystercatchers in response to both treatments. However, there was only a significant difference between the incubating and non-incubating oystercatchers in Noordhoek. Sensitivity or tolerance to a potential threat can be explained by specific life history traits (Blumstein, 2006). Economic models of escape behaviour indicate that animals must assess the costs and benefits of remaining in an area while a potential threat is approaching (Ydenberg & Dill, 1986). Most flight initiation distance research focusses on non-breeding birds despite it being likely that breeding birds will make different assessments of the costs and benefits of flight (Weston et al., 2018). The Leave Early and Avoid Detection (LEAD) hypothesis offers a possible explanation for the difference between the flight initiation distances of breeding and non-breeding birds (Weston et al., 2018). This hypothesis holds that passive nest defenders will take flight earlier to conceal the location of their clutches (Weston et al., 2018). Oystercatchers are more risk-averse than other local species, such as the Kelp Gull (*L. dominicanus vetula*) (van de Voorde, Witteveen & Brown, 2015). Incubating oystercatchers rely on crypsis (Hockey, 1982) and a repertoire of distraction displays (Baker & Hockey, 1984) to protect their eggs and chicks, whereas Kelp Gulls are known to aggressively mob potential threats, often with the help of nearby conspecific parents (van de Voorde, Witteveen & Brown, 2015). However, it is important to note that not all passive nest defenders take flight earlier (Weston et al., 2018), and that taking flight earlier does not necessarily improve breeding success rates (de Jong, Magnhagen & Thulin, 2013). Van de Voorde, Witteveen and Brown (2015) found that clutch location had a significant effect on oystercatcher reactions to disturbance. It is likely that only the incubating oystercatchers in Noordhoek had significantly longer flight initiation distances because their clutches were located further away from protective cover (see Lomas et al., 2014). All of the clutches in Blaauwberg and Scarborough were located at the base of dunes amongst washed-up kelp or within sparse vegetation, whereas all of the clutches in Noordhoek were located out in the open (Fig. 18).

The incubating oystercatchers also took significantly longer to resume incubation after being exposed to the dog treatment, which supports the findings of the few studies that have determined return times in response to dog walkers, and compared them to other stimuli. For example, Lord et al. (2001) found that incubating northern New Zealand Dotterels (*C. obscurus aquilonius*) took flight significantly earlier and spent more time off their nests in response to a walker with a leashed dog than a runner and a walker without a dog. Birds may perceive dogs as a greater threat because they experience persecution from dogs and/or because dogs are more akin to their natural predators (Weston & Stankowich, 2014). Lord et al. (2001) note that dotterel nests are very well-camouflaged and almost impossible for recreationists to find unless they have training, much like oystercatcher clutches. However, dogs may be more likely to find the nests due to their better sense of smell, which is why the dotterels may lower the probability of depredation by taking flight earlier and spending more time off their nests (Lord et al., 2001). Faillace and Smith (2016) also found that Snowy Plovers (*Charadrius nivosus*) had significantly longer flight initiation distances and nest return times in response to a walker with a leashed dog than a walker without a dog. The effect of longer nest absences on breeding success rates was not determined in this study. Oystercatchers resumed incubation relatively soon after they were disturbed, which suggests that thermal stress is unlikely a major concern (see Adams, Kerley & Watson, 1999). However, the longer nest absences in response to dogs will give predators more time to depredate eggs, which is a known or suggested problem in other oystercatcher populations (Summers & Cooper, 2007; Tjørve & Underhill, 2008). Furthermore, leaving a network of tracks and frequently vocalising may also reveal clutch locations to predators (Pienkowski, 1984; Loewenthal, 2007; Colwell, 2010).

2.7. Conclusion

It was found that the oystercatchers had significantly longer flight initiation distances in response to the dog treatment, which is congruent with the general consensus that birds usually perceive dogs as a greater threat than other anthropogenic stimuli that they encounter. The oystercatchers in Noordhoek had the longest flight initiation distances, which is possibly due to a combination of three factors that are linked to the 'expansive' nature of the beach. Firstly, the oystercatchers may have been less habituated to humans because they usually congregate in areas that are further away from recreationists, who possibly avoid these areas due to fear of violent crime. Secondly, the oystercatchers may have detected the researcher much earlier due to the wide, flat morphology of the beach, which would have given them more time to assess the threat and escape while the costs to fitness were at their lowest. Lastly, the oystercatchers were usually situated further away from protective cover and refuge, which has been shown to positively correlate with alert distance and flight initiation distance. As for the incubating oystercatchers, they only had significantly longer flight initiation distances than their non-incubating conspecifics in Noordhoek, which may be because their clutches were all out in the open, far away from people and protective vegetation cover. The incubating oystercatchers also had longer return times in response to the dog treatment at all three study sites, which further indicated that they perceived dogs as a greater threat.

CHAPTER 3. DETERMINING RECREATIONISTS' KNOWLEDGE OF SHOREBIRDS AND THEIR ATTITUDES TOWARDS HYPOTHETICAL REGULATIONS DESIGNED TO PROTECT SHOREBIRDS: A CASE STUDY OF THE BLAAUWBERG NATURE RESERVE

3.1. Introduction

Urbanisation is occurring rapidly in many countries, particularly those within Asia and Africa where urbanisation rates have historically lagged behind all of the other regions (UN, 2019). While urbanisation is inevitable, it is usually viewed as a positive force because cities are seen as hubs for technological innovation, economic growth and human development (UN, 2019). Urbanisation can also be viewed as a negative force because cities draw heavily on natural resources due to the high consumption lifestyles of urbanites (Oliveira, Vidal & Ferraz, 2019). Cities are also expanding into natural areas at a rate that far exceeds human population growth (Fragkias et al., 2013), which further drives global biodiversity loss (Güneralp et al., 2013). Many rapidly expanding cities are located in coastal areas (UN, 2019) and sometimes they are also situated within or adjacent to biodiversity hotspots (Seto, Güneralp & Hutyra, 2012). Urbanisation within biodiversity hotspots can have long-lasting and potentially irreparable effects on biodiversity, which is the case in the City of Cape Town (Rebelo et al., 2011). Beyond resource extraction and land-use change, urbanisation will also likely increase human-wildlife interactions in natural areas adjacent to cities (Soulsbury & White, 2015). Not all of these interactions will be positive and some may develop into conflicts, which can affect people and wildlife (Soulsbury & White, 2015). Human-wildlife conflicts are typically reported between people and charismatic mega-herbivores, charismatic mega-carnivores and meso-mammals because of fear of safety, property damage, and impacts on livelihoods (Peterson et al., 2010).

While human-bird conflicts are also reported in the literature (Peterson et al., 2010), the detrimental effects of these interactions may go unnoticed and can be heavily one-sided. This usually occurs when people do not feel threatened by a potential encounter with a particular taxon or species, and when their interests and livelihoods are not being affected. Birds can damage properties (Spennemann & Watson, 2017) and pose a threat to livelihoods through crop damage (Anderson et al., 2013) or livestock predation (Nyirenda et al ., 2017). However, birds rarely pose a physical threat to people (excluding disease transmission), except for certain species that 'aggressively' defend their offspring (Lees et al., 2013) and occasionally injure people (Jones & Thomas, 1999). In comparison, birds are frequently persecuted due to wrongful preconceived notions or traditions (Nyirenda et al., 2017), illegally traded (Mashele, Thompson, Downs, 2021), hunted for sport (Katzner et al., 2020), killed on motorways (Loss, Will & Marra, 2014), caught as bycatch (Anderson et al., 2011), and disturbed by recreationists (Price, 2008).

The demand for nature-based tourism is increasing in many countries, especially in developing nations such as South Africa (Balmford et al., 2009). This demand will likely increase in the immediate future as the Covid-19 pandemic put a halt to travel and transformed the ways in which people engage with their hobbies, such as bird watching (Randler et al., 2020). There are many complex and often intertwined motives associated with seeking nature-based tourism (Kim et al., 2015), as well as many positive health outcomes that emerge from engaging in nature-based recreational activities (Lackey et al., 2019), including dog walking (Christian et al., 2016). However, these activities have been shown to negatively affect birds (Buckley, 2004; Steven, Pickering & Castley, 2011; Steven & Castley, 2013). A review of the effects of various non-motorised forms of nature-based activities found that these seeming benign pastimes almost always impact birds, with only one study finding a positive effect (Steven, Pickering & Castley, 2011). Recreationists generally do not seek to do harm while they are engaging in their activities, and many indicate that they will stop what they are doing if birds are distressed, or move to different spots (Bridson, 2000). However, recreationists may be unaware of the threats that their activities pose to wildlife or they may not believe that their activities can cause disturbance, and blame other user groups for causing problems (Taylor & Knight, 2003; Sterl, Brandenburg & Arnberger, 2008; Le Corre et al., 2013; Maguire, Rimmer & Weston, 2015). Findings like these highlight the difficulties that reserve managers and other authorities face when trying to find a balance between meeting conservation targets while simultaneously promoting visitation. It has become more evident in recent decades that human dimension research is an essential component in conservation because it elucidates the complexities behind ongoing conflicts, and thus can be used to inform management actions to help achieve a more balanced coexistence between humans, their companion animals, and wildlife (Miller, Ritchie & Weston, 2014; Jorgensen & Brown, 2015).

3.2. The social dimension

3.2.1. Dog walking

It is clear that cognitive processes do not always produce rational beliefs, and that these beliefs can lead to behaviours that are detrimental to conservation (Schultz, 2011). Researchers have emphasised the need to gain a better understanding of the social dimension of human-wildlife conflicts because it is argued that "conservation is a goal that can only be achieved by changing behaviour" (Schultz, 2011:1080). There is usually considerable support among recreationists for shorebird protection (van Polanen Petel & Bunce, 2012; Burger & Niles, 2013; Maguire, Rimmer & Weston, 2013; Hamilton, 2014). However, recreationists have been shown to act in ways that are potentially harmful to shorebirds despite indicating that they support shorebird conservation (Williams et al., 2009). Leashing is perhaps the most common and effective regulation that is employed to reduce the impact of dogs on shorebirds because other regulations such as dog bans and beach closures are highly contentious and they can end in litigation (Lafferty, Goodman & Sandoval, 2006; McCall, 2007; Weston & Stankowich, 2014; Maguire, Miller & Weston, 2019). However, numerous studies have found that dog walkers generally disregard leashing regulations (Dowling & Weston, 1999; Lafferty 2001b; Lafferty, Rodriguez & Chapman, 2013; Jorgensen & Brown, 2014; Bowes et al., 2015; Maguire, Miller & Weston, 2019; Schneider et al., 2020).

There are many reasons for the chronically low leash compliance rates exhibited across continents, including but not limited to: the social norms endorsed by a community, following the actions of others, believing misinformation about leash laws, failure to understand the rationale behind leash laws, owners anthropomorphising their dogs, owners believing that leashing reduces exercise and restricts socialisation, owners believing that their dogs listen to commands and are well-behaved when unleashed, and the lack of leash-free zones to exercise dogs, law enforcement to issue fines, and knowledge of shorebirds and the conservation issues that they are facing (Williams et al., 2009; Bowes et al., 2015; Guinness et al., 2020; Comber & Dayer, 2021; van Eeden et al., 2023). Leashing not only reduces the impact of dogs on wildlife such as shorebirds (Weston & Stankowich, 2014), but can also improve visitor experiences because some recreationists may have unfavourable views of dogs on beaches (Bridson, 2000) or unleashed dogs (Jorgensen & Brown, 2014). Failure to comply with leash laws can also affect compliant dog walkers if reserve managers decide to ban dogs due to frequent disturbances and/or attacks on wildlife, which has happened in local (Petersen, 2020) and international reserves (Maguire, Miller & Weston, 2019).

While many recreationists support shorebird conservation, they are often unaware of the threats facing shorebirds, unfamiliar with local species, and may not even know what shorebirds are despite regularly coming into contact with them (Ormsby & Forys, 2010; van Polanen Petel & Bunce, 2012; Le Corre et al., 2013; Hamilton, 2014; Bowes et al., 2015). Knowledge can affect conservation outcomes because it has been found that knowledge is positively correlated with attitudes towards birds (Prokop, Kubiatko & Fančovičová, 2008). Wilson and Tisdell (2005) found that people were initially inclined to allocate hypothetical funds to protect well-known and common avian species, but allocated more funds to threatened species upon receiving additional information. Zander et al. (2014) found that people with knowledge of birds were more likely to contribute greater sums into conservation funds. Thus, it is possible that some recreationists may be more mindful and change their behaviours if they are educated about shorebirds, threats, and the conservation issues they are facing. Weston et al. (2015) found that bird watchers who acknowledged that their presence was potentially disturbing were more likely to change their behaviours to minimise disturbance. However, some recreationists may not comply with regulations if they perceive that they are being inconvenienced by management decisions (Hamilton, 2014). It is suggested that people are more likely to acknowledge the threats that their activities pose to shorebirds, and support management decisions when compliance is convenient (Maguire, Rimmer & Weston, 2013). For example, Bridson (2000), Maguire, Rimmer and Weston (2013), Jorgensen and Brown (2015, 2016), and Guinness et al. (2020) found that visitation frequency was associated with increased knowledge of shorebirds, but also greater inconvenience with their management. However, perceived inconvenience was low across these studies, possibly because many of the recreationists were dog walkers who usually do not comply with seldomly enforced leash regulations (Jorgensen & Brown, 2014).

Cognitive biases can affect behaviour, and thus conservation outcomes (Cinner, 2018). People may fail to recognise their own biases, and rate themselves or their actions as being better than others (Pronin, Lin & Ross, 2002). For example, knowledgeable user groups such as bird watchers are aware that certain species and breeding birds are more sensitive to human disturbance, but they usually disagree that bird watching can be harmful, and many indicate that other user groups are a greater threat (Weston et al., 2015; Slater et al., 2019). Numerous human dimension studies have found that recreationists tend to look out for their own interests or fail to see that their activities are potential harmful to shorebirds (Bridson, 2000; Williams et al., 2009; Glover et al., 2011; Hamilton, 2014; Jorgensen & Brown, 2014). For example, Glover et al. (2011) found that most recreationists had positive attitudes towards shorebird conservation, were supportive of a range of hypothetical management actions, and were in favour of the implementation of buffer zones. However, most recreationists were not supportive of limiting access to walkers, and they also supported larger buffer zones for all activities except for walking (Glover et al., 2011). This could mean that the recreationists correctly perceived some activities to be more impactful and/or that they were protecting their own interests because most of them used the beaches for walking (Glover et al., 2011). Bridson (2000) found that most recreationists did not support dog access to reserve beaches, and that they were supportive of fining dog walkers and those who enter fenced nesting areas. However, recreationists who indicated that they used the reserve beaches to walk their dogs and/or to ride horses supported dog access and were strongly opposed to fines (Bridson, 2000). Most of the recreationists who did not support dog access were more concerned about their own experiences rather than with the threats that dogs pose to shorebirds (Bridson, 2000). Jorgensen and Brown (2017) found that dog walkers were more likely to leash their dogs to keep them from being attacked or getting into fights rather than to protect wildlife, such as threatened shorebirds. Regardless, the majority (84%) of the dog walkers still did not comply with the leash regulation (Jorgensen & Brown, 2017).

Dog walkers in particular appear to have comparatively large cognitive blind spots, which may be because most people view their dogs as their family or children, and thus do not want to acknowledge that they are capable of harming shorebirds (Bowes et al., 2015). Hence, there is usually a clear disconnect between what dog walkers say and what they do. For example, dog walkers indicate that they support and try to comply with regulations, but it is well-established that leash compliance rates are exceptionally low (Guinness et al., 2020). Despite this, dog walkers agree that they would feel embarrassed if they were stopped and questioned for not complying with leash regulations (Guinness et al., 2020), as well as guilty if they walked their unleashed dog(s) past incubating shorebirds (Comber & Dayer, 2021). A lack of awareness of regulations does not seem to be the main reason for low compliance rates because dog walkers are usually aware of leash laws, and they express a high likelihood of leashing their dogs (Jorgensen & Brown, 2017). Dog walkers who walk their dogs unleashed agree more strongly with the constraints to leashing (prevents socialisation and exercise etc) and less strongly with the benefits of leashing (prevents dogs from bothering people and nesting shorebirds etc) than the dog walkers who walk their dogs leashed (Comber & Dayer, 2021). Dog walkers believe that their dogs are under control, and are unlikely to bother other people or disturb wildlife while they are unleashed (Guinness et al., 2020; Comber & Dayer, 2021). Dog walkers sometimes acknowledge that dogs pose a threat to shorebirds, but most disagree that their unleashed dogs are a problem (Williams et al., 2009). Dog walkers show a moderate level of support for unleashed dog exercise and shorebird protection (Williams et al., 2009). However, their obligation to leash is better predicted by support for unleashed dog exercise than shorebird protection (Williams et al., 2009). In other words, conservation is important to many dog walkers insofar as it does not affect unleashed dog walking (Williams et al., 2009).

3.3. Methodology

3.3.1. Sampling

Surveys were conducted between Eerstesteen (33°46'39.57"S, 18°26'56.50"E) and Holbaai (33°44'49.30"S, 18°26'27.30"E) in the Blaauwberg Nature Reserve (Fig. 19). The surveys were conducted during the 2021 June/July holiday on Fridays, Saturdays and Sundays. This coincided with a period of peak Covid-19 infection in the country and Western Cape (National Institute for Communicable Diseases [NICD], 2021). As such, the recommended mitigation protocol was followed: wearing a mask, social distancing (as far as possible), hand sanitising, and cleaning equipment before and after administering each survey (WHO, 2022). Recreationists were also provided with hand sanitiser before and after completing the survey. Some of the recreationists (>18 years old) were approached in the parking lots of each beach, but the majority were approached while they were on the beaches. The recreationists were only surveyed once, and they were asked not to discuss the survey questions if they were in a group, which was done in order to prevent their responses from being influenced by other members. The number of leashed and unleashed dogs on the reserve beaches and adjacent dune trails was also recorded in-between surveying (Jorgensen & Brown, 2014; Schneider et al., 2020). This was done to assess compliance with the leashing regulation. Dogs were recorded as unleashed if they entered the beach without a leash and/or were taken off the leash at any point (because dogs are always required to be leashed). Binoculars were used to scan for dogs that entered from distant parking lots when the researcher was not in eyesight. In these instances, a ruling was only made if the researcher could clearly determine if the dog(s) were leashed or unleashed.

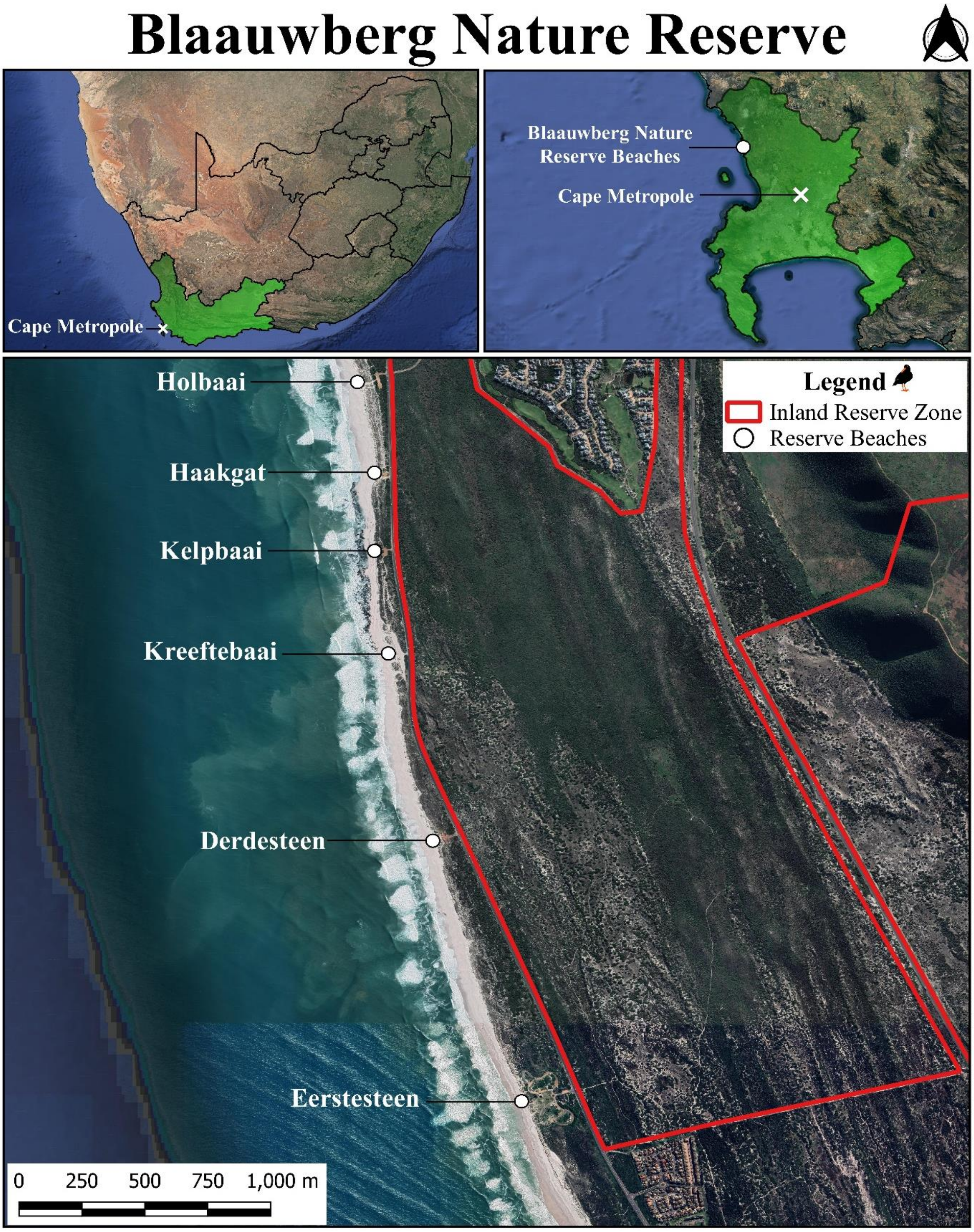

Fig. 19. Sampling sites (Eerstesteen – Holbaai) within the Blaauwberg Nature Reserve.

3.3.2. Survey design

The survey is comprised of 7 sections and 24 questions (Appendix A). It was mainly designed to capture recreationists' awareness of threats posed by human activities, as well as recreationists' attitudes towards hypothetical regulations aimed at protecting shorebirds. Section 1 was designed to capture standard socio-demographic information, such as age, gender, race, employment status, residence, and level of education. This section also included a question on visitation purposes and frequency because both can affect awareness of threats, and attitudes towards shorebirds and regulations (Jorgensen & Brown, 2015). Section 2 was designed to capture attitudes towards shorebird protection, signs as educational tools, threats that dogs pose to shorebirds, and awareness and compliance with regulations. This section was the first to introduce a 5-point Likert scale. Recreationists were asked to indicate the extent to which they 'agreed' or 'disagreed' with the items. This section also asked recreationists to name five different species of shorebirds found on the reserve beaches, which was done because they may lack knowledge of shorebirds (Ormsby & Forys, 2010). This was also done because it was predicted that recreationists would either 'agree' or 'strongly agree' with an earlier statement on shorebird familiarity, but would be unable to name many shorebirds or would name common seabirds, e.g. seagulls (Le Corre et al., 2013). Section 3 was designed to capture dog walkers' attitudes towards the threats that their dogs pose compared to the threats that other peoples' dogs pose in the reserve. This was done because it was predicted that dog walkers would 'disagree' or 'strongly disagree' with the statements concerning the threats that their dogs pose to shorebirds, but may 'agree' or 'strongly agree' that other peoples' dogs are a cause for concern (Williams et al., 2009).

Section 4 was designed to capture their awareness of recreational threats to shorebirds (Objective 2). All of the threats were based on research findings and observations, many of which relate to oystercatchers (Dowling & Weston, 1999; Pond, 1999; Williams, Ward & Underhill, 2004; Loewenthal, 2007; Martín et al., 2015; Jorgensen, Dinan & Brown, 2016; Paijmans, 2016; Paijmans & Stewart, 2016; DeRose-Wilson et al., 2018; Navedo et al., 2019). The recreationists were not told that the threats were factual. This was done to avoid a situation where the recreationists unquestioningly answered 'strongly agree' with all of the statements, thereby biasing the results. The items ranged from the more general knowledge statements such as "human activities can cause shorebird deaths" (Paijmans & Stewart, 2016) to the less intuitive statements such as "human activities can cause shorebird chicks to drown"

(Loewenthal, 2007) or "human activities can cause shorebird chicks to grow slower than usual" (DeRose-Wilson et al., 2018).

