The effects of tourism on the behaviour of the New Zealand fur seal (*Arctocephalus forsteri*)

A thesis submitted in partial fulfillment of the requirements for the

Degree of

DOCTOR OF PHILOSOPHY

In ECOLOGY

At the University of Canterbury

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2013

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ABSTRACT

The demand by ecotourism for easily accessible wildlife encounters has increased the need for regulations to minimise negative effects of tourism on towards marine mammals. High levels of human interaction could have serious consequences for recovering populations of New Zealand fur seals (*Arctocephalus forsteri*). By monitoring behavioural shifts in reactions to human disturbance, the aim of this study was to determine how disturbance by tourism is affecting the behaviour of the New Zealand fur seals. Fur seal breeding colonies, haul-outs, and a pup nursery were studied on the South Island to determine the level of disturbance. Data collected in this study can be used towards improving monitoring regimes to mitigate negative effects of anthropogenic disturbance. I first used behavioural observations to assess a seal's behaviour in response to different types of tourist activities. Next, I examined changes in New Zealand fur seal behaviour as a result of visits to colonies by tourist boats. To quantify the response of fur seals to tourist boats, experimental boat approaches were conducted using a before, during, and after instantaneous scan sampling method at two breeding colonies (one with high vessel traffic and one with none). Impact of noise was also investigated using a loud speaker to mimic local harbour tours. Lastly, behavioural observations on seal pups at a nursery were conducted comparing pup behaviour in the presence and absence of tourism along with variable intensities of tourist behaviour. My observations suggest that seal behaviour was significantly different between sites with and without tourist visits. The type of tourism had a significant effect on the behavioural state of seals, with animals more active when there were people walking in the colonies. There were also signs of habituation in some of the study colonies. Since each colony varied in the type of tourism it experienced, it is possible that it is not only the level of tourism that is

important but also the type of tourism that has a significant role in eliciting short-term behavioural shifts. Observations from a tour boat revealed an increase in the percentage of seals reacting when vessels were close to the shore. This distance effect was overridden and reactions were greater, however, when tours included commentary via an external speaker. The effects of both distance and noises were significantly different between colonies with high and low levels of tourist visits. Due to the overlap of peak tourist visits with fur seal breeding season, these animals are at their most vulnerable when companies are in peak operation. Finally, as with adults, pup behaviour was also significantly affected by tourism presence. Periods of inactivity and awareness increased in the presence of tourists, which is indicative of disruption of “play” and movement towards more vigilant behaviour. Despite the significant effects of tourist visits I found in this study, there was large variation in the degree of responses in different populations of the fur seal. This variation is thought to be due, in part, by the level of desensitisation, especially at locations with high or continual tourism pressures. This study also provides evidence that fur seal pups subject to human disturbance will alter their behaviour, shifting from active (when people are not around) to inactive and more aware (with increased disturbance). The results presented suggest such visits are not without consequences and that animals can be disturbed by human interactions. Therefore, measures should be taken at all seal colonies used in tourism ventures to mitigate any negative long-term effect on the fur seal populations.

Chapter 1

Introduction

Background

Historical exploitations of marine mammals

Wildlife management is defined as the encouragement and conservation of natural resources such as game, fish, and wildlife (Oxford English Dictionary). According to this view, sustainable management arises from a compromise in human behaviour that ensures the continual growth and maintenance of any living resource while, at the same time, obtaining an economic gain from it (Harwood 2010). The traditional economic benefit from marine mammals was based on the assumption that harvesting whales, dolphins and seals (the "resource") for their oils, furs, and other parts was unlimited and sustainable as a consistent monetary source (Harwood 2010). Such direct harvest exploitation of marine mammals has, in recent years, largely given way to non-lethal use in the form of tourism (Harwood 2010), which is not as dependent on population size or growth. However, growth of marine mammal populations may in some cases indirectly increase economic gains, which was not always the case with the harvesting industry (Harwood 2010). Whether directly exploiting an animal population for traditional resource extraction or using them for a non-extractive industry such as tourism, both require the creation of a balance between the pressing need to conserve marine mammal populations and the yearning to obtain financial gains from them.