Section 5 was designed to capture attitudes towards the hypothetical dog and walking regulations aimed at protecting shorebirds (Objective 3). This was done because research has shown that recreationists show greater support for certain regulations (Glover et al., 2011), which can possibly affect compliance rates (Maguire, Miller & Weston, 2019). All of the hypothetical regulations were based on standard management actions, such as dog bans, leash requirements, zonation systems, and restricting beach access during certain seasons, days of the week and/or times (Lafferty, Goodman & Sandoval, 2006; Weston & Stankowich, 2014; Maguire, Miller & Weston, 2019). Section 6 asked recreationists if they would support the implementation of buffer zones during the breeding season, and what size buffer zones they believed should be implemented to protect shorebirds from walkers with and without dogs. This was done to assess if the recreationists would be receptive to the outcome of the ecological component of this research (Chapter 2). It was predicted that the recreationists would show preference for smaller buffer zones because they are less of an inconvenience (Maguire, Rimmer & Weston, 2013). Section 7 provided the recreationists with an opportunity to comment because these types of questions can yield emotive, diverse and valuable insight into contentious issues such as leashing (Nesbitt, 2006).

3.4. Results

3.4.1. Survey section 1

3.4.1.1. Socio-demographics

All statistical analyses were performed using SPSS V28.0.1.0 (IBM Corporation, 2021). Seventy-five recreationists completed the survey, but five surveys were discarded due to missing data (N = 70). Thirty-five identified as male (50%) and the other half as female (50%). The majority were young adults or middle aged, with most being between the ages of 25-34 (27.1%), 35-44 (18.6%), and 45-54 years (25.7%). The recreationists were well educated, with the majority having achieved some form of tertiary qualification either at a college (20%) or through a university at the undergraduate (25.7%) and postgraduate levels (25.7%). Recreationists who indicated that they had attended university had mostly obtained degrees (66.7%) rather than diplomas (33.3%). The majority of the recreationists were employed in some capacity (80%), while the others were either retired (12.9%) or students (5.7%). Recreationists were mainly locals who visited the reserve beaches several times a week (28.6%), on a weekly basis (22.9%), or several times a month (20%). The two most common reasons for visitation by a large margin were walking (81.4%) and dog walking (61.7%). Other selected options included picnicking (22.9%), swimming (22.9%), running (18.6%), surfing (12.9%), and fishing (11.4%). A few recreationists (10%) also indicated that they visited for ‘spiritual’ reasons, such as meditation, relaxation, and connecting with nature.

3.4.2. Survey section 2

3.4.2.1. General opinions: shorebirds, regulations, dogs, and signage

Recreationists had positive attitudes towards conservation because they strongly agreed that shorebird protection was important (Fig. 20). Furthermore, recreationists strongly agreed that regulations were important, and they agreed that they always followed regulations on beaches. Recreationists agreed that they were familiar with regulations such as the leash requirement, but answered neutrally when asked if they believed that regulations were restrictive. Recreationists strongly agreed that dog access to beaches was important, but answered neutrally when asked if dogs posed a threat to shorebirds. Recreationists had positive attitudes towards signage because they strongly agreed that signs with information about shorebirds are helpful. Recreationists also agreed that they always looked out for signs, but answered neutrally when asked if they had seen signs about shorebirds in the reserve. Recreationists also agreed that they were familiar with some species of local shorebirds.

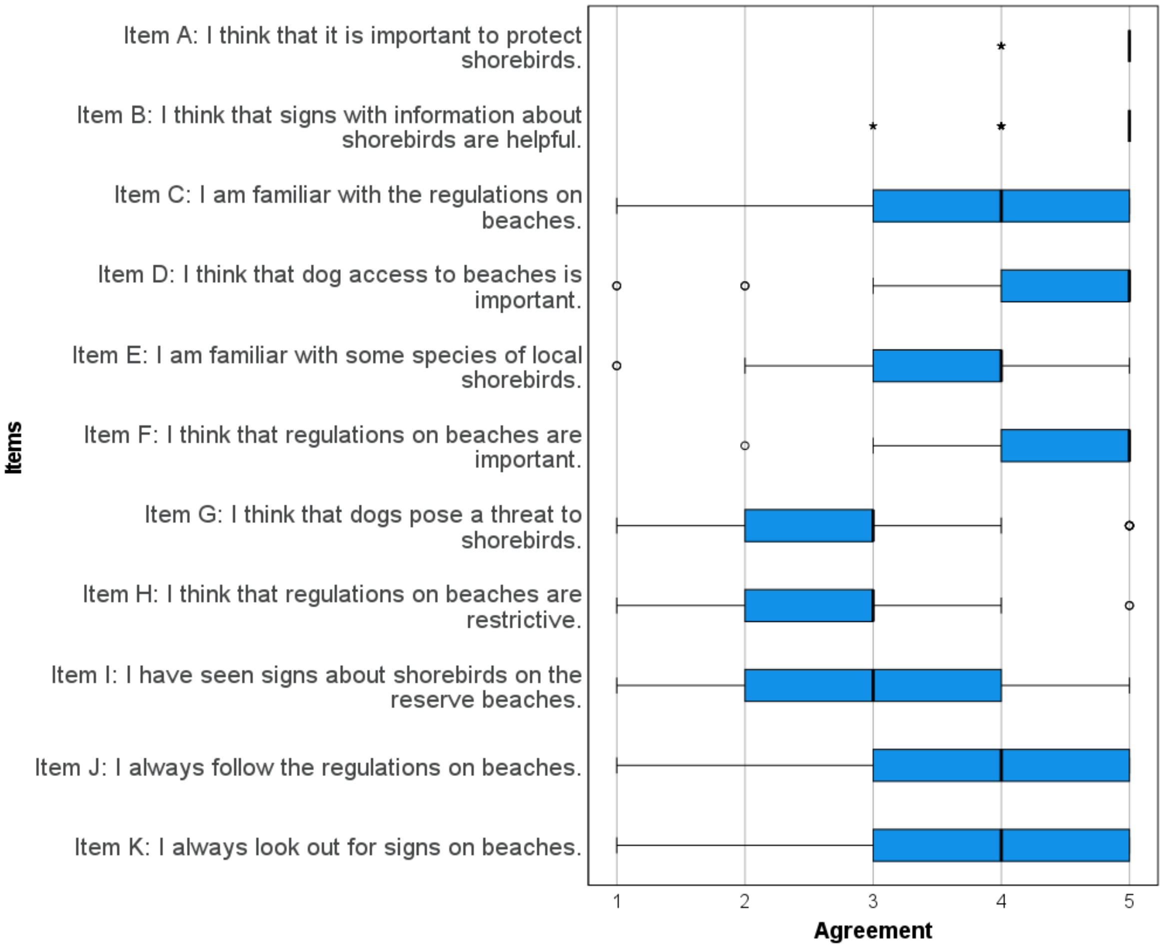

Fig. 20. Recreationists' (N = 70) opinions on a variety of statements concerning shorebirds, regulations, dogs and signage (5 = Strongly agree, 4 = Agree, 3 = Neutral, 2 = Disagree, 1 = Strongly disagree).

3.4.2.2. Shorebird familiarity

Recreationists were asked to name up to five shorebirds that they had seen in the reserve on the day of the survey or during their previous visits. Some recreationists gave descriptions of birds, and many others named birds that were not found in the reserve (see Küyler, 2011). Furthermore, the majority of recreationists understood "shorebirds" to mean any coastal bird, including seabirds such as gulls and terns. While this is incorrect, it shows that recreationists are familiar with some coastal birds, which aligns with the intended purpose of the question. Therefore, seabirds were included, and all of the species that were not found in the reserve or which were described (but not named) were excluded from the analysis. This left the recreationists with 24 possible coastal birds (sea/shorebirds) to name (see Küyler, 2011). The majority of the recreationists were only able to name one (38.6%) or two (31.4%) species (Table 1). Almost as many recreationists were unable to name a single species (11.4%) as those who were able to name three and four combined (18.6%). None of the recreationists correctly named five species.

Table 1. The number of coastal birds (sea/shorebirds) found in the reserve that recreationists (N = 70) were able to name.

Correctly named	Male (n = 35)	Female (n = 35)	Total (N = 70)
None[a]	6	2	8 (11.4%)
One	12	15	27 (38.6%)
Two	9	13	22 (31.4%)
Three	4	4	8 (11.4%)
Four	4	1	5 (7.1%)
Five	0	0	0 (0.0%)

[a]These were not recreationists who gave responses that did not meet the specified criteria. Rather, they were recreationists who could not name a single bird.

Almost none of the recreationists provided the full common names for the species. For example, most recreationists stated "oystercatcher" instead of "African Oystercatcher". Therefore, all of the responses were broadly grouped according to the family (Table 2). Gulls were the most frequently listed birds by a large margin, but only three recreationists provided the full common names for two most abundant species, namely the Hartlaub's Gull (*Chroicocephalus hartlaubii*) and Kelp Gull (*Larus dominicanus vetula*). Twenty recreationists listed the oystercatcher, but only one person provided the full common name. Twenty recreationists also listed cormorants, but none provided the full common names for the three species recorded in the reserve, namely the Cape Cormorant (*Phalacrocorax capensis*), Crowned Cormorant (*Phalacrocorax coronatus*), and White-breasted Cormorant

(*Phalacrocorax lucidus*). The recreationists were also asked if any of the species that they listed are legally protected. Fifty-one (72.9%) recreationists indicated that they were unsure. Sixteen (22.9%) indicated that they are protected, but none correctly stated that all are protected (*Marine Living Resources Act, No. 18 of 1998*). Instead, they singled out particular species. For example, twelve (17.1%) recreationists singled out the oystercatcher, making it the most recognised protected species. Only three (4.3%) recreationists indicated that no species are protected.

Table 2. The coastal birds (sea/shorebirds) named by the recreationists (N = 70).

Category	Name (family)	Number of times mentioned		
		Male (n = 35)	Female (n = 35)	Total
Shorebirds	Plovers (Charadriidae)	1	0	1
	Lapwings (Charadriidae)	0	1	1
	Sandpipers (Scolopacidae)	1	2	3
	Oystercatchers (Haematopodidae)	12	8	20
Seabirds	Gannets (Sulidae)	2	0	2
	Penguins (Spheniscidae)	1	2	3
	Terns (Laridae)	1	2	3
	Cormorants (Phalacrocoracidae)	11	9	20
	Gulls (Laridae)	29	33	62
Total		58	57	115

3.4.3. Survey section 3

3.4.3.1. Dog walkers

A total of 158 (80%) of the dog walkers observed during fieldwork did not leash their dogs. Fifty-two (74.3%) of the recreationists surveyed were dog owners. Forty-nine (70%) of which indicated that they walked their dogs on beaches, but only 47 (67.1%) indicated that they walked their dogs on the reserve beaches (referred to hereafter as 'dog walkers') (Fig. 21). Dog walkers agreed that their dogs did not chase shorebirds, and that they posed no threat to shorebirds, nests and chicks. Dog walkers also agreed that their dogs posed no threat to other dogs, and strongly agreed that their dogs posed no threat to other recreationists. However, dog walkers were less certain when it came to the items concerning other recreationists' dogs. For example, dog walkers answered neutrally to the items assessing the behaviour of other peoples' dogs, and threats that they posed to shorebirds, nests and chicks. Dog walkers also answered neutrally to the item assessing compliance with the leash regulation in the reserve.

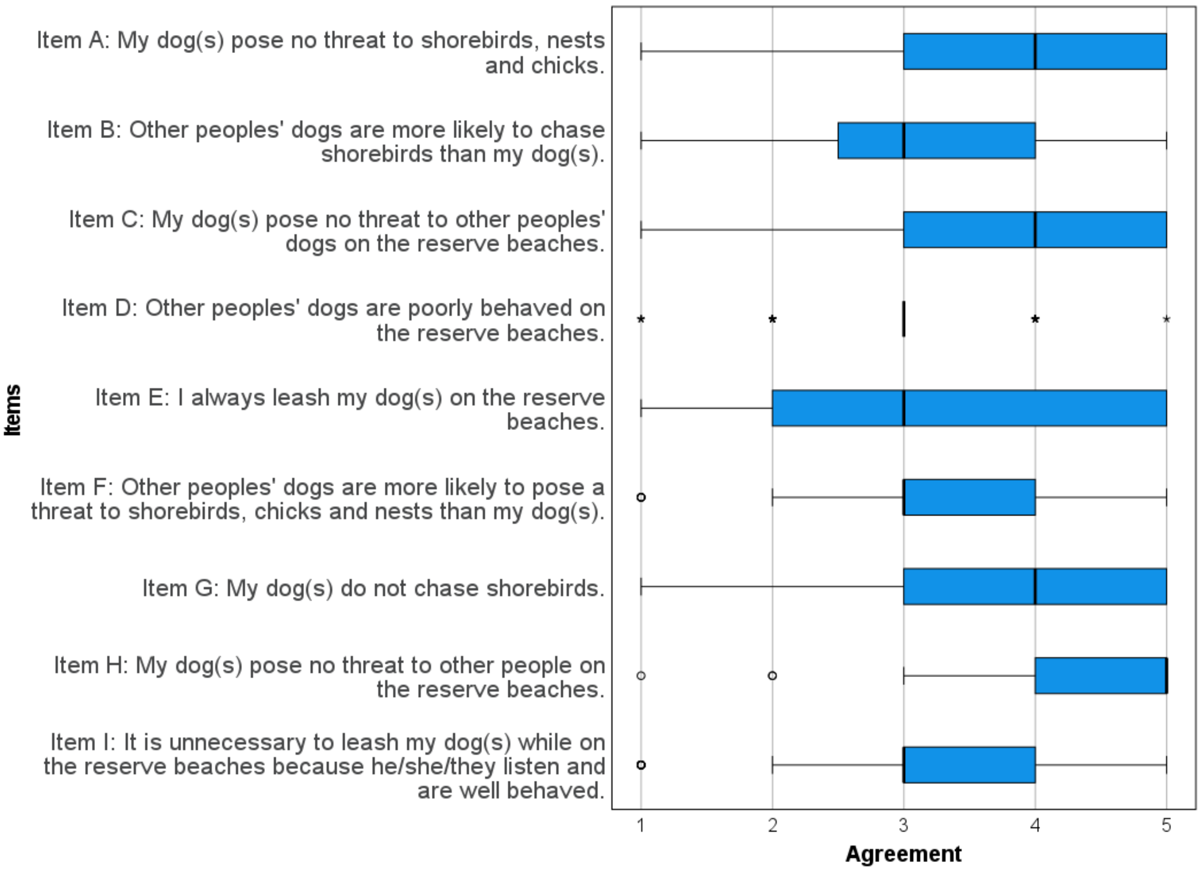

Fig. 21. Dog walkers' (n = 47) opinions on the threats that their dogs pose vs. the threats that other peoples' dogs pose in the reserve (5 = Strongly agree, 4 = Agree, 3 = Neutral, 2 = Disagree, 1 = Strongly disagree).

3.4.4. Survey section 4

3.4.4.1. Awareness of threats

Recreationists were told that the "human activities" referred specifically to recreational activities, including walking, running and swimming with or without dogs (Fig. 22). Recreationists almost unanimously agreed that human activities posed a threat to shorebirds. The only neutral responses were for the items that required greater knowledge of shorebirds and/or deductive reasoning skills to make connections between the impacts of certain items. For example, recreationists agreed that human activities can cause shorebirds to spend time off their nests, and less time feeding their chicks, but they were not certain about human activities affecting chick growth rates.

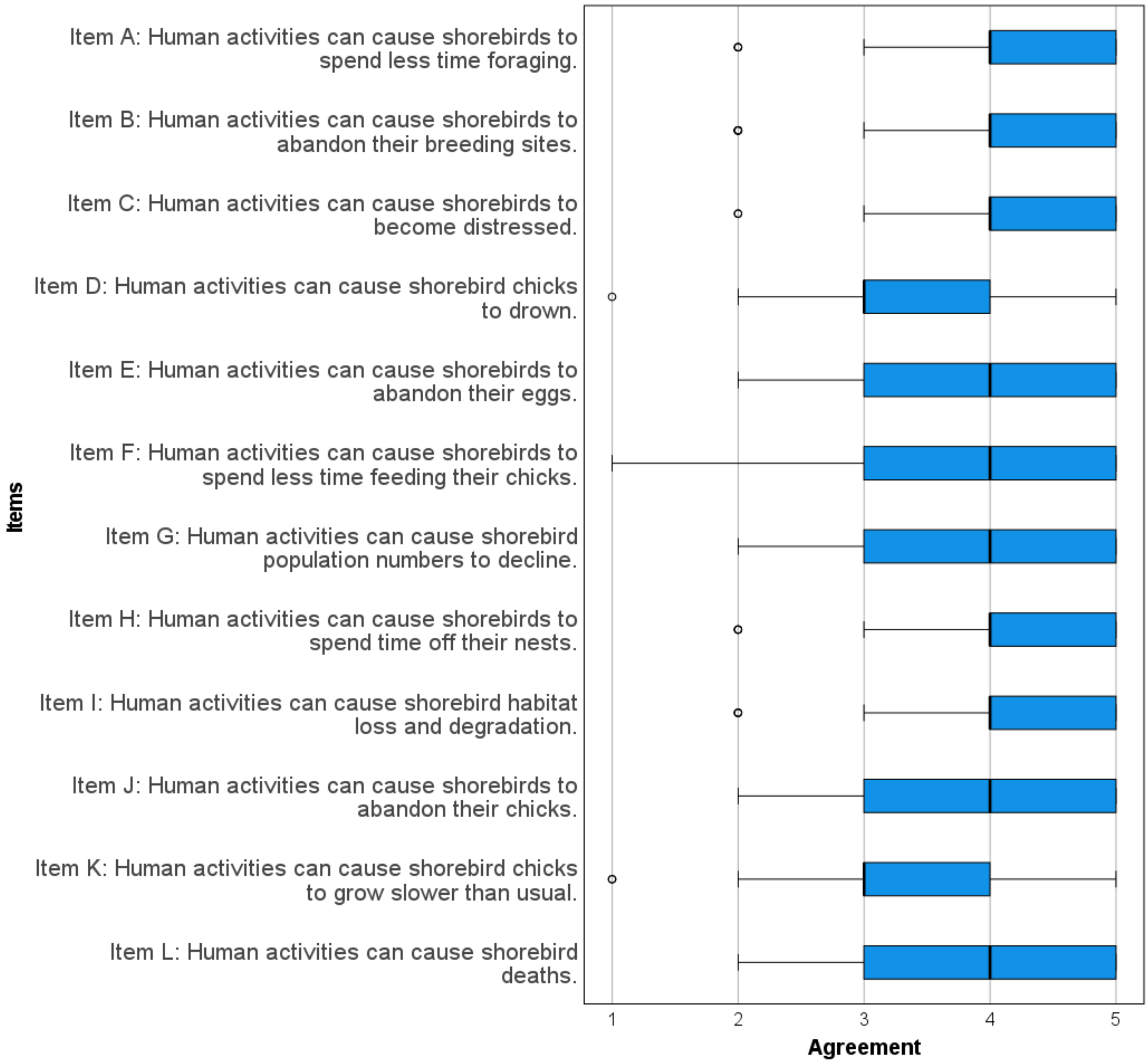

Fig. 22. Recreationists' (N = 70) awareness of threats that human activities pose to shorebirds (5 = Strongly agree, 4 = Agree, 3 = Neutral, 2 = Disagree, 1 = Strongly disagree).

3.4.5. Survey section 5

3.4.5.1. Attitudes towards hypothetical dog walking regulations

Recreationists answered neutrally or disapproved of the majority of the dog walking regulations (Fig. 23). They disagreed that dogs should not be allowed to access the reserve beaches, but agreed that dogs should always be leashed. Recreationists showed support for some limitations being placed on dog walking by agreeing that dogs should be restricted to certain areas and/or banned during the shorebird breeding season. Recreationists were also asked to indicate their most and least supported regulations. The two most supported regulations were "dogs should be leashed at all times on the reserve beaches" and "dogs should only be leashed on the reserve beaches during the shorebird breeding season". Just over a third (34.3%) of the recreationists chose the former, whereas a fifth (20%) chose the latter as their most supported regulation. The two least supported regulations were "there should be no regulations on dog walking" and "dogs should not be allowed to access the reserve beaches". Half (50%) of the recreationists chose the former, whereas just under a third (30%) chose the latter as their least supported regulation.

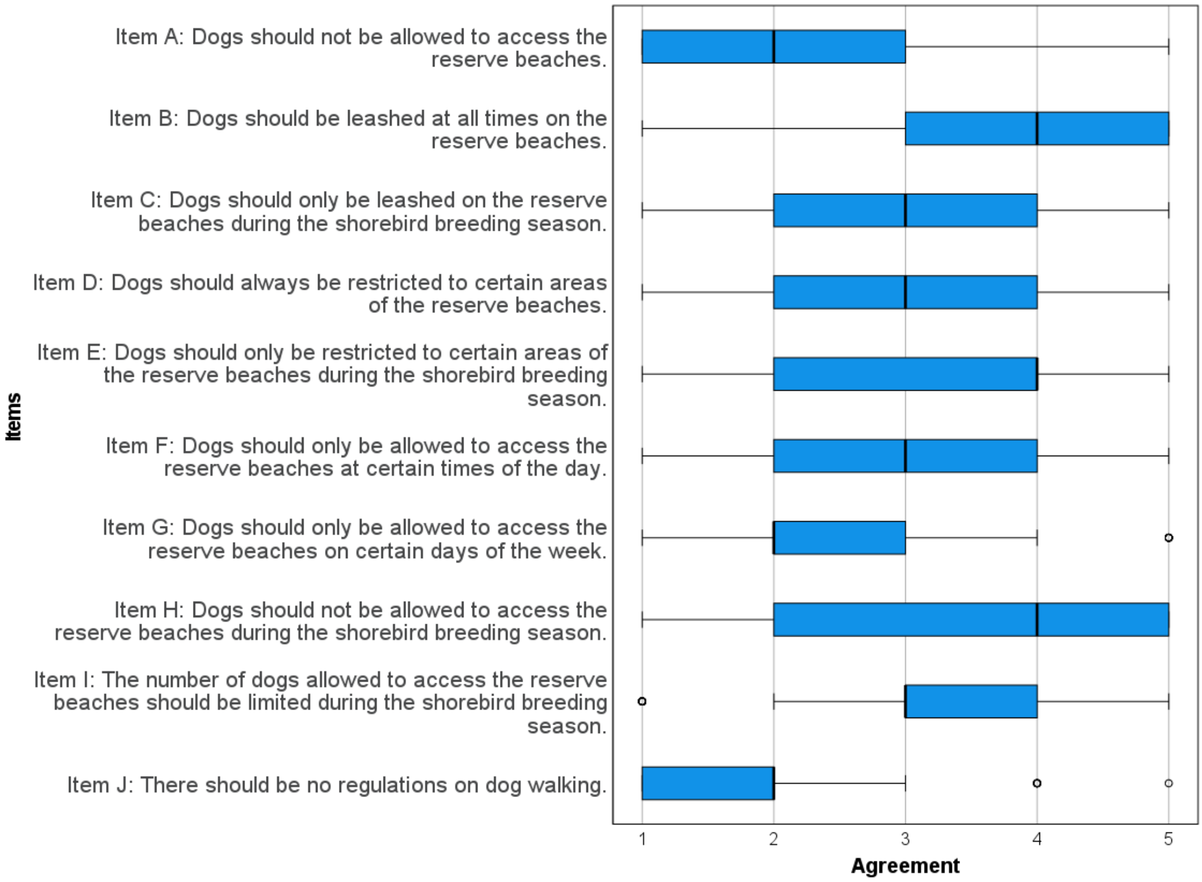

Fig. 23. Recreationists' (N = 70) attitudes towards the hypothetical dog walking regulations. (5 = Strongly approve, 4 = Approve, 3 = Neutral, 2 = Disapprove, 1 = Strongly disapprove).

3.4.5.2. Attitudes towards hypothetical walking regulations

Recreationists answered neutrally or disapproved of the majority of the walking regulations (Fig. 24). Once again, there was agreement that recreationists should be restricted from certain areas of the reserve beaches during the shorebird breeding season. The most supported regulations were "walkers should only be allowed to access certain areas of the reserve beaches during the shorebird breeding season" and "there should be no regulations on walking". Just under half (47.6%) of the recreationists chose the former, whereas a fifth (20%) chose the latter as their most supported regulation, or lack thereof. The two least supported regulations were "there should be no regulations on walking" and "walkers should not be allowed to access the reserve beaches during the shorebird breeding season". Half (50%) of the recreationists chose the former, whereas just over a third (35.7%) chose the latter as their least supported regulation.

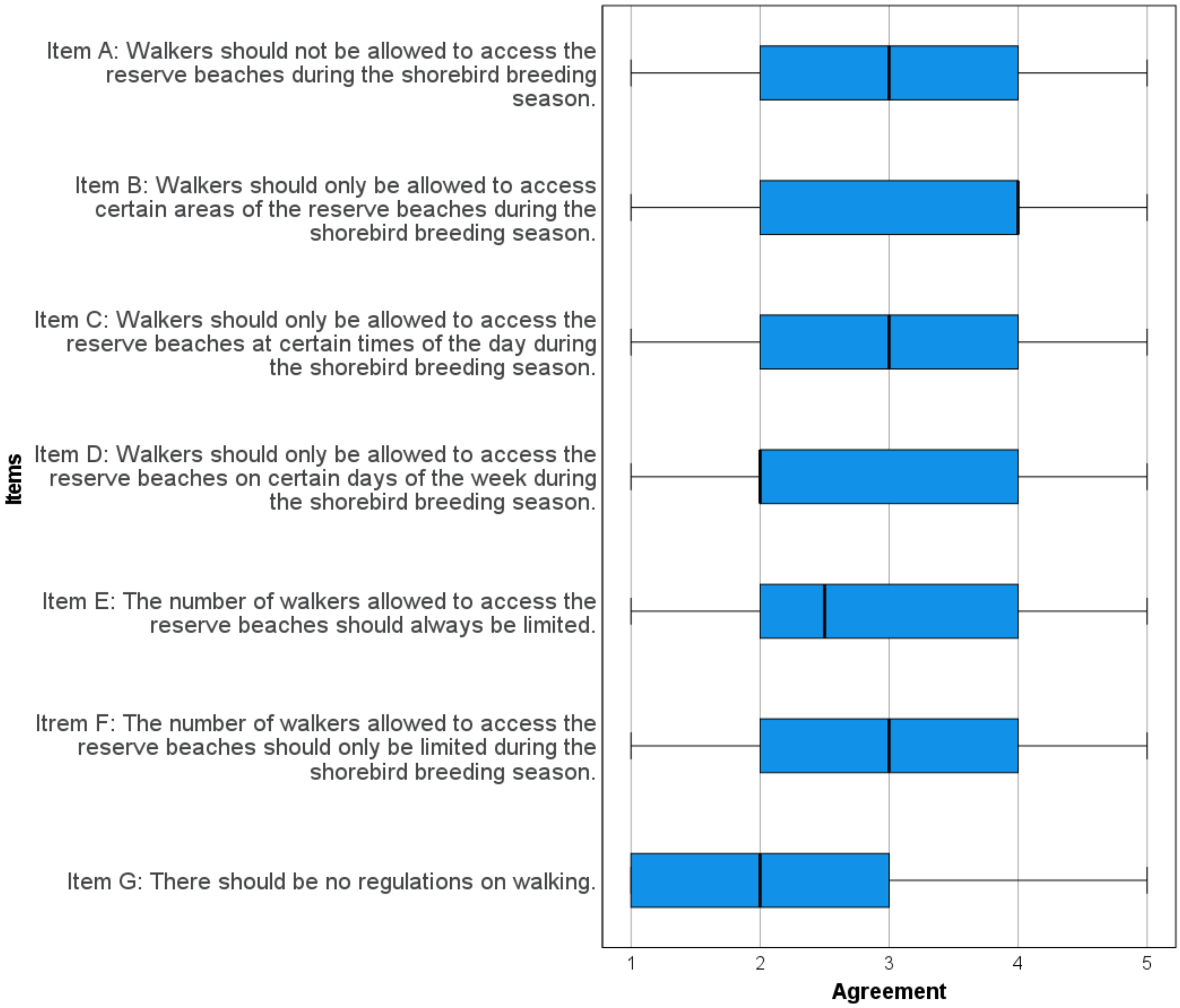

Fig. 24. Recreationists' (N = 70) attitudes towards the hypothetical walking regulations. (5 = Strongly approve, 4 = Approve, 3 = Neutral, 2 = Disapprove, 1 = Strongly disapprove).

3.4.6. Survey section 6

3.4.6.1. Support for buffer zones

The majority (n = 67) of the recreationists supported the implementation of buffer zones to protect incubating shorebirds. Recreationists generally indicated support for smaller buffer zone sizes (10-50 m) for dog walkers (dogs) and walkers without dogs (walkers) (Fig. 25). For example, 49 (73%) and 40 (59.7%) of the recreationists preferred a buffer zone size of between 10-50 m for the walkers and dogs, respectively. The most preferred buffer zone size for the walkers (20.9%) and the dogs (22.4%) was 50 m. However, almost as many recreationists (20.9%) supported buffer zone sizes of greater than 100 m for dogs. The least preferred buffer zone sizes for walkers (3%) and dogs (9%) were between 60 and 90 m. While the recreationists were not asked to indicate if the buffer zones should be smaller or larger for dogs, 31 (46.3%) chose larger buffer zones for dogs. Slightly over half (52.2%) of the recreationists chose equal buffer zone sizes for both, and only one recreationist chose a small buffer zone for dogs. The majority (71%) of the recreationists who chose larger buffer zones for dogs were dog owners (54.8% of which were dog walkers).

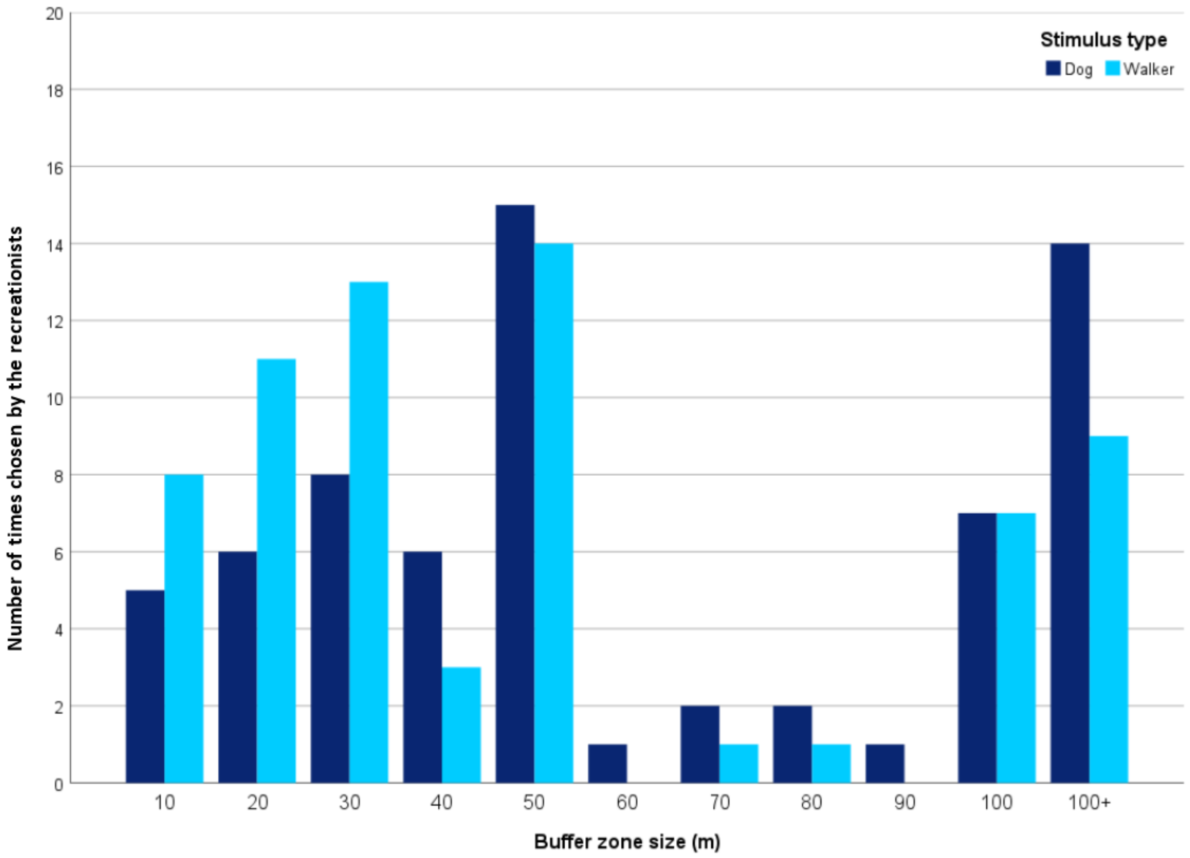

Fig. 25. Recreationists' (n = 67) buffer zone size preferences for walkers with and without dogs.

3.5. Discussion

Two themes were identified from the Likert data and comments provided by the recreationists, namely ‘ambivalence’ and ‘contradiction’. The ambivalence theme centres around the recreationists being uncertain or disliking most of the hypothetical regulations (Section 5), despite strongly agreeing that shorebird protection and regulations are important (Section 2). The contradiction theme centres around two subthemes. Firstly, the species literacy gap that emerged when the recreationists agreed that they are familiar with some shorebird species, while being unable to substantiate this belief (Section 2). Secondly, the cognitive dissonance displayed by recreationists when they showed good awareness of the majority of the threats (Section 4), while also believing that their dogs pose no threat to shorebirds (Section 3), and many indicating that larger buffer zones are required for dog walkers than walkers (Section 6).

3.5.1. Ambivalence

Recreationists strongly agreed that it is important to protect shorebirds, which is congruent with the findings of other studies (Williams et al., 2009; Burger & Niles, 2013; van Polanen Petel & Bunce, 2012; Hamilton, 2014; Jorgensen & Brown, 2016). Their strong support was further emphasised through comments, such as “Birds must always be protected” and “Keep nesting areas free from people. Dog walking or not”. However, support for conservation seems to become slightly more ambivalent when rights of access are considered. For example, one recreationist said “Birds must be protected. However, limitations and restrictions should prevail as it is a playground for both humans and dogs”. Recreationists tend to believe that dog access to beaches is a right (Bowes et al., 2015; Guinness et al., 2020). The recreationists also strongly agreed that dog access to beaches is important, which aligns with other studies (Williams et al., 2009; Jorgensen & Brown, 2014; Guinness et al., 2020). Support for dog access to the reserve beaches was likely related to the fact that the majority of the recreationists were dog owners who indicated that they visited to walk their dogs. This desire for co-existence has been found in other studies. For example, Hamilton (2014) found that recreationists expressed a desire for a balance between conservation and access. Furthermore, the recreationists also exhibited pro-conservation and shorebird attitudes by indicting that beach users must adhere to regulations, and that they should also change their behaviours to protect shorebirds because they are the ‘first’ inhabitants of beaches (Hamilton, 2014). The topic of co-existence, as well as the issues of rights and access to beaches is succinctly captured in one recreationist’s comment below:

> *We often walk in Shark Bay Beach in Langebaan, where from a certain point, no human activities are allowed. This works really well. The bird population there is big and they have their own demarcated area. We need to do more to protect biodiversity and ecosystems. Humans shouldn't be 'allowing' birds privacy during the breeding season. They should have equal rights to beaches.*

Recreationists also strongly agreed that regulations are important. However, the majority of the hypothetical regulations aimed at protecting shorebirds were viewed neutrally or unfavourably. This was despite the recreationists indicating that their least supported management actions were "there should be no regulations on dog walking and/or walking". Hence, recreationists strongly agreed that shorebird protection is important and that regulations are important, but they were not in favour of the majority of the hypothetical regulations. Recreationists possibly viewed the hypothetical regulations as an inconvenience because the majority were locals who visited the reserve beaches frequently, i.e. many times a month. Jorgensen and Brown (2015) found that recreationists who visited beaches frequently were less receptive to hypothetical management actions that would lead to additional restrictions. This may explain why "dogs should be leashed at all times on the reserve beaches" and "dogs should only be leashed on the reserve beaches during the shorebird breeding season" were the two most supported hypothetical dog walking regulations. The recreationists likely knew that their dogs must be leashed because they agreed that they looked out for signs (which detail the regulations) and were familiar with the regulations, but they also likely knew that they would not be affected (fined) or inconvenienced by their hypothetical regulation choices because leashing appears to be seldomly enforced, if ever (pers. obs.). Lucrezi, Saayman and van der Merwe (2015) found that the managers of local Cape beaches claimed to be moderately engaged in enforcing the regulations on their beaches, but many of the regulations depicted on signs at the beach entrances were not enforced, including dog bans. A lack of enforcement can also be attributed to the fact that many managers are expected to 'do more with less' (Jorgensen & Brown, 2014). The lack of enforcement may also affect perceptions of regulations, which some recreationists touched upon in their comments: "The beaches regulate dog walking (on leash). However, some people do not abide by that, so stricter enforcement on that should be considered" and "Overall, my view is that restrictions should be implemented. I am concerned about the enforcement of the restrictions though". Hamilton (2014) found that among other factors, negative perceptions of management can affect attitudes towards shorebird conservation.

The majority of the recreationists indicated that they were in favour of implementing buffer zones to protect shorebirds during the breeding season. However, the majority preferred smaller buffer zone sizes (10-50 m), which may be because these sizes were perceived to have less of an impact on perceived freedom and recreational activities (Hamilton, 2014). Some recreationists' comments seemingly support this assumption: "If you want to protect the birds, a buffer area is good. Not restricting people" and "It is important to find the balance between rules and liberty. A mutual respect of rules". Jorgensen and Brown (2014) found a significant difference between dog owners and non-dog owners in terms of support for increased leash law enforcement on beaches. This is likely because dog owners place great value on unleashed exercise (Guinness et al., 2020; Comber & Dayer, 2021), and thus restricting or removing this 'right' through regulation is a perceived as a slight on liberty. The recreationists in this study may have also chosen the lowest (10-50 m) and highest buffer zones sizes (≥100 m) because they are easier to visualise, which possibly explains why so few chose the middle-of-the-road options (60-90 m). Studies have shown that people tend to be unreliable estimators of distance (Strauss & Carnahan, 2010; Button, Schofield & Croft, 2016). The recreationists who chose the highest buffer zone sizes were perhaps more concerned about protecting shorebirds than looking out for their own 'rights'. For example, many recreationists chose a buffer zone size of 100 m, but more chose buffer zone sizes of greater than 100 m, which indicates that they supported the implementation of buffer zones no matter how large. These recreationists were seemingly willing to make greater 'sacrifices' by relinquishing more space to ensure ongoing co-existence, and to respect the rights of shorebirds.

3.5.2. Contradiction

Recreationists agreed that they were familiar with some species of local shorebirds, but the majority could only name one or two species (mostly seabirds such as seagulls) that are found in the reserve, and almost none were able to provide the full common names for the species. This indicates that there is a disconnect between what the recreationists think or claim to know, and what they actually know, which aligns with the findings of other studies (Ormsby & Forys, 2010; van Polanen Petel & Bunce, 2012; Le Corre et al., 2013). This may have emerged because the recreationists provided the socially desirable response of indicating that they are familiar with local shorebirds to avoid appearing uninformed (Grimm 2010) or because they had an illusory sense of knowledge and overestimated their abilities (Plohl & Musil, 2018). One recreationist who only named two birds and answered neutrally to the item assessing shorebird familiarity highlighted this lack of knowledge: “I believe people aren't educated enough about shorebirds, as well as people don't see the importance of them in the ecosystem”. Hamilton (2014) found that the recreationists indicated that they lacked knowledge of shorebirds and their habitats, which supports the finding of this study.

Recreationists agreed that they always looked out for signs in the reserve. However, only 20 people were familiar with the oystercatcher, despite there being a fairly large population on the beaches, and signs depicting their presence in some of the parking lots. People generally have positive perceptions of birds, and they show greater affinity for species that they recognise and/or are able to name (Schlegel & Rupf, 2010; Cox & Gaston, 2015). Oystercatchers are a charismatic species and they were named Bird of the Year 2018 by BirdLife South Africa (Brown et al., 2019). Hence, a clear opportunity exists to increase awareness about oystercatchers and the threats that unleashed dogs pose in the reserve. Recreationists showed a willingness to learn by strongly agreeing that signs with information about shorebirds would be helpful. The desire to learn and increase awareness was further supported in the following comments: “More visible signage is needed to protect shorebirds”, “Awareness is paramount. Signage and information”, “More signs and information would be helpful”, “Education is important to walkers, and the reasons why rules are implemented”, and “May be useful to make brochures available to heighten awareness of the birds’ habitats and needs”. Another recreationist went as far as to suggest that “It would be great if events were hosted around the season to build support for the birds”.

Recreationists often express a desire for more and/or improved brochures and signage in outdoor settings (Sayan & Karagüzel, 2010; Haukeland et al., 2013; Hamilton, 2014). Some recreationists in this study believed that beach users were not aware of the threats that their activities pose to shorebirds: “The public should be educated around how to prevent endangerment. Most people do not understand their impact” and “The layman on the beaches is not aware of the threat to birds, not enough knowledge”. However, the recreationists were aware of the threats because they agreed with almost all of the items assessing awareness. Rather, it appears that the recreationists did not believe that their activities were potentially harmful because the majority were dog owners who believed that their dogs pose no threat to shorebirds, chicks and nests, as well as to other recreationists and their dogs (Taylor & Knight, 2003; Le Corre et al., 2013; Gruas, Perrin-Malterre & Loison, 2020). This finding is congruent with the prevailing belief among dog walkers that their unleashed dogs will not bother other recreationists or disturb wildlife (Guinness et al., 2020; Comber & Dayer, 2021). It also partly aligns with Williams et al. (2009) who found that dog walkers acknowledged that dogs pose a threat to wildlife, but stopped short of acknowledging that their dogs pose a threat. However, some recreationists in this study acknowledged the threat that dogs pose shorebirds. For example, one non-dog owner stated:

> *Dogs really are dangerous to birds, especially if they don't have a leash. I've seen some dogs fighting, and owners got involved in an argument that was close to physical assault. Language used was horrible.*

Recreationists may have agreed that their dogs pose no threat because they did not want to believe that their dogs are capable of causing harm due to the strong bonds and emotional connections that people have with their pets (Charles, 2014). Humanity’s kinship with dogs has existed for thousands of years (Driscoll & Macdonald, 2010), and nowadays people consider their dogs to be family or children (Bowes et al., 2015; Guinness et al., 2020). While recreationists often believe that other user groups are the problem, they also tend to believe that dog walking poses a greater threat, or is more impactful than other activities (Sterl, Brandenburg & Arnberger, 2008). In comparison, dog walkers rate their own activity as being less impactful than most other activities (Sterl, Brandenburg & Arnberger, 2008). Le Corre et al. (2013) found that the majority of recreationists were aware that human activities can negatively affect shorebirds, but they did not think that their own activities posed a threat. Some recreationists became defensive, which is possibly because they felt that their pastimes were being scrutinised and could be regulated or banned altogether, whereas others minimised their own impacts and blamed other user groups for causing problems (Le Corre et al., 2013). Dog walkers in particular may take umbrage if they believe that their dogs or dogs in general are being blamed for harming shorebirds. In support of this assumption, one dog owner in this study emotionally commented: “Humans need to clean up after themselves. Dogs are not the problem!!” This recreationist strongly agreed that her dogs posed no threat to shorebirds, and agreed that they do not need to be leashed because they listen and are well-behaved.

It is also possible that the recreationists’ dogs have never injured or killed shorebirds and/or that the recreationists have never witnessed their dogs causing any physical harm to shorebirds because they are unleashed and out of sight (Gómez-Serrano, 2021). Thus, dog owners may have ignored or downplayed the amalgam of less tangible or visceral impacts that can arise from human disturbance, such as shorebirds flushing from their nests (Jorgensen, Dinan & Brown, 2016), abandoning their eggs (Loewenthal, 2007), and changing their distributional patterns (Burger & Niles, 2013), which can affect growth rates and survival

(DeRose-Wilson et al., 2018). For example, although a minority, some dog walkers state that they take their dogs to the beach so that they can chase birds, which indicates that they either do not care, or that they see no lasting impacts from such encounters (Guinness et al., 2020). Williams et al. (2009) found that most dog walkers believed that dogs chasing shorebirds without catching them can have long-lasting impacts, whereas far fewer dog walkers believed that dogs being within 50 m of shorebirds can have long-lasting impacts. The dog walkers in this study agreed that their dogs do not chase shorebirds in the reserve. While this may be true or a socially desirable response (because many dogs were observed chasing shorebirds), the dog walkers may not have known that dog-related disturbance can occur without chasing, and that impacts can occur without injury or mortality. One recreationist's comment seemingly supports this assumption: "I think human interaction is our biggest threat to any species actually. If dogs are well-mannered, they will not be your problem".

The recreationists strongly agreed that regulations on beaches are important, and they also agreed they were familiar with regulations, and that they always followed the regulations. However, the dog walkers answered neutrally to the item assessing leash compliance, which was found to be considerably low (20%). This aligns with other studies that report compliance rates of 12% (Dowling & Weston, 1999), 19% (Lafferty, Rodriguez & Chapman, 2013), 20.6% (Maguire, Miller & Weston, 2019), and less than 25% (Jorgensen & Brown, 2014). The most likely reasons for non-compliance on the reserve beaches are (I) social norms, (II) lack of enforcement, (III) belief that dogs are harmless, and (IV) attitudes towards unleashed dog walking (Nesbitt, 2006; Williams et al., 2009; Bowes et al., 2015; Guinness et al., 2020; Comber & Dayer, 2021). In other words, the recreationist may think that there is no need to leash their dogs when no one else does or expects them to, when they are unlikely to be questioned or fined, when they believe that their dogs pose no threat, and when they believe that unleashed dog walking confers greater benefits in terms of exercise and socialisation. While the dog walkers may not have complied with the leash regulation partly because they believed that their dogs pose no threat, the majority of those who chose larger buffer zones for dogs were dog walkers. This indicates that many dog walkers may have inadvertently acknowledged that dogs do pose a greater threat to shorebirds than walkers without dogs. One dog walker's comment seemingly supports this assumption: "I think both walkers and dog walkers don't pose a threat. I agree with the rule that you are not allowed to unleash your dog during the breeding season". This individual did not think that walkers with or without dogs pose a threat to shorebirds, but simultaneously held the contradictory belief that dogs must be leashed to protect incubating shorebirds.

3.6. Conclusion

Positive conservation outcomes are arguably contingent on inducing behavioural change. Human dimension research is beneficial to conservation because it represents a different lens in which to investigate and understand human-wildlife conflicts. However, human dimension research on shorebird conservation has only started to emerge fairly recently, and relatively few studies have included or focussed specifically on the human-dog-shorebird dynamic. This chapter determined recreationists' awareness of threats facing shorebirds, and recreationists' attitudes towards hypothetical regulations in the Blaauwberg Nature Reserve. An 'ambivalence' and 'contradiction' were identified from the Likert data and comments provided by the recreationists. In regards to the ambivalence theme, recreationists strongly agreed that shorebird protection and regulations were important, but were neutral or not in favour of the majority of the hypothetical regulations aimed at protecting shorebirds. Furthermore, recreationists also indicated that their least supported management actions were that "there should be no regulations on dog walking and/or walking". It was suggested that the recreationists were perhaps ambivalent because most visited the reserve beaches frequently, and thus would be affected by the hypothetical regulations if they were to be implemented. In regards to the contradiction theme, recreationists agreed that they were familiar with local shorebirds, but there was clearly a species literacy gap because the majority could only name one or two species, and the most common birds listed by a large margin were 'seagulls'. Recreationists were also found to be aware of almost all of the threats. However, the majority of the recreationists were dog walkers who also believed that their dogs posed no threat to shorebirds, their clutches, and chicks in the reserve. Furthermore, the majority of the recreationists who chose larger buffer zones for dogs were dog walkers, which means that they inadvertently indicated that dogs pose a greater threat to shorebirds than walkers without dogs. Recreationists agreed that they were familiar with regulations, and that they always followed the regulations. However, the majority of the dog walkers (80%) did not comply with the leashing regulation. The belief that their dogs pose no threat may have influenced compliance rates, along with other factors such as social norms, lack of leash enforcement, and the perceived benefits of unleashed dog exercised.

CHAPTER 4. TOWARDS A SOLUTION: PROVIDING EVIDENCE-BASED MANAGEMENT RECOMENDATIONS TO AID THE PROTECTION OF THE AFRICAN OYSTERCATCHER (*HAEMATOPUS MOQUINI*)

4.1. Introduction

It is well-established now that both the ecological and social dimensions of human disturbance need to be taken into account if conservation outcomes are going to be improved not only for shorebirds, but for wildlife in general. Despite this, research on human-shorebird conflicts usually remains siloed and most studies focus almost exclusively on the ecological dimension. The social dimension of human-shorebird conflicts needs to be investigated not only because conservation outcomes are oftentimes contingent on behavioural change, but also because people are stakeholders who stand to be affected by management decisions on beaches. Therefore, it is important to integrate both dimensions in order to identify practical and effective solutions to mitigate human-shorebird conflicts, and achieve 'win-win' outcomes. The aim of this research was to couple the ecological (Chapter 2) and social dimensions (Chapter 3) of human disturbance of oystercatchers in order to gain a better understanding of the ways in which the species can be further protected. Specific emphasis was placed on dog walking because dogs are a known threat to oystercatchers, and many other avian species both locally and internationally (Lord et al., 2001; Banks & Bryant, 2007; Loewenthal, 2007; Weston & Elgar, 2007; Hughes & Macdonald, 2013; Holderness-Roddam & McQuillan, 2014; Jorgensen, Dinan & Brown, 2016; Doherty et al., 2017; Cortés, Navedo & Silva-Rodríguez, 2021; Gómez-Serrano, 2021; Rebolo-Ifrán, Zamora-Nasca & Lambertucci, 2021).