Harvesting of marine mammals has generally not been managed sustainably, especially with the large-scale or industrial level harvesting that began with European expansion (Harwood 2010). There is evidence that some populations of seals were harvested by pre-industrial societies of humans for at least 30,000 years and that this harvesting was sustainable due to the long-term persistence of seal colonies near human settlements (Bonner 1989). These pre-industrial hunters typically only harvested large males and small numbers of pups (which have the highest natural mortality rate) (Bonner 1989). Such sustainable harvesting ended with the global expansion of commercial whaling in the late 18th century (Harwood 2010). Advances in sea travel, processing on board ship, larger nets, and harpooning techniques (Allen 1981, Harwood 2010) brought whalers into contact with large fur seal colonies in the sub-Antarctic region (Harwood 2010). Whaling ships were already equipped to extract oil from marine mammals, so it was an easy switch from the rapidly depleting whale populations to fur seals. By the mid-19th century, over four million fur seals had been killed globally for their oil (Busch 1985). The impact of even this level of exploitation was relatively minimal as sealers were only able to approach colonies with oars and sails, and animals were killed with hand-thrown harpoons (Harwood 2010). This changed in 1864 when a gun powered harpoon was mounted on a steam powered catcher boat (Harwood 2010). This advancement opened up a new era in whaling and sealing that followed, but on a much shorter time scale (Harwood 2010) causing commercial extinction of most stocks of whales by the early 20th century (Tonneson & Johnsen 1982). Seals stocks were no different. In the 1950's, the reported commercial catch was reported as 624,300 hooded (*Cystophora cristata),* and harp seals (*Pagpphilus groenlandicus*). Due to the decline of pinniped populations, harvest yields have declined steadily into modern times (ICES 2006). A prime example was seen in New Zealand fur seals (*Arctocephalus forsteri*) as stocks were decimated on New Zealand main islands in the late 20th century (Bonner 1989).

Marine mammal tourism

In New Zealand, tourism is one of the highest grossing industries, contributing billions of dollars annually to the national economy (Ministry of

Business Innovation and Employment 2012). Although tourism can involve a variety of activities, wildlife watching (often referred to as “wildlife tourism” or “ecotourism”) is one of the fastest growing sectors of tourism in New Zealand and worldwide (Dans et al. 2008). Among conservationists, there are varying opinions on the benefits of wildlife tourism. In the case of marine mammal watching, economic benefits, especially in very small towns or villages, have led to local development and economic growth (Higginbottom 2004). On the other hand, marine mammal tourism is not beneficial if it directly influences an animal’s behaviour or leads to habitat shifts that are detrimental to the long-term condition and survival of the population (Richardson et al. 1995, Dans et al. 2008).

Concerns about the effects of anthropogenic disturbance on the health and survival of marine mammals have increased greatly in recent years. While direct mortality due to hunting and commercial harvesting has generally declined, and stopped altogether for most species, new sources of concern have arisen through excessive mortality due to entrapment in fishing gear, ship strikes, and the effects of pollutants (Richardson et al. 1995). As early as the 1970’s, anthropogenic noise in the marine environment was raised as a concern by biologists (Richardson et al. 1995). Interest in this issue was sparked initially in the Unites States with the boom of the offshore oil industry. More recently, the effects of lower intensity sounds, such as vessel motor noise on marine mammals, have been examined on a more localised scale with pinnipeds in Australia (Tripovich et al. 2012), dusky dolphins (*Lagenorhynchus obscurus)* and sperm whales (*Physeter macrocephalus*) in New Zealand (Markowitz et al. 2009, Markowitz et al. 2011) and various marine mammal species in the Chukchi Sea, United States (Small et al. 2011). Increased vessel traffic may interfere with echolocation and communication within pods of cetaceans (Richardson et al. 1995, Small et al. 2011). This can lead to the separation of individuals, change in foraging/resting behaviours (Williams et al. 2002, Constantine et al. 2004, Markowitz et al. 2009), and increased stress to the animal (Richardson et al. 1995, Bejder & Samuels 2003, Constantine et al. 2004, Bejder et al. 2006, Lusseau et al. 2009).

Most studies of the effects of tourism on wildlife highlight the need for better management practices in areas where wildlife behaviour has been negatively affected (Constantine 1999, Beale & Monaghan 2004, Bejder et al. 2009). As described by Bejder et al. (2009) there are varying types of adaptive behavioural modifications a group or population can exhibit in response to repeated exposure to a stimulus, including long-term habituation or sensitization. Behavioural habituation is defined "as the relative constant weakening of a response as a result of repeated stimulation, which is not followed by any kind of reinforcement" (Bejder et al. 2006, Bejder et al. 2009). Therefore, a habituated animal's responses to a stimulus weaken over time as it determines there is no beneficial or adverse consequences associated with the stimulus (Thorpe 1963, Bejder et al. 2009). Behavioural sensitization is the opposite of habituation and occurs when the "animals' behavioural responses to a stimulus increase over time as they learn the stimulus has significant consequences" (Richardson et al. 1995). Tolerance to a stimulus has also been noted in short-term studies and is defined as when the animals apparently ignore a stimulus and this can lead to, over a longer duration, habituation or desensitization (Nisbet 2000). Therefore, it may be more appropriate to focus on changes in behaviour as a type of tolerance, which if improperly managed, can lead to an eventual long-term unwanted behavioural change.