4.2. Management recommendations

Three management recommendations are provided based on the findings of the two empirical studies, namely (I) implementing buffer zones to protect incubating oystercatchers, (II) enforcing the dog leashing regulation to reduce disturbance and improve breeding success, and (III) improving signage to increase awareness and ideally induce behavioural change. While similar management recommendations are suggested across geographical contexts (Weston et al., 2012b; Le Corre et al., 2013; Jorgensen & Brown, 2014), the presented recommendations will largely apply to the main study site, i.e. the Blaauwberg Nature Reserve. This is because of the context-specific nature of the results from the social dimension study, which was only conducted in the reserve.

4.2.1. Buffer zones

The implementation of buffer zones would be feasible and highly advisable. Buffer zones can be established quickly and affordably because common materials such as wooden poles and rope are sufficient to create a barrier between incubating shorebirds and recreationists. Simple rope fences have been shown to substantially reduce human disturbance, increase shorebird abundance, improve breeding success rates, and positively affect shorebird behaviour (Ikuta & Blumstein, 2003; Lafferty, Goodman & Sandoval, 2006; Weston et al., 2012b). Buffer zones only have to be temporary features. They can either be established prior to the breeding season in October to cordon off larger, known breeding hotspots (see Retief, 2020) or they can be established around pairs when they have made their final nest scrapes, and are in the early stages of producing a clutch (Hockey, 1982). Buffer zones can either be removed at the end of the breeding season in March or after a pair has successfully reared fledglings. Removing buffer zones at the end of the breeding season would be more ideal because oystercatchers may produce a few replacement clutches if their eggs are lost (Hockey, 1983b), and on rare occasions they may re-lay clutches despite successfully rearing chicks to fledgling (Parsons, 2006). Oystercatcher chicks are semi-precocial, but they are vulnerable to human disturbance and predation because they only fledge *ca.* 40 days after hatching (Tjørve, 2006). Thus, keeping buffer zones in place until the end of the breeding season would also protect chicks because they are known to hide in vegetation within their parents' territories (Fig. 26). Buffer zones also serve as a warning to recreationists. Oystercatchers rely on egg crypsis, distress calls, and distraction displays to conceal the location of their clutches and/or chicks (Hockey, 1982; Baker & Hockey, 1984). Therefore, recreationists are unlikely to know when they have stumbled into an incubating oystercatcher's territory and are disturbing the birds.

Fig. 26. A pre-fledgling oystercatcher seen in dune vegetation during the 2021/22 breeding season in the Blaauwberg Nature Reserve.

Including recreationists in the decision-making process can improve conservation outcomes (Burger & Niles, 2013) and possibly help avoid situations where recreationists become hostile towards management authorities (McCall, 2007) and birds (Catania, 2013). The majority of the recreationists in this study supported the implementation of buffer zones. Many recreationists showed preference for buffer zone sizes that happened to align with the incubating oystercatcher flight initiation distances in response to the dog treatment (± 50 m) or which were much greater than required (e.g. 100 m). The recreationists disagreed with a seasonal or permanent dog ban, but agreed that dogs should be restricted to certain areas of the reserve beaches during the breeding season. This possibly indicates that they would support a dog zonation system like those devised to protect the oystercatchers and White-fronted Plovers (*C. marginatus*) in the Greater Plettenberg Bay Area, South Africa (Fig. 27) (Brown, 2018b). Limiting dog access would not only benefit shorebirds (Dowling & Weston, 1999), but also the dog walkers who may only want to walk their dogs in leash zones due to safety concerns (Comber & Dayer, 2021), or the recreationists who seek dog-free experiences (Bridson, 2000). It would also appease the dog walkers who indicate that there are too few beaches that allow unleashed dog walking (Bowes et al., 2015; Guinness et al., 2020; Comber & Dayer, 2021). However, a dog zonation system may not be viable in the reserve at present given that the majority of the dog walkers (80%) do not comply with the leashing regulation. For example, Schneider et al. (2020) found that this system was ineffective in southern Victoria, Australia due to poor compliance with leash regulations. The majority (69.7%) of dogs in leash-only zones were unleashed (Schneider et al., 2020).

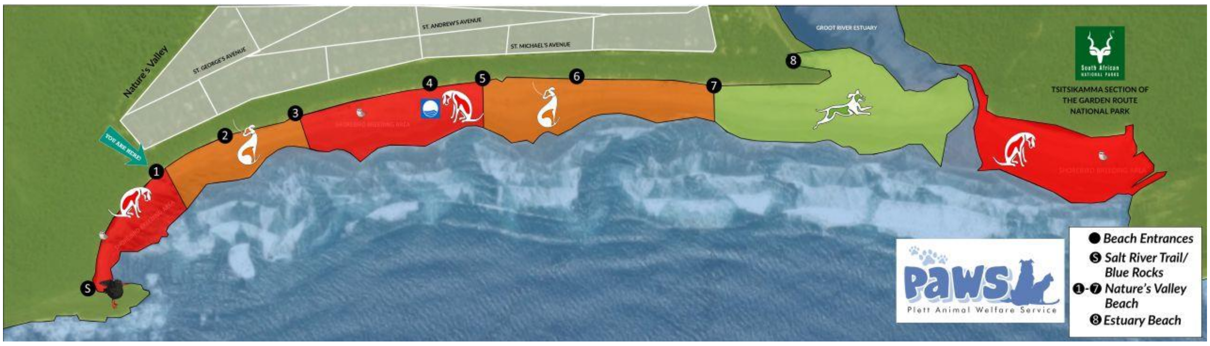

Fig. 27. A dog zonation system developed for Nature's Valley and Estuary Beach, South Africa (Nature's Valley Trust [NVT], 2017). The three different management zones are colour-coded: red zones are off limits to dogs, orange zones only allow leashed dogs, and the green zones allow unleashed dogs provided they are under their owner's command.

The effectiveness of the buffer zones would largely be contingent on reducing the number of unleashed dogs in the reserve. Firstly, it is likely that incubating oystercatchers will have longer flight initiation distances and return times in response to unleashed dogs because their movement patterns are more akin to natural predators (Weston & Stankowich, 2014). Studies have found that shorebirds are more likely to take flight in response to unleashed dogs (Weston & Elgar, 2007; Gómez-Serrano, 2021). A few observations appear to show that oystercatchers react much earlier to unleashed dogs (van de Voorde, Witteveen & Brown, 2015). The dog used to determine the flight initiation distances in this study was leashed. Secondly, unleashed dogs pose a greater threat to oystercatchers and other coastal birds because they can roam into buffer zones where they are not under the control or watch of their owners, and destroy clutches and predate chicks (Loewenthal, 2007; Paijmans, 2016). A local example occurred recently on Seaforth Beach, Western Cape where two free-roaming dogs killed 19 (17 adults and 2 chicks) endangered African Penguins (*Spheniscus demersus*), which is *ca.* 13% of the population (Pinnock, 2022). Unleashed dogs can also indirectly affect breeding success rates by revealing the location of clutches or chicks to natural predators (Summers & Cooper, 1977; Pienkowski, 1984; Calf & Underhill, 2002). The effectiveness of the buffer zones will also be partly contingent on keeping recreationists out because human interference accounts for a small percentage of the known causes of egg loss in mainland oystercatcher populations (Fig. 28) (Loewenthal, 2007).

Fig. 28. Footprints seen during the 2021/22 breeding season in a buffer zone for oystercatchers (pair “SB1”) and plovers in Scarborough.

There are a few potential drawbacks to the buffer zones: vandalism, theft, damage attributed to natural causes such as wave action and strong winds, disruptions to the ‘aesthetics’ of the landscape, buffers zones possibly getting washed away during storm surges, reserve personnel having to devote time to check that the buffer zones are still in place, potential damage to dune vegetation during their establishment and check-ups, and the buffer zones inadvertently attracting inquisitive recreationists to otherwise well-concealed clutches. Buffer zones can also be challenging to establish under certain circumstances, such as when clutches are produced in unfavourable locations. For example, the largest buffer zone placed around an incubating pair (SB1) in Scarborough was frequently stepped over by residents who used the paths through the dunes to get on and off the beach (pers. obs.). The pairs in the reserve between Kelpbaai and Haakgat may experience similar issues because their clutches were in close proximity to paths leading from a trail in the dunes to the beach (Fig. 29).

Fig. 29. An incubating oystercatcher (pair "BB2") in the Blaauwberg Nature Reserve seen from a popular trail during the 2021/22 breeding season.

The benefits of buffer zones arguably outweigh the potential drawbacks. Buffer zones are often suggested to protect multi-species communities (Rodgers & Smith, 1995; Rodgers & Schwikert, 2003; Glover et al., 2011; Chatwin, Joy & Burger, 2013; Braimoh et al., 2017). In such cases, the flight initiation distance of the most sensitive species is used to determine the appropriate size of the buffer zone. Baudains (2006) found that incubating White-fronted Plovers in a site with a comparative user group and disturbance level (Kommetjie Beach) had flight initiation distances that fall below those of the incubating oystercatchers in the reserve. Based on this finding, it is possible that the plovers in the reserve will also benefit from the buffer zones because they usually breed in close proximity to oystercatchers (Fig. 30). However, research would need to be conducted in the reserve given the context-specific nature of flight initiation distances (Blumstein et al., 2003). Overall, buffer zones can be effective by themselves, but they will be more effective with adaptive and pro-active management that tackles non-compliance, as well as in conjunction with other 'supportive' tools such as signage.

Fig. 30. A sequence showing a territorial display initiated by a White-fronted Plover in the Blaauwberg Nature Reserve during the 2021/22 breeding season. The unknowing oystercatcher had walked into the territory of the plover, which likely had a clutch or chicks in the vicinity. Both individuals had overlapping territories.

4.2.2. Signage

Signs have been shown to be important tools for conservation because they can prevent potentially harmful encounters between recreationists and wildlife (Abrams et al., 2020), reduce feeding (Mallick & Driessen, 2003), and keep recreationists from wandering off trails (Hockett, Marion & Leung, 2017). In regards to coastal birds, signs have been shown to improve awareness and knowledge (Ormsby & Forys, 2010), as well as substantially reduce disturbance (Allbrook & Quinn, 2020) and improve breeding success (Medeiros et al., 2007). There is a clear opportunity to increase awareness of oystercatchers and other species because this study showed that recreationists' knowledge of shorebirds in the reserve was very poor. The majority of the recreationists never knew that oystercatchers were found in the reserve despite them visiting frequently and the species being an unmistakable biophysical feature. The recreationists strongly agreed that signs with information about shorebirds would be helpful to them and some commented that they would like to see more signs in the reserve. Therefore, signs would be a welcomed intervention that could be used to help improve species literacy, induce behavioural change, and possibly build a connection between recreationists, oystercatchers and other coastal birds. However, research suggests that careful consideration needs to be placed on the location of the signs to ensure that they are clearly visible, their ability to draw and hold attention, the clarity of the message(s) that they are trying to convey, the illustrations or images used to support the message(s), the persuasive technique(s) employed to induce behavioural change, and the amount of information that they contain

(Hall, Ham & Lackey, 2010; Rimmer, Maguire & Weston, 2013; Marschall, Granquist & Burns, 2017; Cinner, 2018; Schoenleber, 2019). Regardless, some recreationists believe that signs are ineffective (Jorgensen & Brown, 2015), and may act in ways that are detrimental despite indicating that their actions are not acceptable (Hockett, Marion & Leung, 2017). Therefore, the goal is to minimise non-compliance as much as possible because there will always be recreationists who either ignore signs, or read signs but act against the best interests of wildlife and other visitors no matter how important the cause or explicit the message (Fig. 31) (Hall, Ham & Lackey, 2010; Schoenleber, 2019).

Fig. 31. A stolen rescue buoy seen in the Blaauwberg Nature Reserve.

Recreationists might be drawn to the buffer zones, but signs should indicate that they should not directly approach incubating oystercatchers or loiter in the area if they see the oystercatchers leave their clutches, perform distractions displays, and/or issue vocalisations (Baker & Hockey, 1984). Direct approaches have been shown to elicit greater responses from birds than tangential approaches (Burger & Gochfeld, 1981; Burger et al., 2010), and some species have been shown to spend more time off their nests in response to recreationists that are engaged in static activities, such as sunbathing (Weston, Ehmke & Maguire, 2011). Observations have shown that oystercatchers also take longer to resume incubation after being disturbed by stationary recreationists (van de Voorde, Witteveen & Brown, 2015). Therefore, the recreationists should be encouraged to stay away from buffer zones and walk along the foreshore where the probability of disturbing incubating shorebirds would be substantially lower (Lafferty, Goodman & Sandoval, 2006). Two identical and temporary signs should be placed a safe distance away from the buffer zones on either side so that recreationists can see them regardless of their approach direction (Weston et al., 2012b). These signs would represent the 'minimum approach distance', which is the distance that recreationists should be separated from wildlife in order to avoid eliciting a flight response (Livezey, Fernández-Juricic & Blumstein, 2016). Abrams et al. (2020) depicted safe wildlife viewing distances numerically and visually in the form of 'bus length' illustrations so that the message was understandable regardless of literacy or language barriers. The same approach can be adopted in the reserve because people tend to be unreliable estimators of distance (Strauss & Carnahan, 2010; Button, Schofield & Croft, 2016), which can have implications for conservation because recreationists may believe that they are viewing from a safe distance, while actually being too close. If possible, reserve personnel or volunteers could also be occasionally stationed near the signs to educate the recreationists about the incubating oystercatchers, as well as the reasons for the buffer zones (Lafferty, Goodman & Sandoval, 2006; Weston et al., 2012b; Hockett, Marion & Leung, 2017).

Information boards could be placed in the parking lots or on the beaches near the entrance and exit points (Brown, 2018b). Placing the information boards on the beaches may be more effective because it would make them stand out from the others in the parking lots (Rimmer, Maguire & Weston, 2013), while also minimising the 'visual pollution' caused by having too many signs in public spaces (Portella, 2014). Simply detailing regulations either with instructions (teleologically) or through interpretation (ontologically) appears to be ineffective because the recreationists agreed that they were familiar with the regulations depicted on the signs at the beach entrances. Yet, the majority of the dog walkers did not comply with the leash regulation. Therefore, alternative approaches need to be considered. Rimmer, Maguire and Weston (2013) found that recreationists preferred educational and persuasive messages over regulatory messages to help manage and protect Hooded Plovers (*Thinornis rubricollis*). However, preferences differed between user groups and according to visitation frequency (Rimmer, Maguire & Weston, 2013). As for dog walkers, those who visited most frequently preferred emotional messages and believed authoritative language and content (fines) to be the least effective approach (Rimmer, Maguire & Weston, 2013). This finding may have implications for management in the reserve given that the majority of the dog walkers visited many times each month. Dog walkers tend to be less supportive of fines and leash enforcement than non-dog owners (Bridson, 2000; Jorgensen & Brown, 2014). Other studies have found that certain user groups and/or demographics are more likely to disturb wildlife than others (Weston et al., 2012b; Marschall, Granquist & Burns, 2017). For example, men hold stronger beliefs that their dogs are more important than wildlife (Guinness et al., 2020) and they are also more likely to be non-compliant with buffer zones, along with younger (<20 years old) and older cohorts (>60 years old) (Weston et al., 2012b). Together, these findings indicate that signs should target certain user groups and/or demographics that typically engage in undesirable behaviours in order to improve conservation outcomes (see Kidd et al., 2019).

Emotion can play an important role in conservation because it shapes the ways in which species are perceived (Castillo-Huitrón et al., 2020). An 'appeal to emotion' is a commonly employed persuasive technique in daily life (Hamelin, Moujahid & Thaichon, 2017) that can be used to induce behavioural change because it has been shown to affect attitudes towards the environment (Searles, 2010). Different emotions can be targeted depending on the nature of the conservation issue, as some emotions may produce more favourable outcomes (Searles, 2010). For example, an enthusiasm appeal framed in a positive manner produced favourable attitudes towards the environment in public service announcements, whereas an anxiety appeal framed in a negative manner produced unfavourable attitudes (Searles, 2010). However, appealing to sadness rather than hope has been shown to motivate people to want to adopt pro-environmental behaviours and seek further information on the ways in which they can aid in conservation (Lu, 2015). Once again, framing is important because appeals to sadness appear to be more effective when framed positively (gain framing) (Lu, 2015). However, loss aversion bias dictates that people tend to view potential losses as being more emotionally salient than potential gains (Kahneman, Knetsch & Thaler, 1991). In regards to the incubating oystercatchers, an appeal to sadness could frame leash non-compliance in a manner that emphasises the potential losses (loss framing) linked to unleashed dog walking, which would be egg loss and chick mortality for the oystercatchers (Loewenthal, 2007), and emotional trauma and financial damages for the dog walkers if a fight occurs between pets (Jorgensen & Brown, 2017).

Appealing to the character and aesthetics of a species may also improve compliance. Character and aesthetic characteristics such as colour, texture, body size, body shape and life history stage all influence perception (Shackleton et al., 2019; Castillo-Huitrón et al., 2020). For example, species that are perceived as 'lovable' receive higher affinity ratings from women than those that typically invoke feelings of fear, anxiety and disgust (Schlegel & Rupf, 2010). For this reason, it is easier to gain public support for the eradication of rats than other invasive alien species like 'cute' squirrels (Kueffer & Kull, 2017). Birds are usually viewed favourably

(Schlegel & Rupf, 2010) and oystercatchers are described as 'charismatic' (Brown et al., 2019). While there is no ubiquitous definition of a charismatic species, the term is frequently employed because it can help raise public awareness and support for conservation efforts (Ducarme, Luque & Courchamp, 2013). Recreationists in some cases have been shown to be more captivated by narrative signage (Hall, Ham & Lackey, 2010; Schoenleber, 2019), as well as signage with colourful images and messages that help personalise shorebirds and the issues that they are facing (Rimmer, Maguire & Weston, 2013). Therefore, narrative signs could be used to tell the oystercatcher story in the reserve, which may help recreationists personalise and form a bond with these charismatic shorebirds. Recreationists could be informed about the fact that oystercatchers are a long-lived species that are site and mate-faithful (Loewenthal, 2007). This means that the same pairs can be found in the same areas for well over a decade if they are not forced out by disturbance (Williams, Ward & Underhill, 2003) or succumb to natural or anthropogenic causes (Loewenthal, 2007). In essence, the 'resident' oystercatchers form part of the community and undesirable activities such as unleashed dog walking can have cumulative effects that may only emerge over a long period of time. Images of 'cute' (Wang, Mukhopadhyay & Patrick, 2017) oystercatcher chicks or fledglings could be used on the narrative signs as an appeal to emotion to induce empathy and encourage pro-social behaviours (Hall, Ham & Lackey, 2010).

People are becoming increasingly separated from nature in what is termed the 'extinction of experience' (Soga & Gaston, 2016). This progressive alienation from nature is detrimental to the physical and psychological well-being of society (Soga & Gaston, 2016). Furthermore, it is also detrimental to nature and conservation efforts because it can lead to a decline in pro-environmental attitudes and behaviours, as well as create a cycle of disaffection (Soga & Gaston, 2016). Children in particular are spending less time in nature than previous generations, and consequently the percentage of those who have never engaged in common outdoor activities like fishing, climbing trees, catching insects, and bird watching is increasing (Soga & Gaston, 2016). Engaging in 'appreciative' outdoor activities like bird watching or 'consumptive' outdoor activities like fishing during formative years has been shown to positively influence environmental attitudes later on in life (Ewert, Place & Sibthorp, 2005). Childrens' willingness to conserve biodiversity is also associated with their 'vicarious' experiences of nature that occurs through reading, watching nature-oriented TV programmes, and learning through conversation (Soga et al., 2016). Providing environmental education to children has been shown to improve interest, awareness, identification skills, and attitudes towards birds (White, Eberstein & Scott, 2018), and it can also have a positive 'knock-on' effect on their parents' knowledge and behaviours (Damerell, Howe & Milner-Gulland, 2013). Children and teenagers have also been shown to be less compliant with non-descript signage, and disturb wildlife more so than older cohorts (Marschall, Granquist & Burns, 2017). Therefore, children visiting the reserve beaches should be targeted through tailored signage. This can possibly be done by creating eye-catching, narrative signs that depict oystercatchers in a cartoonish manner with neotenic features, such as larger eyes (Shackleton et al., 2019). Local school children could also learn about and indirectly help protect the incubating oystercatchers by creating signs for the recreationists to read (see Comber & Dayer, 2019).

4.3. Limitations and future research

This research did not determine the effect of dog walking on oystercatcher breeding success. It was conducted under the assumption that dogs have an impact on oystercatchers because they have been shown to directly affect breeding success in other parts of the country (Loewenthal, 2007). Dogs have also been shown to kill chicks in Noordhoek (Paijmans, 2016), and possibly damage eggs, and cause or contribute to clutch abandonment in Blaauwberg (Retief, 2020). This research also did not determine if the incubating oystercatchers habituate to disturbance over the course of the breeding season (see Baudains, 2006), which may have implications for buffer zone size. However, van de Voorde, Witteveen and Brown (2015) found that incubating oystercatchers in other parts of the country do not habituate to frequent, high levels of disturbance that appears to be common in the study sites. This research adopted an experimental design, which allowed the researcher to control a range of potentially confounding variables, namely starting distance (Blumstein, 2003), approach speed (Bernard et al., 2018), approach direction (Burger et al., 2010), and clothing colour (Gould et al., 2004). However, the data obtained from experimental approaches are not necessarily representative of typical human-wildlife interactions because recreationists are unlikely to approach in a straight line at a constant walking speed of 1 m/s like the standard procedure recommends (Blumstein, 2003). The leash approach adopted in this study is also not necessarily representative of the typical dog-oystercatcher interactions because the majority of the dog walkers do not comply with the leash regulation. Hence, the need for observational research to determine oystercatcher flight initiation distances and return times in response to stimuli as they occur 'naturally' (van de Voorde, Witteveen & Brown, 2015). It is also possible that oystercatcher flight initiation distances were somewhat affected by Covid-19 lockdowns.

Some studies have reported differences in flight initiation distances before, during and after lockdowns (Diamant et al., 2023; Díaz & Møller, 2023), but not all (Mikula et al., 2022).

Sample size was another limitation in both chapters of this research. In regards to Chapter 2, there were relatively few breeding pairs across the three study sites, in comparison to local island sites which can have well over 100 breeding pairs and clutches a season (Quintana, Button & Underhill, 2021). Hence, all of the breeding pairs that were detected across the three study sites were approached. In regards to Chapter 3, the majority of the recreationists that were approached during surveying were unwilling to participate, which differs from similar studies that report response rates between 65-94% (Nesbitt, 2006; van Polanen Petel & Bunce, 2012; Jorgensen & Brown, 2017; Schoenleber, 2019). This may have been precautionary because the surveys coincided with a period of peak Covid-19 infection. Furthermore, it may have also been associated with elevated levels of stress and depression exhibited by the South African population, which was caused by uncertainty for the future, lengthy lockdowns, loss of loved ones, loss of income, and other factors (Greyling, Rossouw & Adhikari, 2020; Nguse & Wassenaar, 2021; Posel, Oyenubi & Kollamparambil, 2021). Future research should aim to determine the effectiveness of the recommended protective measures from an ecological and social perspective. In regards to the ecological dimension, a 'before-and-after' study should determine whether the buffer zones increase breeding success at the incubation (hatching success rate) and chick-rearing stages (fledgling success rate) of the oystercatcher reproductive cycle (Loewenthal, 2007). This would involve a comparison between the pre-intervention data kept by the reserve and the post-intervention data collected over a few breeding seasons. As for the social dimension, research should be conducted to determine the effectiveness of various types of signs (e.g. normative, narrative, descriptive etc) in terms (I) getting dog walkers to adhere to the leash regulation, and (II) keeping recreationists out of the buffer zones.

4.4. Conclusion

Three evidence-based management recommendations are provided based on the findings of the ecological and social components of this research. Firstly, it is suggested that buffer zones should be implemented due to their affordability, ease of establishment, effectiveness elsewhere, and because they have the support of the recreationists visiting the reserve. Secondly, it is recommended that a pro-active approach should be adopted by management to quell the number of unleashed dogs in the reserve because the effectiveness of buffer zones is largely contingent on preventing dogs from depredating oystercatcher eggs and chicks. Lastly, it is recommended that signs should be used in conjunction with the buffer zones. However, careful consideration needs to be placed on a range of factors to ensure their effectiveness, such as their location, ability to draw attention, the type of message, and the clarity of the message that they are conveying. It is suggested that signs depicting safe viewing distances both numerically and visually (via illustrations) should be erected on either side of the buffer zones so that they are interpretable regardless of literacy or language barriers, and so that they are unmissable regardless of the recreationists' approach directions. Larger information boards are suggested for the beach entrance and exit points. These boards can adopt a 'narrative' format and use persuasive techniques such as 'an appeal to emotion' to help personalise the oystercatchers, educate recreationists about the plight of this 'charismatic' species, and ideally encourage recreationists to adopt pro-social behaviours. Signage should also be designed to be accessible or appealing to children because they are the next generation of stewards of the environment, yet younger cohorts are becoming increasingly disconnected from the environment, which has many conservation implications. However, future research should ultimately determine the effectiveness the buffer zones and different types of signage from both an ecological and social standpoint.

References

Abrams, K.M., Leong, K., Melena, S. & Teel, T. 2020. Encouraging safe wildlife viewing in national parks: effects of a communication campaign on visitors' behavior. *Environmental Communication*. 14(2):255-270. DOI:10.1080/17524032.2019.1649291

Adams, N.J., Kerley, G.I.H. & Watson, J.J. 1999. Disturbance of incubating African Black Oystercatchers: is heating of exposed eggs a problem? *Ostrich*. 70(3-4):225-228. DOI:10.1080/00306525.1999.9634241

Allbrook, D.L. & Quinn, J.L. 2020. The effectiveness of regulatory signs in controlling human behaviour and Northern gannet (*Morus bassanus*) disturbance during breeding: An experimental test. *Journal for Nature Conservation*. 58(2020):1-8. DOI:10.1016/j.jnc.2020.125915

Amiot, C., Bastian, B. & Martens, P. 2016. People and companion animals: it takes two to tango. *BioScience*. 66(7):552-560. DOI:10.1093/biosci/biw051

Andersen, S.M., Teilmann, J., Dietz, R., Schmidt, N.M. & Miller, L.A. 2012. Behavioural responses of harbour seals to human-induced disturbances. *Aquatic Conservation: Marine and Freshwater Ecosystems*. 22(1):113-121. DOI:10.1002/aqc.1244

Anderson, A., Lindell, C.A., Moxcey, K.M., Siemer, W.F., Linz, G.M., Curtis, P.D., Carroll, J.E., Burrows, C.L. et al. 2013. Bird damage to select fruit crops: the cost of damage and the benefits of control in five states. *Crop Protection*. 52(2013):103-109. DOI:10.1016/j.cropro.2013.05.019

Anderson, O.R., Small, C.J., Croxall, J.P., Dunn, E.K., Sullivan, B.J., Yates, O. & Black, A. 2011. Global seabird bycatch in longline fisheries. *Endangered Species Research*. 14(2):91-106. DOI:10.3354/esr00347

Antos, M.J., Ehmke, G.C., Tzaros, C.L. & Weston, M.A. 2007. Unauthorised human use of an urban coastal wetland sanctuary: current and future patterns. *Landscape and Urban Planning*. 80(1-2):173-183. DOI:10.1016/j.landurbplan.2006.07.005

Assis, J., Zupan, M., Nicastro, K.R., Zardi, G.I., McQuaid, C.D. & Serrao, E.A. 2015. Oceanographic conditions limit the spread of a marine invader along southern African shores. *PLoS One*. 10(6):1-17. DOI:10.1371/journal.pone.0128124

Bailey, R.L., Faulkner-Grant, H.A., Martin, V.Y., Phillips, T.B. & Bonter, D.N. 2020. Nest usurpation by non-native birds and the role of people in nest box management. *Conservation Science and Practice.* 2(5):1-12: DOI:10.1111/csp2.185

Baker, A.J. & Hockey, P.A.R. 1984. Behavioral and vocal affinities of the African black oystercatcher (*Haematopus moquini*). *The Wilson Bulletin*. 96(4):656-671. Available: https://www.jstor.org/stable/4161999 [2022, March 6]

Balmford, A., Beresford, J., Green, J., Naidoo, R., Walpole, M. & Manica, A. 2009. A global perspective on trends in nature-based tourism. *PLoS Biology*. 7(6):1-6. DOI:10.1371/journal.pbio.1000144

Banks, P.B. & Bryant, J.V. 2007. Four-legged friend or foe? Dog walking displaces native birds from natural areas. *Biology Letters*. 3(6):611-613. DOI:10.1098/rsbl.2007.0374

Barbier, E.B., Hacker, S.D., Kennedy, C., Koch, E.W., Stier, A.C. & Silliman, B.R. 2011. The value of estuarine and coastal ecosystem services. *Ecological Monographs*. 81(2):169-193. DOI:10.1890/10-1510.1

Baudains, T.P. 2006. The effect of human disturbance on the response behaviour and breeding success of a common shore-nesting bird, the White-fronted plover *Charadrius marginatus*, on the Cape Peninsula. MSc. Thesis. University of Cape Town

Beale, C.M. & Monaghan, P. 2004. Behavioural responses to human disturbance: a matter of choice? *Animal Behaviour*. 68(5):1065-1069. DOI:10.1016/j.anbehav.2004.07.002

Bellard, C., Cassey, P. & Blackburn, T.M. 2016. Alien species as a driver of recent extinctions. *Biology Letters*. 12(2):p20150623. DOI:10.1098/rsbl.2015.0623

Bell, T., Harriss, J., Ruzaini, A., Fernando, C., Guay, P.J. & Weston, M.A. 2019. Flight initiation distance in dragonflies is species-specific, positively related to starting distance and sometimes body length. *International Journal of Odonatology*. 22(3-4):173-179. DOI:10.1080/13887890.2019.1668306

Bennett, P.M. & Harvey, P.H. 1987. Active and resting metabolism in birds: allometry, phylogeny and ecology. *Journal of Zoology*. 213(2):327-344. DOI:10.1111/j.1469-7998.1987.tb03708.x

Bernard, G.E., van Dongen, W.F., Guay, P.J., Symonds, M.R., Robinson, R.W. & Weston, M.A. 2018. Bicycles evoke longer flight-initiation distances and higher intensity escape behaviour of some birds in parks compared with pedestrians. *Landscape and Urban Planning*. 178(2018):276-280. DOI:10.1016/j.landurbplan.2018.06.006

Bezuidenhout, N. 2022. *Armed robbery at 'high risk' beach area*. Available: https://www.news24.com/news24/southafrica/local/peoples-post/armed-robbery-at-high-risk-beach-area-20220214 [2022, July 20].

BirdLife International. 2017. *Haematopus moquini*. The IUCN Red List of Threatened Species. Available: https://www.iucnredlist.org/species/22693627/118385157 [2022, June 7]

BirdLife International. 2018. *State of the world's birds: taking the pulse of the planet*. Available: https://www.birdlife.org/wp-content/uploads/2021/02/SOWB2018_en.pdf [2022, June 7]

BirdLife International. 2021. *State of the world's birds: 2021 update*. Available: http://datazone.birdlife.org/2021-annual-update [2022, June 8]

Blumstein, D.T. 2003. Flight-initiation distance in birds is dependent on intruder starting distance. *The Journal of Wildlife Management*. 67(4):852-857. DOI:10.2307/3802692

Blumstein, D.T. 2006. Developing an evolutionary ecology of fear: how life history and natural history traits affect disturbance tolerance in birds. *Animal Behaviour*. 71(2):389-399. DOI:10.1016/j.anbehav.2005.05.010

Blumstein, D.T., Anthony, L.L., Harcourt, R. & Ross, G. 2003. Testing a key assumption of wildlife buffer zones: is flight initiation distance a species-specific trait? *Biological Conservation*. 110(1):97-100. DOI:10.1016/S0006-3207(02)00180-5

Blumstein, D.T., Samia, D.S. & Cooper Jr, W.E. 2016. Escape behavior: dynamic decisions and a growing consensus. *Current Opinion in Behavioral Sciences*. 12(2016):24-29. DOI:10.1016/j.cobeha.2016.08.006

Borneman, T.E., Rose, E.T. & Simons, T.R. 2016. Off-road vehicles affect nesting behaviour and reproductive success of American Oystercatchers *Haematopus palliatus*. *Ibis*. 158(2):261-278. DOI:10.1111/ibi.12358

Bowes, M., Keller, P., Rollins, R. & Gifford, R. 2015. Parks, dogs, and beaches: human-wildlife conflict and the politics of place. In *Domestic Animals and Leisure*. N. Carr, Ed. London: Palgrave Macmillan. 146-171.

Bradshaw, C.J., Leroy, B., Bellard, C., Roiz, D., Albert, C., Fournier, A., Barbet-Massin, M., Salles, J.M. et al. 2016. Massive yet grossly underestimated global costs of invasive insects. *Nature Communications*. 7(1):1-8. DOI:10.1038/ncomms12986

Braimoh, B., Iwajomo, S., Wilson, M., Chaskda, A., Ajang, A. & Cresswell, W. 2017. Managing human disturbance: factors influencing flight-initiation distance of birds in a West African nature reserve. *Ostrich*. 89(1):59-69. DOI:10.2989/00306525.2017.1388300

Braine, S., 1987. Extension of the breeding range of the African Black Oystercatcher *Haematopus moquini*. *Modoqua*. 15(1):87-88. Available: https://journals.co.za/doi/pdf/10.10520/AJA10115498_544 [2022, June 7]

Breheny, P. & Burchett, W. 2017. Visualization of regression models using visreg. *The R Journal*. 9(2):56-71.

Bridson, L. 2000. *Minimising visitor impacts on threatened shorebirds and their habitats*. Wellington, New Zealand: Department of Conservation.

Brown, A.L. 1990. Measuring the effect of aircraft noise on sea birds. *Environment International*. 16(4-6):587-592. DOI:10.1016/0160-4120(90)90029-6

Brown, M. 2018a. Inclusive conservation. *African Birdlife*. 6(6). September/October 2018.

Brown, M. 2018b. #ShareTheShores: a proactive approach to coastal conservation. *African Birdlife.* 6(5). July/August 2018.

Brown, M., Arendse, B., Mels, B. & Lee, A.T. 2019. Bucking the trend: the African Black Oystercatcher as a recent conservation success story. *Journal of African Ornithology*. 90(4):327-333. DOI: 10.2989/00306525.2019.1679904

Brown, M. & Hockey, P.A.R. 2007. The status and distribution of African black oystercatchers *Haematopus moquini* in Kwazulu-Natal, South Africa. *Ostrich*. 78(1):93-96. DOI:10.2989/OSTRICH.2007.78.1.14.58

Buchanan, G.M., Butchart, S.H., Chandler, G. & Gregory, R.D. 2020. Assessment of national-level progress towards elements of the Aichi Biodiversity Targets. *Ecological Indicators*. 116(2020):106497. DOI:10.1016/j.ecolind.2020.106497

Buchanan, G.M., Donald, P.F. & Butchart, S.H. 2011. Identifying priority areas for conservation: a global assessment for forest-dependent birds. *PloS One*. 6(12):1-10. DOI:10.1371/journal.pone.0029080

Buckley, R. 2004. Impacts of ecotourism on birds. In *Environmental impacts of ecotourism*. R. Buckley, Ed. Cambridge: CAB International. 187-210.

Bulleri, F. & Chapman, M.G. 2010. The introduction of coastal infrastructure as a driver of change in marine environments. *Journal of Applied Ecology*. 47(1):26-35. DOI:10.1111/j.1365-2664.2009.01751.x

Burger, J. & Gochfeld, M. 1981. Discrimination of the threat of direct versus tangential approach to the nest by incubating herring and great black-backed gulls. *Journal of Comparative and Physiological Psychology*. 95(5):676-684. DOI:10.1037/h0077811

Burger, J., Gochfeld, M., Saliva, J.E., Gochfeld, D., Gochfeld, D. & Morales, H. 1989. Antipredator behaviour in nesting zenaida doves (*Zenaida aurita*): parental investment or offspring vulnerability. *Behaviour*. 111(1-4):129-143.

Burger, J., Gochfeld, M., Jenkins, C.D. & Lesser, F. 2010. Effect of approaching boats on nesting black skimmers: using response distances to establish protective buffer zones. *The Journal of Wildlife Management*. 74(1):102-108. DOI:10.2193/2008-576

Burger, J. & Niles, L. 2013. Shorebirds and stakeholders: effects of beach closure and human activities on shorebirds at a New Jersey coastal beach. *Urban Ecosystems*. 16(3):657-673. DOI:10.1007/s11252-012-0269-9

Burns, F., Eaton, M.A., Burfield, I.J., Klvaňová, A., Šilarová, E., Staneva, A. & Gregory, R.D. 2021. Abundance decline in the avifauna of the European Union reveals cross-continental similarities in biodiversity change. *Ecology and Evolution*. 11(23):16647-16660. DOI:10.1002/ece3.8282

Butchart, S.H., Walpole, M., Collen, B., Van Strien, A., Scharlemann, J.P., Almond, R.E., Baillie, J.E., Bomhard, B. et al. 2010. Global biodiversity: indicators of recent declines. *Science*. 328(5982):1164-1168. DOI:10.1126/science.1187512

Button, C., Schofield, M. & Croft, J. 2016. Distance perception in an open water environment: Analysis of individual differences. *Attention, Perception, & Psychophysics*. 78(3):915-922. DOI:10.3758/s13414-015-1049-4

Cabrera, D., Andres, D., McLoughlin, P.D., Debeffe, L., Medill, S.A., Wilson, A.J. & Poissant, J. 2017. Island tameness and the repeatability of flight initiation distance in a large herbivore. *Canadian Journal of Zoology*. 95(10):771-778. DOI:10.1139/cjz-2016-0305

Calf, K.M. & Underhill, L.G. 2002. Productivity of African black oystercatchers *Haematopus moquini* on Robben Island, South Africa, in the 2001-2002 breeding season. *Wader Study Group Bulletin*. 99. 45-49.

Calf, K.M. & Underhill, L.G., 2005. Tidal impact on breeding African Black Oystercatchers on Robben Island, Western Cape, South Africa. *Ostrich*. 76(3-4):219-221. DOI:10.2989/00306520509485497

Cardinale, B.J., Duffy, J.E., Gonzalez, A., Hooper, D.U., Perrings, C., Venail, P., Narwani, A., Mace, G.M., Tilman, D. et al. 2012. Biodiversity loss and its impact on humanity. *Nature*. 486(7401):59-67. DOI:10.1038/nature11148

Castillo-Huitrón, N.M., Naranjo, E.J., Santos-Fita, D. & Estrada-Lugo, E. 2020. The importance of human emotions for wildlife conservation. *Frontiers in Psychology*. 11(1277):1-11. DOI:10.3389/fpsyg.2020.01277

Catania, T.R. 2013. (K) not on Our Watch: The Politics of Saving Migratory Shorebirds in Delaware Bay. MA. Thesis. Wesleyan University.

Cavalli, M., Baladrón, A.V., Isacch, J.P., Biondi, L.M. & Bó, M.S. 2016. Differential risk perception of rural and urban Burrowing Owls exposed to humans and dogs. *Behavioural Processes*. 124(2016):60-65. DOI:10.1016/j.beproc.2015.12.006

Ceballos, G., Ehrlich, P.R., Barnosky, A.D., García, A., Pringle, R.M. & Palmer, T.M. 2015. Accelerated modern human–induced species losses: entering the sixth mass extinction. *Science Advances*. 1(5):1-5. DOI:10.1126/sciadv.1400253

Celliers, L. & Ntombela, C. 2015. Urbanisation, coastal development and vulnerability, and catchments. In *Regional state of the coast report: Western Indian Ocean*. J. Paula, Ed. United Nations Environmental Programme. 387-406.

Charles, N. 2014. 'Animals just love you as you are': experiencing kinship across the species barrier. *Sociology*. 48(4):715-730. DOI:10.1177/0038038513515353

Charuvi, A., Lees, D., Glover, H.K., Rendall, A.R., Dann, P. & Weston, M.A. 2020. A physiological cost to behavioural tolerance. *Behavioural Processes*. 181(2020):1-9. DOI:10.1016/j.beproc.2020.104250

Chatwin, T.A., Joy, R. & Burger, A.E. 2013. Set-back distances to protect nesting and roosting seabirds off Vancouver Island from boat disturbance. *Waterbirds*. 36(1):43-52. DOI:10.1675/063.036.0108

Christian, H., Bauman, A., Epping, J.N., Levine, G.N., McCormack, G., Rhodes, R.E., Richards, E., Rock, M. et al. 2016. Encouraging dog walking for health promotion and disease prevention. *American Journal of Lifestyle Medicine*. 12(3):233-243. DOI:10.1177/1559827616643686

Cinner, J. 2018. How behavioral science can help conservation. *Science*. 362(6417):889-890. DOI:10.1126/science.aau6028

Coleman, R.A. & Hockey, P.A.R. 2008. Effects of an alien invertebrate species and wave action on prey selection by African black oystercatchers (*Haematopus moquini*). *Austral Ecology*. 33(2):232-240. DOI:10.1111/j.1442-9993.2008.01864.x

Collar, N.J. & Butchart, S.H.M. 2014. Conservation breeding and avian diversity: chances and challenges. *International Zoo Yearbook*. 48(1):7-28. DOI:10.1111/izy.12039

Colwell, M.A. 2010. *Shorebird ecology, conservation, and management*. California, United States of America: University of California Press.

Cooke, A.S. 1980. Observations on how close certain passerine species will tolerate an approaching human in rural and suburban areas. *Biological Conservation*. 18(2):85-88. DOI:10.1016/0006-3207(80)90072-5

Cooper, T.J., Wannenburgh, A.M. & Cherry, M.I. 2017. Atlas data indicate forest dependent bird species declines in South Africa. *Bird Conservation International*. 27(3):337-354. DOI:10.1017/S095927091600040X

Cooper, W.E.J & Whiting, M.J. 2007. Universal optimization of flight initiation distance and habitat-driven variation in escape tactics in a Namibian lizard assemblage. *Ethology*. 113(7):661-672. DOI:10.1111/j.1439-0310.2007.01363.x

Comber, C. & Dayer, A.A. 2019. *Evaluating the effectiveness of children's signs at reducing the threat of human disturbance to coastal birds*. Department of Fish and Wildlife. Blacksburg, Virginia: College of Natural Resources & Environment

Comber, C.A. & Dayer, A.A. 2021. Understanding attitudes and norms of dog walkers to reduce disturbances to shorebirds. *Human Dimensions of Wildlife*. 27(3):236-250. DOI:10.1080/10871209.2021.1915437

Concepción, E.D., Moretti, M., Altermatt, F., Nobis, M.P. & Obrist, M.K. 2015. Impacts of urbanisation on biodiversity: the role of species mobility, degree of specialisation and spatial scale. *Oikos*. *124*(12):1571-1582. DOI:10.1111/oik.02166

Cortés, E.I., Navedo, J.G. & Silva-Rodríguez, E.A. 2021. Widespread presence of domestic dogs on sandy beaches of southern Chile. *Animals*. 11(1):161-172. DOI:10.3390/ani11010161

Cox, D.T. & Gaston, K.J. 2015. Likeability of garden birds: Importance of species knowledge & richness in connecting people to nature. *PloS One*. 10(11):1-14. DOI:10.1371/journal.pone.0141505

Damerell, P., Howe, C. & Milner-Gulland, E.J. 2013. Child-orientated environmental education influences adult knowledge and household behaviour. *Environmental Research Letters*. 8(1):1-7. DOI:10.1088/1748-9326/8/1/015016

Davenport, J. & Davenport, J.L. 2006. The impact of tourism and personal leisure transport on coastal environments: a review. *Estuarine, Coastal and Shelf Science*. 67(1-2):280-292. DOI:10.1016/j.ecss.2005.11.026

Day, L., Ollis, D., Ngobela, T. & Rivers-Moore, N. 2020. *Water quality of rivers and open waterbodies in the City of Cape Town: Status and historical trends, with a focus on the period April 2015 to March 2020*. Cape Town, South Africa: Liz Day Consulting.

Dear, E.J., Guay, P.J., Robinson, R.W. & Weston, M.A. 2015. Distance from shore positively influences alert distance in three wetland bird species. *Wetlands Ecology and Management*. 23(2):315-318. DOI:10.1007/s11273-014-9376-0

de Blocq van Scheltinga, A. 2017. Disturbance effects of boat-based tourism on waterbirds at the Ramsar-designated De Hoop Vlei, Western Cape, South Africa. MSc. Thesis. University of Cape Town.

de Boer, W.F. & Bento, C.M. 1999. Birds of Inhaca Island, Mozambique. Mondi BLSA Guide 22. BirdLife South Africa: Johannesburg.

de Jong, A., Magnhagen, C. & Thulin, C.G. 2013. Variable flight initiation distance in incubating Eurasian curlew. *Behavioral Ecology and Sociobiology*. 67(7):1089-1096. DOI:10.1007/s00265-013-1533-6

DeRose-Wilson, A.L., Hunt, K.L., Monk, J.D., Catlin, D.H., Karpanty, S.M. & Fraser, J.D. 2018. Piping Plover chick survival negatively correlated with beach recreation. *The Journal of Wildlife Management*. 82(8):1608-1616. DOI:10.1002/jwmg.21552

de Villiers, M.S., Mecenero, S., Sherley, R.B., Heinze, E., Kieser, J., Leshoro, T.M., Merbold, L., Nordt, A. et al. 2010. Introduced European rabbits (*Oryctolagus cuniculus*) and domestic cats (*Felis catus*) on Robben Island: population trends and management recommendations. *South African Journal of Wildlife Research*. 40(2):139-148. DOI:10.3957/056.040.0205

Diamant, E.S., MacGregor-Fors, I., Blumstein, D.T. & Yeh, P.J. 2023. Urban birds become less fearful following COVID-19 reopenings. *Proceedings of the Royal Society B*. 290(2005):1-8. DOI:10.1098/rspb.2023.1338

Díaz, M. & Møller, A.P. 2023. Lockdown effects on fear revealed direct and indirect effects of human presence on perceived predation risk. *Science of The Total Environment*. 872(2023):1-7. DOI:10.1016/j.scitotenv.2023.162122

Doherty, T.S., Dickman, C.R., Glen, A.S., Newsome, T.M., Nimmo, D.G., Ritchie, E.G., Vanak, A.T. & Wirsing, A.J. 2017. The global impacts of domestic dogs on threatened vertebrates. *Biological Conservation*. 210(2017):56-59. DOI:10.1016/j.biocon.2017.04.007

Doherty, T.S., Glen, A.S., Nimmo, D.G., Ritchie, E.G. & Dickman, C.R., 2016. Invasive predators and global biodiversity loss. *Proceedings of the National Academy of Sciences*. 113(40):11261-11265. DOI:10.1073/pnas.1602480113

Dowling, B. & Weston, M.A. 1999. Managing a breeding population of the Hooded Plover *Thinornis rubricollis* in a high-use recreational environment. *Bird Conservation International*. 9(3):255-270. DOI:10.1017/S0959270900003440

Driscoll, C.A. & Macdonald, D.W. 2010. Top dogs: wolf domestication and wealth. *Journal of Biology*. 9(2):1-6. DOI:10.1186/jbiol226

Ducarme, F., Luque, G.M. & Courchamp, F. 2013. What are "charismatic species" for conservation biologists? *BioSciences Master Reviews*. 10(2013):1-8.

Dueñas, M.A., Hemming, D.J., Roberts, A. & Diaz-Soltero, H. 2021. The threat of invasive species to IUCN-listed critically endangered species: a systematic review. *Global Ecology and Conservation*. 26(2021):e01476. DOI:10.1016/j.gecco.2021.e01476

Dulvy, N.K., Pacoureau, N., Rigby, C.L., Pollom, R.A., Jabado, R.W., Ebert, D.A., Finucci, B., Pollock, C.M. et al. 2021. Overfishing drives over one-third of all sharks and rays toward a global extinction crisis. *Current Biology*. 31(21):4773-4787. DOI:10.1016/j.cub.2021.08.062

Engelhardt, S.C. & Weladji, R.B. 2011. Effects of levels of human exposure on flight initiation distance and distance to refuge in foraging eastern gray squirrels (*Sciurus carolinensis*). *Canadian Journal of Zoology*. 89(9):823-830. DOI:10.1139/z11-054

Ens, B.J. & Underhill, L.G. 2014. Synthesis of oystercatcher conservation assessments: general lessons and recommendations. *International Wader Studies*. 20:5-22.

Ewert, A., Place, G. & Sibthorp, J. 2005. Early-life outdoor experiences and an individual's environmental attitudes. *Leisure Sciences*. 27(3):225-239. DOI:10.1080/01490400590930853

Faillace, C.A. & Smith, B.W. 2016. Incubating snowy plovers (*Charadrius nivosus*) exhibit site-specific patterns of disturbance from human activities. *Wildlife Research*. 43(4):288-297. DOI:10.1071/WR15194

Fanning, A.L., O'Neill, D.W., Hickel, J. & Roux, N. 2022. The social shortfall and ecological overshoot of nations. *Nature Sustainability*. 5(1):26-36. DOI:10.1038/s41893-021-00799-z

Fernández-Juricic, E., Jimenez, M.D. and Lucas, E., 2002. Factors affecting intra-and inter-specific variations in the difference between alert distances and flight distances for birds in forested habitats. *Canadian Journal of Zoology*. 80(7):1212-1220. DOI:10.1139/Z02-104

Fernández-Juricic, E., Venier, M.P., Renison, D. & Blumstein, D.T. 2005. Sensitivity of wildlife to spatial patterns of recreationist behavior: a critical assessment of minimum approaching distances and buffer areas for grassland birds. *Biological Conservation*. 125(2):225-235. DOI:10.1016/j.biocon.2005.03.020

Flemming, S., Lanctot, R.B., Price, C., Mallory, M.L., Kühn, S., Drever, M.C., Barry, T. & Provencher, J.F. 2022. Shorebirds ingest plastics too: what we know, what we don't know, and what we should do next. *Environmental Reviews*. 30(1):1-15. DOI:10.1139/er-2022-0008

Fragkias, M., Güneralp, B., Seto, K.C. & Goodness, J. 2013. A synthesis of global urbanization projections. In *Urbanization, biodiversity and ecosystem services: challenges and opportunities*. *A global assessment.* T. Elmqvist, M. Fragkias, J. Goodness, B. Güneralp, P.J. Marcotullio, R.I. McDonald, S. Parnell, M. Schewenius et al., Eds. Springer. 409-435.

García-Arroyo, M. & MacGregor-Fors, I. 2020. Tolerant to humans? Assessment of alert and flight initiation distances of two bird species in relation to sex, flock size, and environmental characteristics. *Ethology Ecology & Evolution*. 32(5):445-456. DOI:10.1080/03949370.2020.1753115

Geist, C., Liao, J., Libby, S. & Blumstein, D.T. 2005. Does intruder group size and orientation affect flight initiation distance in birds? *Animal Biodiversity and Conservation*. 28(1):69-73.

Gilman, E.L. 2011. Bycatch governance and best practice mitigation technology in global tuna fisheries. *Marine Policy*. 35(5):590-609. DOI:10.1016/j.marpol.2011.01.021

Glover, H.K., Weston, M.A., Maguire, G.S., Miller, K.K. & Christie, B.A. 2011. Towards ecologically meaningful and socially acceptable buffers: response distances of shorebirds in Victoria, Australia, to human disturbance. *Landscape and Urban Planning*. 103(3-4):326-334. DOI:10.1016/j.landurbplan.2011.08.006

Gnanapragasam, J.J., Ekanayake, K.B., Ranawana, K., Symonds, M.R. & Weston, M.A. 2021. Civil war is associated with longer escape distances among Sri Lankan birds. *The American Naturalist*. 198(5):653-659. DOI:

Gómez-Serrano, M.Á. 2021. Four-legged foes: dogs disturb nesting plovers more than people do on tourist beaches. *Ibis*. 163(2):338-352. DOI:10.1111/ibi.12879

Gompper, M.E. 2014. The dog-human-wildlife interface: assessing the scope of the problem. In *Free-Ranging Dogs and Wildlife Conservation*. M.E. Gompper, Ed. New York: Oxford University Press. 9-45.

Gonthier, D.J., Ennis, K.K., Farinas, S., Hsieh, H.Y., Iverson, A.L., Batáry, P., Rudolphi, J., Tscharntke, T. et al. 2014. Biodiversity conservation in agriculture requires a multi-scale approach. *Proc. R. Soc. B*. 281(1791):20141358. DOI:10.1098/rspb.2014.1358

Gould, M.L., Green, L., Altenau, B. & Blumstein, D.T. 2004. A study of the species-confidence hypothesis with Spiny-cheeked Honeyeaters (*Acanthagenys rufogularis*). *Emu*. 104(3):267-271. DOI:10.1071/MU03033

Grant, W.S. & Cherry, M.I. 1985. Mytilus galloprovincialis Lmk. in southern Africa. *Journal of Experimental Marine Biology and Ecology*. 90(2):179-191. DOI:10.1016/0022-0981(85)90119-4

Grimm, P. 2010. Social desirability bias. In *Wiley international encyclopedia of marketing*. J.N. Sheth & N.K. Malhotra, Eds.

Gruas, L., Perrin-Malterre, C. & Loison, A. 2020. Aware or not aware? A literature review reveals the dearth of evidence on recreationists awareness of wildlife disturbance. *Wildlife Biology*. 2020(4):1-16. DOI:10.2981/wlb.00713

Guay, P.J., van Dongen, W.F., Robinson, R.W., Blumstein, D.T. & Weston, M.A. 2016. AvianBuffer: an interactive tool for characterising and managing wildlife fear responses. *Ambio*. 45(2016):841-851. DOI:10.1007/s13280-016-0779-4

Guay, P.J., Lorenz, R.D., Robinson, R.W., Symonds, M.R. & Weston, M.A., 2013. Distance from water, sex and approach direction influence flight distances among habituated black swans. *Ethology*. 119(7):552-558. DOI:10.1111/eth.12094

Guinness, S.J., Maguire, G.S., Miller, K.K. & Weston, M.A. 2020. My dog, my beach! Attitudes towards dog management on Victorian beaches. *Australasian Journal of Environmental Management*. 27(3):329-342. DOI:10.1080/14486563.2020.1760950

Guinness, S.J., Van Dongen, W.F., Guay, P.J., Robinson, R.W. & Weston, M.A. 2019. Evaluating how the group size of domestic, invasive dogs affect coastal wildlife responses: the case of flight-initiation distance (FID) of birds on Southern Australian beaches. In *Impacts of invasive species on coastal environments: coasts in crisis*. C. Makowski & C.W. Finkle, Eds. Springer Nature. 413-424. DOI:10.1007/978-3-319-91382-7_12

Güneralp, B., McDonald, R.I., Fragkias, M., Goodness, J., Marcotullio, P.J. & Seto, K.C. 2013. Urbanization forecasts, effects on land use, biodiversity, and ecosystem services. In *Urbanization, biodiversity and ecosystem services: challenges and opportunities. A global assessment.* T. Elmqvist, M. Fragkias, J. Goodness, B. Güneralp, P.J. Marcotullio, R.I. McDonald, S. Parnell, M. Schewenius et al., Eds. Springer. 437-452.

Gutzwiller, K.J. & Marcum, H.A. 1993. Avian responses to observer clothing color: caveats from winter point counts. *The Wilson Bulletin*. 105(4):628-636.

Hall, M.J., Burns, A.L., Martin, J.M. & Hochuli, D.F. 2020. Flight initiation distance changes across landscapes and habitats in a successful urban coloniser. *Urban Ecosystems*. 23(2020):785-791. DOI:10.1007/s11252-020-00969-5

Hall, T.E., Ham, S.H. & Lackey, B.K. 2010. Comparative evaluation of the attention capture and holding power of novel signs aimed at park visitors. *Journal of Interpretation Research*. 15(1):15-36. DOI:10.1177/109258721001500103

Hamelin, N., El Moujahid, O. & Thaichon, P. 2017. Emotion and advertising effectiveness: A novel facial expression analysis approach. *Journal of Retailing and Consumer Services*. 36(2017):103-111. DOI:10.1016/j.jretconser.2017.01.001

Hamilton, M. 2014. Understanding public perceptions about beach nesting shorebirds and habitat management on Cape Cod, Massachusetts. PhD. Thesis. Clemson University.

Hammer, T.L., Bize, P., Saraux, C., Gineste, B., Robin, J.P., Groscolas, R. & Viblanc, V.A. 2022. Repeatability of alert and flight initiation distances in king penguins: effects of colony, approach speed, and weather. *Ethology*. 128(4):303-316. DOI:10.1111/eth.13264

Haukeland, J.V., Veisten, K., Grue, B. & Vistad, O.I. 2013. Visitors' acceptance of negative ecological impacts in national parks: comparing the explanatory power of psychographic scales in a Norwegian mountain setting. *Journal of Sustainable Tourism*. 21(2):291-313. DOI:10.1080/09669582.2012.692685

Havel, J.E., Kovalenko, K.E., Thomaz, S.M., Amalfitano, S. & Kats, L.B. 2015. Aquatic invasive species: challenges for the future. *Hydrobiologia*. 750(1):147-170. DOI:10.1007/s10750-014-2166-0

Heinecken, T.J.E. 1985. *Estuaries of the Cape part II: synopses of available information on individual systems*. (CSIR report; no. 27: Wildevoëlvlei/Noordhoek). Stellenbosch, South Africa: Council for Scientific and Industrial Research. Available: http://researchspace.csir.co.za/dspace/bitstream/handle/10204/3481/Estuaries%20of%20the%20Cape_27.pdf?sequence=1&isAllowed=y [2022, July 20].

Hockett, K.S., Marion, J.L. & Leung, Y.F. 2017. The efficacy of combined educational and site management actions in reducing off-trail hiking in an urban-proximate protected area. *Journal of Environmental Management*. 203(2017):17-28. DOI:10.1016/j.jenvman.2017.06.073

Hockey, P.A.R. 1981. Morphometrics and sexing of the African Black Oystercatcher. *Journal of African Ornithology*. 52(4):244-247. DOI:10.1080/00306525.1981.9633614

Hockey, P.A.R. 1982. Adaptiveness of nest site selection and egg coloration in the African Black Oystercatcher *Haematopus moquini*. *Behavioral Ecology and Sociobiology*. 11(2):117-123. DOI:10.1007/BF00300100

Hockey, P.A.R. 1983a. The distribution, population size, movements and conservation of the African Black Oystercatcher *Haematopus moquini*. *Biological Conservation*. 25(3):233-262. DOI:10.1016/0006-3207(83)90038-1

Hockey, P.A.R. 1983b. Aspects of the breeding biology of the African Black Oystercatcher. *Ostrich*. 54(1):26-35. DOI:10.1080/00306525.1983.9634440

Hockey, P.A.R. 1985. Observations on the communal roosting of African Black Oystercatchers. *Ostrich*. 56(1-3):52-57. DOI:10.1080/00306525.1985.9639569

Hockey, P.A.R. 1987. The influence of coastal utilisation by man on the presumed extinction of the Canarian black oystercatcher *Haematopus meadewaldoi* Bannerman. *Biological Conservation*. 39(1):49-62.

Hockey, P.A.R. & Underhill, L.G. 1984. Diet of the African black oystercatcher *Haematopus moquini* on rocky shores: spatial, temporal and sex-related variation. *African Zoology*. 19(1):1-11. DOI:10.1080/02541858.1984.11447849

Hockey, P.A.R. & van Erkom Schurink, C. 1992. The invasive biology of the mussel Mytilus galloprovincialis on the southern African coast. *Transactions of the Royal Society of South Africa*. 48(1):123-139. DOI:10.1080/00359199209520258

Hockey, P.A.R., Leseberg, A. & Loewenthal, D. 2003. Dispersal and migration of juvenile African Black Oystercatchers *Haematopus moquini*. *Ibis*. 145(3):114-123. DOI:10.1046/j.1474-919X.2003.00174.x

Holderness-Roddam, B. & McQuillan, P.B. 2014. Domestic dogs (*Canis familiaris*) as a predator and disturbance agent of wildlife in Tasmania. *Australasian Journal of Environmental Management*. 21(4):441-452. DOI:10.1080/14486563.2014.952787

Holmes, T.L., Knight, R.L., Stegall, L. & Craig, G.R. 1993. Responses of wintering grassland raptors to human disturbance. *Wildlife Society Bulletin.* 21(4):461-468. DOI:10.2307/3783420

Hughes, J. & Macdonald, D.W. 2013. A review of the interactions between free-roaming domestic dogs and wildlife. *Biological Conservation*. 157(2013):341-351. DOI:10.1016/j.biocon.2012.07.005

IBM Corporation. 2021. IBM SPSS Statistics for Windows. V28.0.1.0.

Ikuta, L.A. & Blumstein, D.T. 2003. Do fences protect birds from human disturbance? *Biological Conservation*. 112(3):447-452. DOI:10.1016/S0006-3207(02)00324-5

IPBES. 2019. Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz & H. T. Ngo, Eds.

Isbell, F., Calcagno, V., Hector, A., Connolly, J., Harpole, W.S., Reich, P.B., Scherer-Lorenzen, M., Schmid, B. et al. 2011. High plant diversity is needed to maintain ecosystem services. *Nature*. 477(7363):199-202. DOI:10.1038/nature10282

IUCN. 2021. *The IUCN Red List of Threatened Species*. Version 2021-3. Available: https://www.iucnredlist.org/statistics [2022, June 20].

Jalihal, S., Rana, S. & Sharma, S. 2022. Systematic mapping on the importance of vultures in the Indian public health discourse. *Environmental Sustainability*. 5(2022):135-143. DOI:10.1007/s42398-022-00224-x

Jeffery, R.G. & Scott, H.A. 2005. Breeding success of African black oystercatchers *Haematopus moquini* at Cape Agulhas, Western Cape, from 1978/79 to 2001/02. *Ostrich*. 76(1-2):8-13. DOI:10.2989/00306520509485467

Johnson, C.N., Balmford, A., Brook, B.W., Buettel, J.C., Galetti, M., Guangchun, L. & Wilmshurst, J.M. 2017. Biodiversity losses and conservation responses in the Anthropocene. *Science*. 356(6335):270-275. DOI:10.1126/science.aam9317

Jones, D.N. & Thomas, L.K. 1999. Attacks on humans by Australian magpies: management of an extreme suburban human-wildlife conflict. *Wildlife Society Bulletin*. 27(2):473-478.

Jorgensen, J.G. & Brown, M.B. 2014. Piping Plovers *Charadrius melodus* and dogs: compliance with and attitudes toward a leash law on public beaches at Lake McConaughy, Nebraska, USA. *Wader Study Group Bulletin*. 121(2):7-12.

Jorgensen, J.G. & Brown, M.B. 2015. Evaluating recreationists’ awareness and attitudes toward Piping Plovers (*Charadrius melodus*) at Lake McConaughy, Nebraska, USA.

Human Dimensions of Wildlife. 20(4):367-380. DOI:10.1080/10871209.2015.1020579

Jorgensen, J.G. & Brown, M.B. 2017. Evaluating Persuasive Messages to Influence Dog Leash Law Compliance at a Public Area in the Great Plains. *Great Plains Research*. 27(2):131-142. DOI:10.1353/gpr.2017.0021

Jorgensen, J.G., Dinan, L.R. & Brown, M.B. 2016. Flight initiation distances of nesting Piping Plovers (*Charadrius melodus*) in response to human disturbance. *Avian Conservation & Ecology*. 11(1):1-10. DOI:10.5751/ACE-00826-110105

Kahneman, D., Knetsch, J.L. & Thaler, R.H. 1991. Anomalies: the endowment effect, loss aversion, and status quo bias. *Journal of Economic Perspectives*. 5(1):193-206. DOI:10.1257/jep.5.1.193

Kaplanis, N.J., Edwards, C.B., Eynaud, Y. & Smith, J.E. 2020. Future sea-level rise drives rocky intertidal habitat loss and benthic community change. *PeerJ*. 1-21. DOI:10.7717/peerj.9186

Karlsson, J., Eriksson, M. & Liberg, O. 2007. At what distance do wolves move away from an approaching human? *Canadian Journal of Zoology*. 85(11):193-1197. DOI:10.1139/Z07-099

Katzner, T.E., Carlisle, J.D., Poessel, S.A., Thomason, E.C., Pauli, B.P., Pilliod, D.S., Belthoff, J.R., Heath, J.A. et al. 2020. Illegal killing of nongame wildlife and recreational shooting in conservation areas. *Conservation Science and Practice*. 2(11):1-15. DOI:10.1111/csp2.279

Kidd, L.R., Garrard, G.E., Bekessy, S.A., Mills, M., Camilleri, A.R., Fidler, F., Fielding, K.S., Gordon, A. et al. 2019. Messaging matters: a systematic review of the conservation messaging literature. *Biological Conservation*. 236(2019):92-99. DOI:10.1016/j.biocon.2019.05.020

Kim, H., Lee, S., Uysal, M., Kim, J. & Ahn, K. 2015. Nature-based tourism: motivation and subjective well-being. *Journal of Travel & Tourism Marketing*. 32(2015):76-96. DOI:10.1080/10548408.2014.997958

Kohler, S.A., Connan, M., Hill, J.M., Mablouké, C., Bonnevie, B., Ludynia, K., Kemper, J. & Huisamen, J. et al. 2011. Geographic variation in the trophic ecology of an avian rocky shore predator, the African black oystercatcher, along the southern African coastline. *Marine Ecology Progress Series*. 435(2011):235-249 DOI:10.3354/meps09215

Kohler, S.A., Connan, M., Kolasinski, J., Cherel, Y., McQuaid, C.D. & Jaquemet, S. 2014. Trophic overlap between sexes in the dimorphic African black oystercatcher foraging on an alien mussel. *Austral Ecology*. 39(5):567-578. DOI:10.1111/aec.12117

Kueffer, C. & Kull, C.A. 2017. Non-native species and the aesthetics of nature. In *Impact of biological invasions on ecosystem services*. M. Vilà & P.E. Hulme, Eds. Switzerland: Springer Cham. 311-324.

Küyler, E.J. 2011. *Integrated Reserve Management Plan: Blaauwberg Nature Reserve*. Cape Town, South Africa: Environmental Resource Management Department. Available: http://resource.capetown.gov.za/documentcentre/Documents/City%20strategies,%20plans%20and%20frameworks/Blaauwberg_IRMP_Jun2011v02_Final.pdf [2022, July 20].

Küyler, E.J. 2019. *Blaauwberg Nature Reserve quarterly report: January – March 2019*. Cape Town, South Africa: Environmental Resource Management Department. Available: https://www.bca.org.za/docman/bbnr-quarterly-reports/163-quarterly-report-january-march-2019/file.html [2022, July 20].

Lackey, N.Q., Tysor, D.A., McNay, G.D., Joyner, L., Baker, K.H. & Hodge, C. 2021. Mental health benefits of nature-based recreation: a systematic review. *Annals of Leisure Research*. 24(3):379-393. DOI:10.1080/11745398.2019.1655459

Lafferty, K.D. 2001a. Disturbance to wintering western snowy plovers. *Biological Conservation*. 101(3):315-325. DOI:10.1016/S0006-3207(01)00075-1

Lafferty, K.D., 2001b. Birds at a Southern California beach: seasonality, habitat use and disturbance by human activity. *Biodiversity & Conservation*. 10(11):1949-1962. DOI:10.1023/A:1013195504810

Lafferty, K.D., Goodman, D. & Sandoval, C.P. 2006. Restoration of breeding by snowy plovers following protection from disturbance. *Biodiversity & Conservation*. 15(7):2217-2230. DOI:10.1007/s10531-004-7180-5

Lafferty, K.D., Rodriguez, D.A. & Chapman, A. 2013. Temporal and spatial variation in bird and human use of beaches in southern California. *SpringerPlus*. 2(38):1-14. DOI:10.1186/2193-1801-2-38

Le Corre, N., Peuziat, I., Brigand, L., Gélinaud, G. & Meur-Férec, C. 2013. Wintering waterbirds and recreationists in natural areas: a sociological approach to the awareness of bird disturbance. *Environmental Management*. 52(4):780-791. DOI:10.1007/s00267-013-0118-5

Lees, A.C., Haskell, L., Allinson, T., Bezeng, S.B., Burfield, I.J., Renjifo, L.M., Rosenberg, K.V., Viswanathan, A. et al. 2022. State of the world's birds. *Annual Review of Environment and Resources*. 47(1). DOI:10.1146/annurev-environ-112420- 014642

Lees, D., Sherman, C.D., Maguire, G.S., Dann, P., Cardilini, A.P. & Weston, M.A., 2013. Swooping in the suburbs; parental defence of an abundant aggressive urban bird against humans. *Animals*. 3(3):754-766. DOI:10.3390/ani3030754

Leseberg, A. 2001. The foraging ecology, demographics and conservation of African black oystercatchers *Haematopus moquini* in Namibia nursery areas. MSc. Thesis. University of Cape Town.

Leseberg, A., Hockey, P.A. & Loewenthal, D. 2000. Human disturbance and the chick-rearing ability of African black oystercatchers (*Haematopus moquini*): a geographical perspective. *Biological Conservation*. 96(3):379-385. DOI:10.1016/S0006-3207(00)00076-8

Lethlean, H., Van Dongen, W.F., Kostoglou, K., Guay, P.J. & Weston, M.A., 2017. Joggers cause greater avian disturbance than walkers. *Landscape and Urban Planning*. 159(2017):42-47. DOI:10.1016/j.landurbplan.2016.08.020

Lin, D-L., Cheng, Y-C. & Chen, W-T. 2013. Effects of clothing color on flight initiation distance of Black Drongo (*Dicrurus macrocercus*) [Abstract]. *Taiwan Journal of Biodiversity*. 15(3):209-218.

Linley, G.D., Guay, P.J. & Weston, M.A. 2019. Are disturbance separation distances derived from single species applicable to mixed-species shorebird flocks? *Wildlife Research*. 46(8):719-723. DOI:10.1071/WR18198

Linz, G.M., Homan, H.J., Gaulker, S.M., Penry, L.B. & Bleier, W.J. 2007. European starlings: a review of an invasive species with far-reaching impacts. *Managing Vertebrate Invasive Species*. 24(2007):378-386. Available: https://digitalcommons.unl.edu/nwrcinvasive/24/ [2022, February 16]

Livezey, K.B., Fernandez-Juricic, E. & Blumstein, D.T. 2016. Database of bird flight initiation distances to assist in estimating effects from human disturbance and delineating buffer areas. *Journal of Fish and Wildlife Management*. 7(1):181-191. DOI:10.3996/082015-JFWM-078

Loewenthal, D. 2007. The population dynamics and conservation of the African Black Oystercatcher, *Haematopus moquini*. PhD. Thesis. University of Cape Town.

Lomas, S.C., Whisson, D.A., Maguire, G.S., Tan, L.X., Guay, P.J. & Weston, M.A. 2014. The influence of cover on nesting red-capped plovers: a trade-off between thermoregulation and predation risk? *Vic. Nat.* 131(4):115-127.

Lord, A., Waas, J.R., Innes, J. & Whittingham, M.J. 2001. Effects of human approaches to nests of northern New Zealand dotterels. *Biological Conservation*. 98(2):233-240. DOI:10.1016/S0006-3207(00)00158-0

Loss, S.R., Will, T. & Marra, P.P. 2014. Estimation of bird-vehicle collision mortality on U.S. roads. *The Journal of Wildlife Management*. 78(5):763-771. DOI:10.1002/jwmg.721

Lu, H. 2016. The effects of emotional appeals and gain versus loss framing in communicating sea star wasting disease. *Science Communication*. 38(2):143-169. DOI:10.1177/1075547015619173

Lucrezi, S., Saayman, M. & van der Merwe, P. 2015. Managing beaches and beachgoers: lessons from and for the Blue Flag award. *Tourism Management*. 48(2015):211-230. DOI:10.1016/j.tourman.2014.11.010

Maguire, G.S., Miller, K.K. & Weston, M.A. 2019. Only the strictest rules apply: investigating regulation compliance of beaches to minimize invasive dog impacts on threatened shorebird populations. In *Impacts of invasive species on coastal environments: coasts in crisis*. C. Makowski & C.W. Finkle, Eds. Springer Nature. 397-412. DOI:10.1007/978-3-319-91382-7_12

Maguire, G.S., Rimmer, J.M. & Weston, M.A. 2013. Stakeholder perceptions of threatened species and their management on urban beaches. *Animals*. 3(4):1002-1020. DOI:10.3390/ani3041002

Maguire, G.S., Rimmer, J.M. & Weston, M.A. 2015. Stakeholder knowledge of threatened coastal species; the case of beach-goers and the Hooded Plover *Thinornis rubricollis*. *Journal of Coastal Conservation*. 19(2015):73-77. DOI:10.1007/s11852-014-0361-9

Mallick, S.A. & Driessen, M.M. 2003. Feeding of wildlife: How effective are the ‘Keep Wildlife Wild’signs in Tasmania's National Parks? *Ecological Management & Restoration*. 4(3):199-204. DOI:10.1046/j.1442-8903.2003.00157.x

Mantyka-pringle, C.S., Martin, T.G. & Rhodes, J.R. 2012. Interactions between climate and habitat loss effects on biodiversity: a systematic review and meta-analysis. *Global Change Biology*. 18(4):1239-1252. DOI:10.1111/j.1365-2486.2011.02593.x

Marine Living Resources Act, No. 18 of 1998. *Publication of policy on the management of seals, seabirds and shorebirds*. Available:

https://www.dffe.gov.za/sites/default/files/gazetted_notices/mlra_sealsmanagement_publicationpolicy_g30534gen1717_0.pdf [2022, December 20].

Marschall, S., Granquist, S.M. & Burns, G.L. 2017. Interpretation in wildlife tourism: Assessing the effectiveness of signage on visitor behaviour at a seal watching site in Iceland. *Journal of Outdoor Recreation and Tourism*. 17(2017):11-19. DOI:10.1016/j.jort.2016.11.001

Martín, B., Delgado, S., De la Cruz, A., Tirado, S. & Ferrer, M. 2015. Effects of human presence on the long-term trends of migrant and resident shorebirds: evidence of local population declines. *Animal Conservation*. 18(1):73-81. DOI:10.1111/acv.12139

Mashele, N.M., Thompson, L.J. & Downs, C.T. 2021. Uses of vultures in traditional medicines in the Kruger to Canyons Biosphere Region, South Africa. *Journal of Raptor Research*. 55(3):328-339. DOI:10.3356/JRR-20-36

Maxwell, S.L., Fuller, R.A., Brooks, T.M. & Watson, J.E. 2016. Biodiversity: the ravages of guns, nets and bulldozers. *Nature*. 536(7615):143-145. DOI:10.1038/536143a

Mayer, M., Natusch, D. & Frank, S. 2019. Water body type and group size affect the flight initiation distance of European waterbirds. *PloS One*. 14(7):1-13. DOI:10.1371/journal.pone.0219845

Mayo, T.W., Paton, P.W. & August, P.V. 2015. Responses of birds to humans at a coastal barrier beach: Napatree Point, Rhode Island. *Northeastern Naturalist*. 22(3):501-512. DOI:10.1656/045.022.0302

McBain, B., Lenzen, M., Wackernagel, M. & Albrecht, G. 2017. How long can global ecological overshoot last? *Global and Planetary Change*. 155(2017):13-19. DOI:10.1016/j.gloplacha.2017.06.002

McBlain, M., Jones, K.A. & Shannon, G. 2020. Sleeping Eurasian oystercatchers adjust their vigilance in response to the behaviour of neighbours, human disturbance and environmental conditions. *Journal of Zoology*. 312(2):75-84. DOI:10.1111/jzo.12812

McCall, R. 2007. Dogs vs. birds: negotiated rulemaking at Fort Funston. *Hastings Environmental Law Journal*. 13(1):187-210. DOI:

McCauley, D.J., Pinsky, M.L., Palumbi, S.R., Estes, J.A., Joyce, F.H. & Warner, R.R. 2015. Marine defaunation: animal loss in the global ocean. *Science*. 347(6219):1255641. DOI:10.1126/science.1255641

McNeely, J. 2001. Invasive species: a costly catastrophe for native biodiversity. *Land Use and Water Resources Research*. 1(2001):1-10. DOI:10.22004/ag.econ.47850

Medeiros, R., Ramos, J.A., Paiva, V.H., Almeida, A., Pedro, P. & Antunes, S. 2007. Signage reduces the impact of human disturbance on little tern nesting success in Portugal. *Biological Conservation*. 135(1):99-106. DOI:10.1016/j.biocon.2006.10.001

Meiri, S. & Chapple, D.G. 2016. Biases in the current knowledge of threat status in lizards, and bridging the 'assessment gap'. *Biological Conservation*. 204(2016):6-15. DOI:10.1016/j.biocon.2016.03.009

Mengak, L. & Dayer, A.A. 2020. Defining human disturbance to shorebirds using manager and scientist input. *Environmental Management*. 65(1):62-73. DOI:10.1007/s00267-019-01230-2

Mikula, P., Bulla, M., Blumstein, D.T., Benedetti, Y., Floigl, K., Jokimäki, J., Kaisanlahti-Jokimäki, M.L., Markó, G. et al. 2022. Urban birds' flight responses were unaffected by the COVID-19 shutdowns. *BioRxiv*. DOI:10.1101/2022.07.15.500232

Mikula, P., Šaffa, G., Nelson, E. & Tryjanowski, P. 2018. Risk perception of vervet monkeys *Chlorocebus pygerythrus* to humans in urban and rural environments. *Behavioural Processes*. 147(February 2018):21-27. DOI:10.1016/j.beproc.2017.12.011

Milcu, A.I., Hanspach, J., Abson, D. & Fischer, J., 2013. Cultural ecosystem services: a literature review and prospects for future research. *Ecology and Society*. 18(3):44-77. DOI:10.5751/ES-05790-180344

Miller, K.K., Ritchie, E.G. & Weston, M.A. 2014. The human dimensions of dog-wildlife interactions. In *Free-Ranging Dogs and Wildlife Conservation*. M.E. Gompper, Ed. New York: Oxford University Press. 286-300.

Møller, A.P. 2009. Basal metabolic rate and risk-taking behaviour in birds. *Journal of Evolutionary Biology*. 22(12):2420-2429. DOI:10.1111/jeb.12399

Møller, A.P. 2014. Life history, predation and flight initiation distance in a migratory bird. *Journal of Evolutionary Biology*. 27(6):1105-1113. DOI:10.1111/jeb.12399

Møller, A.P. & Erritzøe, J. 2014. Predator–prey interactions, flight initiation distance and brain size. *Journal of Evolutionary Biology*. 27(1):34-42. DOI:10.1111/jeb.12272

Møller, A.P., Liang, W. & Samia, D.S. 2019. Flight initiation distance, color and camouflage. *Current Zoology*. 65(5):535-540. DOI:10.1093/cz/zoz005

Morelli, F., Benedetti, Y., Díaz, M., Grim, T., Ibáñez-Álamo, J.D., Jokimäki, J., Kaisanlahti-Jokimäki, M.L., Tätte, K. et al. 2019. Contagious fear: escape behavior increases with flock size in European gregarious birds. *Ecology and Evolution*. 9(10):6096-6104. DOI:10.1002/ece3.5193

National Environmental Management: Integrated Coastal Management Act, No. 28 of 2008. Regulation. 2014. *Government gazette*. 588(10221). 27 June. Government notice no. 37761. Pretoria: Government Printer.

National Institute for Communicable Diseases. 2021. *Latest confirmed cases of Covid-10 in South Africa (30 July 2021).* Available: https://www.nicd.ac.za/latest-confirmed-cases-of-covid-19-in-south-africa-30-july-2021/ [2023, January 16].

Nature's Valley Trust. 2017. *Nature's Valley Beach* [Map]. Available: https://www.naturesvalleytrust.co.za/assets/Uploads/Natures-Valley3.jpg [2022, October, 27].

Navedo, J.G., Verdugo, C., Rodríguez-Jorquera, I.A., Abad-Gómez, J.M., Suazo, C.G., Castañeda, L.E., Araya, V., Ruiz, J. et al. 2019. Assessing the effects of human activities on the foraging opportunities of migratory shorebirds in Austral high-latitude bays. *Plos One*. 14(3):1-16. DOI:10.5061/dryad.p0q053s

Nesbitt, R.K. 2006. Toward an understanding of noncompliant behaviour in outdoor recreation: linking the Theory of Planned Behaviour to off-leash dogs at William B. Umstead State Park. MSc. Thesis. North Carolina State University.

Newbold, T., Hudson, L.N., Hill, S.L., Contu, S., Lysenko, I., Senior, R.A., Börger, L., Bennett, D.J. et al. 2015. Global effects of land use on local terrestrial biodiversity. *Nature*. 520(7545):45-50. DOI:10.1038/nature14324

Nguse, S. & Wassenaar, D. 2021. Mental health and COVID-19 in South Africa. *South African Journal of Psychology*. 51(2):304-313. DOI:10.1177/00812463211001543

Niles, L.J., Bart, J., Sitters, H.P., Dey, A.D., Clark, K.E., Atkinson, P.W., Baker, A.J., Bennett, K.A. et al. 2009. Effects of horseshoe crab harvest in Delaware Bay on red knots: are harvest restrictions working? *BioScience*. 59(2):153-164. DOI:10.1525/bio.2009.59.2.8

Nunez, S., Arets, E., Alkemade, R., Verwer, C. & Leemans, R. 2019. Assessing the impacts of climate change on biodiversity: is below 2°C enough? *Climatic Change*. 154(2019):351-365. DOI:10.1007/s10584-019-02420-x

Nyirenda, V.R., Musonda, F., Kambole, S. & Tembo, S. 2017. Peasant farmer–raptor conflicts around Chembe Bird Sanctuary, Zambia, Central Africa: poultry predation, ethno–biology, land use practices and conservation. *Animal Biodiversity and Conservation*. 40(1):121-132. DOI:10.32800/abc.2017.40.0121

Oliveira, G.M., Vidal, D.G. & Ferraz, M.P. 2020. Urban lifestyles and consumption patterns. In *Sustainable cities and communities.* W.L. Filho, A.M. Azul, L. Brandli, P.G. Özuyar & T. Wall, Eds. Springer International Publishing. 851-860.

Ordiz, A., Moen, G.K., Sæbø, S., Stenset, N., Swenson, J.E. & Støen, O.G. 2019. Habituation, sensitization, or consistent behavioral responses? Brown bear responses after repeated approaches by humans on foot. *Biological Conservation*. 232(2019):228-237. DOI:10.1016/j.biocon.2019.01.016

Ormsby, A.A. & Forys, E.A. 2010. The effects of an education campaign on beach user perceptions of beach-nesting birds in Pinellas County, Florida. *Human Dimensions of Wildlife*. 15(2):119-128. DOI:10.1080/10871200903428366

Paijmans, D.M. 2014. Investigating the possible change in breeding strategy of African Black Oystercatchers. MSc. Thesis. University of Cape Town.

Paijmans, D.M. 2016. Oystercatcher (*Haematopus moquini*) chick fatality due to dogs. *Biodiversity Observations*. 7(41):1-3.

Paijmans, D.M. & Stewart, M. 2016. African Black Oystercatcher fatality as a result of fishing line. *Biodiversity Observations*. 7(27):1-3.

Palm, K. 2018. *Family attacked, robbed at Noordhoek Beach*. Available: https://ewn.co.za/2018/02/19/family-attacked-robbed-at-noordhoek-beach [2022, July 20].

Pandiyan, J., Mahboob, S., Jagadheesan, R., Elumalai, K., Krishnappa, K., Al-Misned, F., Kaimkhani, Z.A. & Govindarajan, M. 2020. A novel approach to assess the heavy metal content in the feathers of shorebirds: A perspective of environmental research. *Journal of King Saud University – Science*. 32(7):3065-3071. DOI: 10.1016/j.jksus.2020.08.014

Parsons, N.J. 2006. Quantifying abundance, breeding and behaviour of the African Black Oystercatcher. PhD. Thesis. University of Cape Town.

Pereira, H.M., Leadley, P.W., Proença, V., Alkemade, R., Scharlemann, J.P., Fernandez-Manjarrés, J.F., Araújo, M.B., Balvanera, P. et al. 2010. Scenarios for global biodiversity in the 21st century. *Science*. 330(6010):1496-1501. DOI:10.1126/science.1196624

Pereira, H.M., Navarro, L.M. & Martins, I.S. 2012. Global biodiversity change: the bad, the good, and the unknown. *Annual Review of Environment and Resources*. 37(2012):25-50. DOI:10.1146/annurev-environ-042911-093511

Petersen, C. 2020. *Section of Zandvlei closed to dogs after grysbok killed*. Available: https://news.vanniekaap.com/news/section-of-zandvlei-closed-to-dogs-after-grysbok-killed/ [2022, August 31].

Peterson, M.N., Birckhead, J.L., Leong, K., Peterson, M.J. and Peterson, T.R. 2010. Rearticulating the myth of human–wildlife conflict. *Conservation Letters*. 3(2):74-82. DOI:10.1111/j.1755-263X.2010.00099.x

Pienkowski, M.W. 1984. Breeding biology and population dynamics of Ringed plovers *Charadrius hiaticula* in Britain and Greenland: nest-predation as a possible factor limiting distribution and timing of breeding. *Journal of Zoology*. 202(1):83-114. DOI:10.1111/j.1469-7998.1984.tb04289.x

Pinheiro, J., Bates, D., DebRoy, S. & Sarkar, D. 2021. nlme: linear and nonlinear mixed effects models. Version. 3.1-152. Available: https://CRAN.R-project.org/package=nlme [2022, July 22].

Pinnock, D. 2022. *Jogger finds mutilated penguins on Simon's Town's Seaforth Beach after dog attack*. Available: https://www.dailymaverick.co.za/article/2022-11-01-jogger-finds-mutilated-penguins-on-simons-towns-seaforth-beach-after-dog-attack/ [2022, November 4]

Plieninger, T., Dijks, S., Oteros-Rozas, E. & Bieling, C. 2013. Assessing, mapping, and quantifying cultural ecosystem services at community level. *Land Use Policy*. 33(2013):118-129. DOI:10.1016/j.landusepol.2012.12.013

Plohl, N. & Musil, B. 2018. Do I know as much as I think I do? The Dunning-Kruger effect, overclaiming, and the illusion of knowledge. *Horizons of Psychology*. 27(2018):20-30. DOI:10.20419/2018.27.481

Pond, U. 1999. Comparative breeding performance and chick growth rates of African Black Oystercatchers Haematopus moquini inside and outside protected areas. Unpubl. Student report.

Posel, D., Oyenubi, A. & Kollamparambil, U. 2021. Job loss and mental health during the COVID-19 lockdown: evidence from South Africa. *PloS One*. 16(3):1-15. DOI:10.1371/journal.pone.0249352

Price, M. 2008. The impact of human disturbance on birds: a selective review. In *Too Close for Comfort: Contentious Issues in Human–Wildlife Encounters*. D. Lunney., A. Munn & W. Meikle, Eds. Royal Zoological Society of New South Wales. 163-196.

Prokop, P., Kubiatko, M. & Fančovičová, J. 2008. Slovakian pupils' knowledge of, and attitudes toward, birds. *Anthrozoös*. 21(3):221-235. DOI:10.2752/175303708X332035

Pronin, E., Lin, D.Y. & Ross, L. 2002. The bias blind spot: Perceptions of bias in self versus others. *Personality and Social Psychology Bulletin*. 28(3):369-381. DOI:10.1177/0146167202286008

QGIS. 2022. QGIS Geographic Information System. Version 3.22.2. Available: https://www.qgis.org/en/site/

Que, P., Chang, Y., Eberhart-Phillips, L., Liu, Y., Székely, T. & Zhang, Z. 2015. Low nest survival of a breeding shorebird in Bohai Bay, China. *Journal of Ornithology*. 156(2015):297-307. DOI:10.1007/s10336-014-1126-9

Quintana, I., Button, R. & Underhill, L.G. 2021. African Oystercatchers on Robben Island, South Africa: the 2019/2020 breeding season in its two decadal context. *Wader Study*. 128(3):209-219. DOI:10.18194/ws.00245

Rao, A.S. 2005. Dispersal of young African Black Oystercatchers (*Haematopus moquini*): movement patterns, individual characteristics, habitat use and conservation implications. Masters. Thesis. Memorial University of Newfoundland.

Randler, C. 2006. Disturbances by dog barking increase vigilance in coots *Fulica atra*. *European Journal of Wildlife Research*. 52(4):265-270. DOI:10.1007/s10344-006-0049-z

Randler, C., Tryjanowski, P., Jokimäki, J., Kaisanlahti-Jokimäki, M.L. & Staller, N., 2020. SARS-CoV2 (COVID-19) Pandemic lockdown influences nature-based recreational activity: the case of birders. *International Journal of Environmental Research and Public Health*. 17(19):1-16. DOI0.3390/ijerph17197310

R Core Team. 2022. R: A language and environment for statistical computing. Version 4.1.0. Available: https://www.r-project.org/ [2022, July 21].

Rebelo, A.G., Holmes, P.M., Dorse, C. & Wood, J. 2011. Impacts of urbanization in a biodiversity hotspot: conservation challenges in Metropolitan Cape Town. *South African Journal of Botany*. 77(1):20-35. DOI:10.1016/j.sajb.2010.04.006

Rebolo-Ifrán, N., Zamora-Nasca, L. & Lambertucci, S.A. 2021. Cat and dog predation on birds: the importance of indirect predation after bird-window collisions. *Perspectives in Ecology and Conservation*. 19(3):293-299. DOI:10.1016/j.pecon.2021.05.003

Retief, K. 2020. *Blaauwberg Nature Reserve quarterly report: January – March 2020.* Cape Town, South Africa: Environmental Resource Management Department. Available: https://www.bca.org.za/docman/bbnr-quarterly-reports/175-quarterly-report-jan-to-mar-2020/file.html [2022, July 20].

Reynolds, C., Henry, D.A., Tye, D.R. & Tye, N.D. 2020. Defining separation zones for coastal birds at a wetland of global importance. *Wildlife Research*. 48(2):134-141. DOI:10.1071/WR20098

Richardson, D.M., Pyšek, P., Rejmánek, M., Barbour, M.G., Panetta, F.D. & West, C.J., 2000. Naturalization and invasion of alien plants: concepts and definitions. *Diversity and Distributions*. 6(2):93-107. DOI:10.1046/j.1472-4642.2000.00083.x

Richardson, D.M. & Rejmánek, M. 2011. Trees and shrubs as invasive alien species–a global review. *Diversity and Distributions*. 17(5):788-809. DOI:10.1111/j.1472-4642.2011.00782.x

Rimmer, J.M., Maguire, G.S. & Weston, M.A. 2013. Perceptions of effectiveness and preferences for design and position of signage on Victorian beaches for the management of Hooded Plovers' *Thinornis rubricollis'*. The *Victorian Naturalist.* 130(2):75-80. DOI:

Rodgers, J.A. & Smith, H.T. 1995. Set-back distances to protect nesting bird colonies from human disturbance in Florida. *Conservation Biology*. 9(1):89-99. DOI:10.1046/j.1523-1739.1995.09010089.x

Rodgers Jr, J.A. & Schwikert, S.T. 2003. Buffer zone distances to protect foraging and loafing waterbirds from disturbance by airboats in Florida. *Waterbirds*. 26(4):437-443. DOI:10.1046/j.1523-1739.2002.00316.x

Rosenberg, K.V., Dokter, A.M., Blancher, P.J., Sauer, J.R., Smith, A.C., Smith, P.A., Stanton, J.C., Panjabi, A. et al. 2019. Decline of the North American avifauna. *Science*. 366(6461):120-124. DOI:10.1126/science.aaw1313

Runyan, A.M. & Blumstein, D.T. 2004. Do individual differences influence flight initiation distance? *The Journal of Wildlife Management*. 68(4):1124-1129. DOI: 10.2193/0022-541X(2004)068[1124:DIDIFI]2.0.CO;2

Russell, V.L., Buerkner, P., Herve, M., Love, J., Miguez, F., Riebl, H. & Singmann, H. 2022. emmeans: estimated marginal means, aka least-square means. Version 1.7.3. Available: https://CRAN.R-project.org/package=emmeans [2022, July 22].

Ryan, P.G. 2012. Medium-term changes in coastal bird communities in the Western Cape, South Africa. *Austral Ecology*. 38(3):251-259. DOI:10.1111/j.1442-9993.2012.02397.x

Sala, O.E., Chapin, F.S., Armesto, J.J., Berlow, E., Bloomfield, J., Dirzo, R., Huber-Sanwald, E., Huenneke, L.F. et al. 2000. Global biodiversity scenarios for the year 2100. *Science*. 287(5459):1770-1774. DOI:10.1126/science.287.5459.1770

Samia, D.S. & Blumstein, D.T. 2015. Birds flush early and avoid the rush: an interspecific study. *PLoS One*. 10(3):1-8. DOI:10.1371/journal.pone.0119906

Samia, D.S., Nakagawa, S., Nomura, F., Rangel, T.F. & Blumstein, D.T. 2015. Increased tolerance to humans among disturbed wildlife. *Nature Communications*. 6(1):1-8. DOI:10.1038/ncomms9877

Saul, W.C., Roy, H.E., Booy, O., Carnevali, L., Chen, H.J., Genovesi, P., Harrower, C.A., Hulme, P.E. et al. 2017. Assessing patterns in introduction pathways of alien species by linking major invasion data bases. *Journal of Applied Ecology*. 54(2):657-669. DOI:10.1111/1365-2664.12819

Sayan, S. & Karagüzel, O. 2010. Problems of outdoor recreation: the effect of visitors' demographics on the perceptions of Termessos National Park, Turkey. *Environmental Management*. 45(6):1257-1270. DOI:10.1007/s00267-010-9500-8

Schaefer, N., Mayer-Pinto, M., Griffin, K.J., Johnston, E.L., Glamore, W. & Dafforn, K.A. 2020. Predicting the impact of sea-level rise on intertidal rocky shores with remote sensing. *Journal of Environmental Management*. 261(March 2020):1-9. DOI:10.1016/j.jenvman.2020.110203

Schlacher, T.A., Dugan, J., Schoeman, D.S., Lastra, M., Jones, A., Scapini, F., McLachlan, A. & Defeo, O. 2007. Sandy beaches at the brink. *Diversity and Distributions*. 13(5):556-560. DOI:10.1111/j.1472-4642.2007.00363.x

Schlacher, T.A., Weston, M.A., Lynn, D. & Connolly, R.M. 2013. Setback distances as a conservation tool in wildlife-human interactions: testing their efficacy for birds affected by vehicles on open-coast sandy beaches. *PloS One*. 8(9):p.e71200. DOI:10.1371/journal.pone.0071200

Schlegel, J. & Rupf, R. 2010. Attitudes towards potential animal flagship species in nature conservation: a survey among students of different educational institutions. *Journal for Nature Conservation*. 18(4):278-290. DOI:10.1016/j.jnc.2009.12.002

Schoenleber, C.J. 2019. Using interpretive signs and theory-based messaging to protect the Western Snowy Plover (Charadriys alexandrius nivosus). MSc. Thesis. Oregon State University.

Schneider, T.J., Maguire, G.S., Whisson, D.A. & Weston, M.A. 2020. Regulations fail to constrain dog space use in threatened species beach habitats. *Journal of Environmental Planning and Management*. 63(6):1022-1036. DOI:10.1080/09640568.2019.1628012

Schultz, P.W. 2011. Conservation means behavior. *Conservation Biology*. 25(6):1080-1083. DOI:10.1111/j.1523-1739.2011

Searles, K. 2010. Feeling good and doing good for the environment: the use of emotional appeals in pro-environmental public service announcements. *Applied Environmental Education and Communication*. 9(3):173-184. DOI:10.1080/1533015X.2010.510025

Seebens, H., Bacher, S., Blackburn, T.M., Capinha, C., Dawson, W., Dullinger, S., Genovesi, P., Hulme, P.E. et al. 2021. Projecting the continental accumulation of alien species through to 2050. *Global Change Biology*. 27(5):970-982. DOI:10.1111/gcb.15333

Şekercioğlu, Ç.H., Mendenhall, C.D., Oviedo-Brenes, F., Horns, J.J., Ehrlich, P.R. & Daily, G.C. 2019. Long-term declines in bird populations in tropical agricultural countryside. *Proceedings of the National Academy of Sciences*. 116(20):9903-9912. DOI:10.1073/pnas.1802732116

Seltmann, M.W., Öst, M., Jaatinen, K., Atkinson, S., Mashburn, K. & Hollmén, T. 2012. Stress responsiveness, age and body condition interactively affect flight initiation distance in breeding female eiders. *Animal Behaviour*. 84(4):889-896. DOI:10.1016/j.anbehav.2012.07.012

Senfeld, T., Shannon, T.J., van Grouw, H., Paijmans, D.M., Tavares, E.S., Baker, A.J., Lees, A.C. & Collinson, J.M. 2020. Taxonomic status of the extinct Canary Islands Oystercatcher *Haematopus meadewaldoi*. *Ibis*. 162(3):1068-1074. DOI:10.1111/ibi.12778

Seto, K.C., Güneralp, B. & Hutyra, L.R. 2012. Global forecasts of urban expansion to 2030 and direct impacts on biodiversity and carbon pools. *Proceedings of the National Academy of Sciences*. 109(40):16083-16088. DOI:10.1073/pnas.1211658109

Sgrillo, R. 2013. GE-Path freeware. Version 1.4.6. Available: https://www.sgrillo.net/googleearth/gepath.htm [2022, July 21].

Shackleton, R.T., Richardson, D.M., Shackleton, C.M., Bennett, B., Crowley, S.L., Dehnen-Schmutz, K., Estévez, R.A., Fischer, A. et al. 2019. Explaining people's perceptions of invasive alien species: a conceptual framework. *Journal of Environmental Management*. 229(2019):10-26. DOI:10.1016/j.jenvman.2018.04.045

Simmons, R.E., Mills, M.S.L. & Dean, W.R.J. 2009. Oystercatcher Haematopus records from Angola. *Bulletin of the Cooper Ornithological Club*. 16(2):211-212. Available: https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Oystercatcher+Haematopus+records+from+Angola&btnG= [2022, June 7].

Simmons, R.E., Sakko, A., Paterson, J. & Nzuzi, A. 2006. Birds and conservation significance of the Namib Desert's least known coastal wetlands: Baia and Ilha dos Tigres, Angola. *African Journal of Marine Science*. 28(3-4):713-717. DOI:10.2989/18142320609504220

Slater, C., Cam, G., Qi, Y., Liu, Y., Guay, P.J. & Weston, M.A. 2019. Camera shy? Motivations, attitudes and beliefs of bird photographers and species-specific avian responses to their activities. *Biological Conservation*. 237(2019):327-337. DOI:10.1016/j.biocon.2019.07.016

Smith, G-L. 2018. *Police investigate stabbing of Egyptian tourist at CT beach*. Available: https://ewn.co.za/2018/01/08/police-investigate-stabbing-of-egyptian-tourist-at-ct-beach [2022, July 20].

Smith-Castro, J.R. & Rodewald, A.D. 2010. Behavioral responses of nesting birds to human disturbance along recreational trails. *Journal of Field Ornithology*. 81(2):130-138. DOI:10.1111/j.1557-9263.2010.00270.x

Soga, M. & Gaston, K.J., 2016. Extinction of experience: the loss of human–nature interactions. *Frontiers in Ecology and the Environment*. 14(2):94-101. DOI:10.1002/fee.1225

Soulsbury, C.D. & White, P.C. 2015. Human–wildlife interactions in urban areas: a review of conflicts, benefits and opportunities. *Wildlife Research*. 42(7):541-553. DOI:10.1071/WR14229

Sparks, C., Odendaal, J.P., Toefy, R. & Snyman, R. 2018. Metal concentrations in Mytilus galloprovincialis along the west coast of the Cape Peninsula, Cape Town, South Africa. *Pollution Research*. 37(4):841-852. Available: http://digitalknowledge.cput.ac.za/handle/11189/6899 [2022, June 7].

Spennemann, D.H. & Watson, M.J. 2017. Dietary habits of urban pigeons (*Columba livia*) and implications of excreta pH–a review. *European Journal of Ecology*. 3(1):27-41. DOI:10.1515/eje-2017-0004

Stankowich, T. & Blumstein, D.T. 2005. Fear in animals: a meta-analysis and review of risk assessment. *Proceedings of the Royal Society B: Biological Sciences*. 272(1581):2627-2634. DOI:10.1098/rspb.2005.3251

Sterl, P., Brandenburg, C. & Arnberger, A. 2008. Visitors’ awareness and assessment of recreational disturbance of wildlife in the Donau-Auen National Park. *Journal for Nature Conservation*. 16(3):135-145. DOI:10.1016/j.jnc.2008.06.001

Steven, R. & Castley, J.G. 2013. Tourism as a threat to critically endangered and endangered birds: global patterns and trends in conservation hotspots. *Biodiversity and Conservation*. 22(4):1063-1082. DOI:10.1007/s10531-013-0470-z

Steven, R., Pickering, C. & Castley, J.G. 2011. A review of the impacts of nature based recreation on birds. *Journal of Environmental Management*. *92*(10):2287-2294. DOI: 10.1016/j.jenvman.2011.05.005

Strassburg, B.B., Iribarrem, A., Beyer, H.L., Cordeiro, C.L., Crouzeilles, R., Jakovac, C.C., Braga Junqueira, A., Lacerda, E. et al. 2020. Global priority areas for ecosystem restoration. *Nature*. 586(7831):724-729. DOI:10.1038/s41586-020-2784-9

Strauss, M. & Carnahan, J. 2010. Observed errors in distance estimation. *SAE International*.1-12. DOI:10.4271/2010-01-0046

Summers, R.W. & Cooper, J. 1977. The population, ecology and conservation of the Black Oystercatcher *Haematopus moquini*. *Journal of African Ornithology*. 48(1-2):28-40. DOI:10.1080/00306525.1977.9634076

Sutherland, W.J. 1998. The effect of local change in habitat quality on populations of migratory species. *Journal of Applied Ecology*. 35(3):418-421. DOI:10.1046/j.1365-2664.1998.00320.x

Symonds, M.R., Weston, M.A., Robinson, R.W. & Guay, P.J., 2014. Comparative analysis of classic brain component sizes in relation to flightiness in birds. *PLoS One*. 9(3):1-8. DOI:10.1371/journal.pone.0091960

Tang, Z., Huang, Q., Nie, Z. & Yang, Y. 2015. Pollution threatens migratory shorebirds. *Science*. 350(6265):1176-1177. DOI:10.1126/science.350.6265.1176-c

Taylor, A.R. & Knight, R.L. 2003. Wildlife responses to recreation and associated visitor perceptions. *Ecological Applications*. 13(4):951-963. DOI:10.1890/1051-0761(2003)13[951:WRTRAA]2.0.CO;2

Taylor, M.R. & Peacock, F. 2018. The state of South Africa's birds. Johannesburg: BirdLife South Africa. Available: https://www.birdlife.org.za/wp-content/uploads/2018/04/State-of-South-Africas-Birds-Report-2018-1.pdf [2022, June 7]

Tedeschi, L., Biancolini, D., Capinha, C., Rondinini, C. & Essl, F. 2021. Introduction, spread, and impacts of invasive alien mammal species in Europe. *Mammal Review*. DOI:10.1111/mam.12277

Tjørve, K.C. 2006. From an egg to fledgling: a perspective on shorebird breeding ecology and chick energetics. PhD. Thesis. University of Groningen

Tjørve, K.C. & Underhill, L.G. 2008. Influence of disturbance and predation on breeding success of the African Black Oystercatcher, *Haematopus moquini*, on Robben Island, South Africa. *Waterbirds*. 31(1):83-96. DOI:10.1675/1524-4695(2008)31[83:IODAPO]2.0.CO;2

Tsipoura, N., Burger, J., Niles, L., Dey, A., Gochfeld, M., Peck, M. & Mizrahi, D., 2017. Metal levels in shorebird feathers and blood during migration through Delaware Bay. *Archives of Environmental Contamination and Toxicology*. 72(4):562-574. DOI:10.1007/s00244-017-0400-2

Tynon, J.F. & Gómez, E. 2012. Interpersonal and social values conflict among coastal recreation activity groups in Hawaii. *Journal of Leisure Research*. 44(4):531-543. DOI:10.1080/00222216.2012.11950277

Underhill, L.G. 2014. Assessment of the conservation status of African Black Oystercatcher Haematopus moquini. *International Wader Studies*. 20:97-108. Available: http://amoywg.org/wp-content/uploads/2014/09/Underhill_2014_conservation-status-African-Black-Oystercatcher.pdf [2022, June 8]

United Nations. 2019. *World urbanization prospects: the 2018 revision*. New York: United Nations. Available: https://population.un.org/wup/Publications/Files/WUP2018-Report.pdf [2022, March 7].

van Eeden, L.M., Geschke, A., Hames, F., Squires, Z.E. & Weston, M.A. 2023. The leashing behavior of dog owners in different types of natural areas. *Human Dimensions of Wildlife*. 28(4):356-371. DOI:10.1080/10871209.2022.2077482

van de Voorde, S., Witteveen, M. & Brown, M. 2015. Differential reactions to anthropogenic disturbance by two ground-nesting shorebirds. *Ostrich*. 86(1-2):43-52. DOI:10.2989/00306525.2015.1029558

van Polanen Petel, T. & Bunce, A. 2012. Understanding beach users' behavior, awareness, and attitudes to shorebird conservation in central Queensland: tools for effective shorebird conservation. *Coastal Management*. 40(5):501-509. DOI:10.1080/08920753.2012.709464

Verhoeven, J.T. & Setter, T.L. 2010. Agricultural use of wetlands: opportunities and limitations. *Annals of Botany*. 105(1):155-163. DOI:10.1093/aob/mcp172

Verhulst, S., Oosterbeek, K. & Ens, B.J. 2001. Experimental evidence for effects of human disturbance on foraging and parental care in oystercatchers. *Biological Conservation*. 101(3):375-380. DOI:10.1016/S0006-3207(01)00084-2

Vikas, M. & Dwarakish, G.S. 2015. Coastal pollution: a review. *Aquatic Procedia*. 4(2015):381-388. DOI:10.1016/j.aqpro.2015.02.051

Villatoro, F.J., Naughton-Treves, L., Sepúlveda, M.A., Stowhas, P., Mardones, F.O. & Silva-Rodríguez, E.A. 2019. When free-ranging dogs threaten wildlife: public attitudes toward management strategies in southern Chile. *Journal of Environmental Management.* 229(2019):67-75. DOI:10.1016/j.jenvman.2018.06.035

Wang, T., Mukhopadhyay, A. & Patrick, V.M. 2017. Getting consumers to recycle NOW! When and why cuteness appeals influence prosocial and sustainable behavior. *Journal of Public Policy & Marketing*. 36(2):269-283. DOI:10.1509/jppm.16.089

Weston, M.A. 2019. Human disturbance. In *The population ecology and conservation of Charadrius plovers.* M.A. Colwell & S.M. Haig, Eds. Boca Raton: CRC Press. 277-308.

Weston, M.A. & Elgar, M.A. 2007. Responses of incubating hooded plovers (*Thinornis rubricollis*) to disturbance. *Journal of Coastal Research*. 23(3):569-576. DOI:10.2112/04-0151.1

Weston, M.A., Ehmke, G.C. & Maguire, G.S. 2011. Nest return times in response to static versus mobile human disturbance. *The Journal of Wildlife Management*. 75(1);252-255. DOI:10.1002/jwmg.7

Weston, M.A., Guay, P.J., McLeod, E.M. & Miller, K.K. 2015. Do birdwatchers care about bird disturbance? *Anthrozoös*. 28(2):305-317. DOI:10.1080/08927936.2015.11435404

Weston, M.A., McLeod, E.M., Blumstein, D.T. & Guay, P.J. 2012a. A review of flight-initiation distances and their application to managing disturbance to Australian birds. *Emu-Austral Ornithology*. 112(4):269-286. DOI:10.1071/MU12026

Weston, M.A., Dodge, F., Bunce, A., Nimmo, D.G. & Miller, K.K. 2012b. Do temporary beach closures assist in the conservation of breeding shorebirds on recreational beaches? *Pacific Conservation Biology*. 18(1):47-55. DOI:10.1071/PC120047

Weston, M.A., Ju, Y.K., Guay, P.J. & Naismith, C. 2018. A test of the "Leave Early and Avoid Detection" (LEAD) hypothesis for passive nest defenders. *The Wilson Journal of Ornithology*. 130(4):1011-1013. DOI:10.1676/1559-4491.130.4.1011

Weston, M.A., Radkovic, A., Kirao, L., Guay, P.J., Van Dongen, W.F., Malaki, P., Blumstein, D.T. & Symonds, M.R. 2021. Differences in flight initiation distances between African and Australian birds. *Animal Behaviour*. 179(2021):235-245. DOI:10.1016/j.anbehav.2021.07.008

Weston, M.A. & Stankowich, T. 2014. Dogs as agents of disturbance. In *Free-Ranging Dogs and Wildlife Conservation*. M.E. Gompper, Ed. New York: Oxford University Press. 94-113.

Whelan, C.J., Wenny, D.G. & Marquis, R.J. 2008. Ecosystem services provided by birds. *Annals of the New York Academy of Sciences*. 1134(1):25-60. DOI:10.1196/annals.1439.003

White, R.L., Eberstein, K. & Scott, D.M. 2018. Birds in the playground: evaluating the effectiveness of an urban environmental education project in enhancing school children's awareness, knowledge and attitudes towards local wildlife. *PloS One*. 13(3):1-23. DOI:10.1371/journal.pone.0193993

Whitfield, D.P., Ruddock, M. & Bullman, R. 2008. Expert opinion as a tool for quantifying bird tolerance to human disturbance. *Biological Conservation*. 141(11):2708-2717. DOI:10.1016/j.biocon.2008.08.007

Wilcove, D.S., Giam, X., Edwards, D.P., Fisher, B. & Koh, L.P. 2013. Navjot's nightmare revisited: logging, agriculture, and biodiversity in Southeast Asia. *Trends in Ecology & Evolution*. 28(9):531-540. DOI:10.1016/j.tree.2013.04.005

Williams, A.J., Ward, V.L. & Underhill, L.G. 2004. Waders respond quickly and positively to the banning of off-road vehicles from beaches in South Africa. *Wader Study Group Bulletin*. 104:79-81.

Williams, K.J., Weston, M.A., Henry, S. & Maguire, G.S. 2009. Birds and beaches, dogs and leashes: dog owners' sense of obligation to leash dogs on beaches in Victoria, Australia. *Human Dimensions of Wildlife*. 14(2):89-101. DOI:10.1080/10871200802649799

Wilson, C. & Tisdell, C. 2005. Knowledge of birds and willingness to support their conservation: an Australian case study. *Bird Conservation International*. 15(3):225-235. DOI:10.1017/S0959270905000419

Wolf, I.D. & Croft, D.B. 2010. Minimizing disturbance to wildlife by tourists approaching on foot or in a car: a study of kangaroos in the Australian rangelands. *Applied Animal Behaviour Science*. 126(1-2):75-84. DOI:10.1016/j.applanim.2010.06.001

World Health Organisation. 2022. *Advice for the public: Coronavirus disease (COVID-19)*. Available: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public [2022, September 12].

Worm, B., Barbier, E.B., Beaumont, N., Duffy, J.E., Folke, C., Halpern, B.S., Jackson, J.B., Lotze, H.K. et al. 2006. Impacts of biodiversity loss on ocean ecosystem services. *Science*. 314(5800):787-790. DOI:10.1126/science.1132294

Ydenberg, R.C. & Dill, L.M. 1986. The economics of fleeing from predators. *Advances in the Study of Behavior*. 16(1986):229-249. DOI:10.1016/S0065-3454(08)60192-8

Zander, K.K., Ainsworth, G.B., Meyerhoff, J. & Garnett, S.T. 2014. Threatened bird valuation in Australia. *Plos One*. 9(6):1-9. DOI:10.1371/journal.pone. 0100411

Zhou, B. & Liang, W. 2020. Avian escape responses to observers wearing clothing of different colors: a comparison of urban and rural populations. *Global Ecology and Conservation*. 22:1-8. DOI:10.1016/j.gecco.2020.e00921

Appendices

Appendix A

Section 1

Thank you for your participation in this anonymous survey. Please do not write your name and/or any other comments that will make you identifiable. Please answer all of the following questions on your own behalf and do not complete this survey more than once.

Please note that all of the survey questions and items have been constructed by the researcher. Thus, the City of Cape Town's Biodiversity Management Branch and the management/staff of the Blaauwberg Nature Reserve are not liable for any issues that may arise before, during or after completion of the survey. However, the researcher is conducting this research at the request of the City of Cape Town's Biodiversity Management Branch, and has the support of the reserve management/staff. The researcher acknowledges that some people may consider some of the items in the survey to be 'inflammatory', such as those pertaining to the hypothetical regulations (Section 5). These regulations are purely hypothetical, which means that the reserve management is under no obligation to implement any of them both now and/or in the future. Furthermore, the reserve management does not necessarily intend to implement any of the regulations both now and/or in the future. Thank you for your understanding.

Please fill in all of the following:

1) Age:

2) Sex:

3) Race:

4) Suburb: Zip code:

5) Highest level of education:

No schooling	
Primary school	
High school	
College	
University undergraduate diploma	
University postgraduate diploma	
University undergraduate degree	
University postgraduate degree	
Other (specify)	

6) Employment:

Unemployed	
Employed full time	
Employed part time	
Retired	
Student	
Unpaid home duties	
Other (specify)	

7) Why do you visit the reserve beaches? Select all the options that apply to you.

Walking	
Running	
Walking dog(s)	
Surfing	
Swimming	
Fishing	
Picnicking	
Other (specify)	

8) How often do you visit the reserve beaches?

On a daily basis	
Several times a week (but not daily)	
On a weekly basis	
Several times a month (but not weekly)	
On a monthly basis	
Several times a year (but not monthly)	
Other (specify)	

Section 2

9) Evaluate the following statements and indicate the extent to which you agree or disagree with them by **circling** or **crossing** your choice. Please note that **regulations** refer to the rules and/or directives that are established and maintained by an authority.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1	2	3	4	5

	Example: I am completing a survey	1	2	3	4	(5)
A	I think that it is important to protect shorebirds.	1	2	3	4	5
B	I think that signs with information about shorebirds are helpful.	1	2	3	4	5
C	I am familiar with the regulations on beaches.	1	2	3	4	5
D	I think that regulations on beaches are unimportant.	1	2	3	4	5
E	I think that dog access to beaches is important.	1	2	3	4	5
F	I am familiar with some species of local shorebirds.	1	2	3	4	5
G	I think that regulations on beaches are important.	1	2	3	4	5
H	I think that dogs pose a threat to shorebirds.	1	2	3	4	5
I	I think that regulations on beaches are restrictive.	1	2	3	4	5
J	I have seen signs about shorebirds on the reserve beaches.	1	2	3	4	5
K	I always follow the regulations on beaches.	1	2	3	4	5
L	I always look out for signs on beaches.	1	2	3	4	5

10) Name five different species of shorebirds that you have seen in the reserve either today or during your previous visits. If you cannot name five species, then name as many as you can.

(1) ____________________ (2) ____________________ (3) ____________________

(4) ____________________ (5) ____________________

11) Are any of these shorebirds legally protected?

Yes ☐ No ☐ Unsure ☐

If yes, which are protected: ____

Section 3

Please complete all of the following questions in this section **only** if you are a **dog owner**. If you are not a dog owner, please continue with **Section 4**.

12) How many dogs do you own?

____

13) Do you ever walk your dog(s) at the beach?

Yes ☐ No ☐

14) Do you ever walk your dog(s) at the reserve beaches?

Yes ☐ No ☐

15) Evaluate the following statements and indicate the extent to which you agree or disagree with them by **circling** or **crossing** your choice.

Strongly disagree 1	Disagree 2	Neither agree nor disagree 3	Agree 4	Strongly agree 5

A	My dog(s) pose no threat to shorebirds, nests and chicks.	1	2	3	4	5
B	Other peoples' dogs are more likely to chase shorebirds than my dog(s).	1	2	3	4	5
C	My dog(s) pose no threat to other peoples' dogs on the reserve beaches.	1	2	3	4	5
D	Other peoples' dogs are poorly behaved on the reserve beaches.	1	2	3	4	5
E	I always leash my dog(s) on the reserve beaches.	1	2	3	4	5
F	Other peoples' dogs are more likely to pose a threat to shorebirds, chicks and nests than my dog(s).	1	2	3	4	5
G	My dog(s) do not chase shorebirds.	1	2	3	4	5
H	My dog(s) pose no threat to other people on the reserve beaches.	1	2	3	4	5
I	It is unnecessary to leash my dog(s) while on the reserve beaches because he/she/they listen and are well behaved.	1	2	3	4	5

Section 4

16) Evaluate the following statements and indicate the extent to which you agree or disagree with them by **circling** or **crossing** your choice. Please note that **human activities** refer to the activities that people often engage in while at beaches, such as those involving walking, running and swimming with or without dogs. **Human activities** also include a range of other activities, such as surfing, fishing and bait collection on the shore and/or rocky intertidal zone.

Strongly disagree 1	Disagree 2	Neither agree nor disagree 3	Agree 4	Strongly agree 5

A	Human activities can cause shorebirds to spend less time foraging.	1	2	3	4	5
B	Human activities can cause shorebirds to abandon their breeding sites.	1	2	3	4	5
C	Human activities can cause shorebirds to become distressed.	1	2	3	4	5
D	Human activities can cause shorebird chicks to drown.	1	2	3	4	5
E	Human activities can cause shorebirds to abandon their eggs.	1	2	3	4	5
F	Human activities can cause shorebirds to spend less time feeding their chicks.	1	2	3	4	5
G	Human activities can cause shorebird population numbers to decline.	1	2	3	4	5
H	Human activities can cause shorebirds to spend time off their nests.	1	2	3	4	5
I	Human activities can cause shorebird habitat loss and degradation.	1	2	3	4	5
J	Human activities can cause shorebirds to abandon their chicks.	1	2	3	4	5
K	Human activities can cause shorebird chicks to grow slower than usual.	1	2	3	4	5
L	Human activities can cause shorebird deaths.	1	2	3	4	5

Section 5

17) Evaluate the following **dog walking** regulations and indicate the extent to which you approve or disapprove of them by **circling** or **crossing** your choice. Please note that (I) **regulations** refer to the rules and/or directives that are established and maintained by an authority, (II) **all** of the regulations listed below are purely **hypothetical**, and (III) most shorebirds nest **above the high-water mark** usually between **October-March**.

Strongly disapprove 1	Disapprove 2	Neither approve nor disapprove 3	Approve 4	Strongly approve 5

A	Dogs should not be allowed to access the reserve beaches.	1	2	3	4	5
B	Dogs should be leashed at all times on the reserve beaches.	1	2	3	4	5
C	Dogs should only be leashed on the reserve beaches during the shorebird breeding season.	1	2	3	4	5
D	Dogs should always be restricted to certain areas of the reserve beaches.	1	2	3	4	5
E	Dogs should only be restricted to certain areas of the reserve beaches during the shorebird breeding season.	1	2	3	4	5
F	Dogs should only be allowed to access the reserve beaches at certain times of the day.	1	2	3	4	5
G	Dogs should only be allowed to access the reserve beaches on certain days of the week.	1	2	3	4	5
H	Dogs should not be allowed to access the reserve beaches during the shorebird breeding season.	1	2	3	4	5
I	The number of dogs allowed to access the reserve beaches should be limited during the shorebird breeding season.	1	2	3	4	5
J	There should be no regulations on dog walking.	1	2	3	4	5

18) Which dog regulation do you support the most and least? Please **only list the letter.**

Most: _________

Least: _________

Section 5

19) Evaluate the following **walking** regulations and indicate the extent to which you approve or disapprove of them by **circling** or **crossing** your choice. Please note that (I) **regulations** refer to the rules and/or directives that are established and maintained by an authority, (II) **all** of the regulations listed below are purely **hypothetical**, (III) **walking** includes **all** human activities without dogs that involve traversing the reserve beaches, and (IV) most shorebirds nest **above the high-water mark** usually between **October-March**.

Strongly disapprove 1	Disapprove 2	Neither approve nor disapprove 3	Approve 4	Strongly approve 5

A	Walkers should not be allowed to access the reserve beaches during the shorebird breeding season.	1	2	3	4	5
B	Walkers should only be allowed to access certain areas of the reserve beaches during the shorebird breeding season.	1	2	3	4	5
C	Walkers should only be allowed to access the reserve beaches at certain times of the day during the shorebird breeding season.	1	2	3	4	5
D	Walkers should only be allowed to access the reserve beaches on certain days of the week during the shorebird breeding season.	1	2	3	4	5
E	The number of walkers allowed to access the reserve beaches should always be limited.	1	2	3	4	5
F	The number of walkers allowed to access the reserve beaches should only be limited during the shorebird breeding season.	1	2	3	4	5
G	There should be no regulations on walking.	1	2	3	4	5

20) Which walking regulation do you support the most and least? Please **only list the letter**.

Most: _________

Least: _________

Section 6

21) Would you support the implementation of buffer zones to protect nesting shorebirds? Please note that (I) **buffer zones** refer to demarcated areas around nesting shorebirds that prohibit human activities, and (II) most shorebirds nest **above the high-water mark** usually between **October-March**.

Yes ☐ No ☐

22) If you answered 'yes' to question 21, then what size buffer zone do you think should be placed around nesting shorebirds to protect them from **walkers**? Please only tick one box.

10 m ☐ 20 m ☐ 30 m ☐ 40 m ☐ 50 m ☐

+100 m ☐

60 m ☐ 70 m ☐ 80 m ☐ 90 m ☐ 100 m ☐

23) If you answered 'yes' to question 21, then what size buffer zone do you think should be placed around nesting shorebirds to protect them from **dog walkers**? Please only tick one box.

10 m ☐ 20 m ☐ 30 m ☐ 40 m ☐ 50 m ☐

+100 m ☐

60 m ☐ 70 m ☐ 80 m ☐ 90 m ☐ 100 m ☐

Section 7

24) Do you have any comments that you would like to provide?

____

____

____

____

Your participation and completion of this survey is greatly appreciated, thank you.