Apart from behavioural changes due to habituation or sensitization, encounters between wildlife and tourists can lead to “stress” in some animals. High levels of stress can even impact an animal more negatively than changes in behaviour alone (Dawkins 1980, Hutson 1985, Hemsworth et al. 1986, Maier et al. 1994). Physiologically, stress can increase the secretion of corticosteroids (Hemsworth et al. 1981), heart rate, and the adrenal response (Hutson 1985). Over the long-term, stress can impact an animal’s health (e.g., reducing periods of rest and feeding) (Maier et al. 1994), welfare (Dawkins 1980), and fecundity (Hemsworth et al. 1986). Psychologically, there is a “flight or fight” stress response, which is even inherent in domesticated animals and humans (Grandin 1987, Markowitz et al. 1998).

Tourism activities have the potential to negatively impact animals, whether by deleterious changes in their behavior or through increased stress. In New Zealand, marine mammals are protected under the Marine Mammals Protection Act of 1978. Marine mammal tourism is managed by the Marine Mammals Protection Regulations of 1992, which was written with a focus on cetacean tourism, and does not specifically pertain to pinnipeds. However, there are two items the 1992 regulations mentions: 1) no person shall make any loud or disturbing noise near seals and 2) no more than 3 vessels or aircraft shall approach within 300 m of any heard of seals (if their purpose is to enable passengers to view seals) (Tizard 1992). Any pinniped related “rule” occurring after 1992 are guidelines and non-regulatory. The demand for easily accessible encounters, specifically with fur seals and New Zealand sea lions (*Phocarctos hookeri*) has increased in the last 25 years (Acevedo-Gutierrez et al. 2010a). The increased tourism pressures are creating the need for additional research to help set up regulations to minimize tourist effects on these species. Current management practices are not always effective (Pagh 1999, Goslinga & Denkers 2009, Acevedo-Gutierrez et al. 2010a). For example, posted signs at popular viewing areas in Kaikoura had no effect on tourist compliance of viewing regulations, and "official-looking" people at a tourist location were more effective in encouraging compliance around wildlife than posted signs (Acevedo-Gutierrez et al. 2010b).

There are regulations in place for permitted tour operators that focus on New Zealand fur seals during their wilderness tours. Some specifics of these permits include restricted vessel approaches to 20 m from the coast line when viewing seals, limits to the number of tour vessels viewing within 300 m, and restrictions to tour locations. Additionally, there are recommendations in place for the general public to maintain a distance of 20 m from seals on land.

Given the importance of ecotourism to the New Zealand economy, and concerns both here and overseas on the effects of this activity on wildlife, the objective of my thesis was to examine the effects of the ecotourism on the New Zealand fur seal (*Arctocephalus forsteri*). In the following sections, I first give an overview on the general history, breeding biology and protection status of New Zealand fur seal. I then follow with an outline of research goals addressed in the subsequent chapters of the thesis.

History

The New Zealand fur seal was once on the brink of extinction due to overhunting for food and furs by both the Maori and European settlers (Lalas & Bradshaw 2001). Historical population estimates of the fur seals on New Zealand were presumed to be between 1.5 to 2 million pre harvesting (Lalas & Bradshaw 2001). Populations began to collapse around 1815, by which time entire colonies had been hunted to extinction and population had fallen to only 10% of their original numbers (Mattlin 1987, Lalas & Bradshaw 2001). The seal trade industry was closed in 1897 due to low numbers of animals, but re-opened in 1946 when populations appeared to be recovering. Hunting was banned again in 1978 when *A. forsteri* received full protection under the Marine Mammals Protection Act (Cawthorn et al. 1985). Since then, fur seals have begun to re-colonize historic breeding grounds and the species is now reportedly reaching an overall population estimated at 200,000 between New Zealand and South Australia, with half of these being in New Zealand (Harcourt 2001, Boren 2005, Goldsworthy & Gales 2008).

Current trends indicate the New Zealand fur seal population is increasing in both numbers and geographic range (Boren 2005, Goldsworthy & Gales 2008). Figure 1.1 shows an increase in distribution of *A. forsteri* around New Zealand in 2005 as compared to the late 1970's. In New Zealand, fur seal breeding areas are located on offshore temperate and sub-Antarctic islands, Stewart Island, the South Island, and are currently expanding their range up to the North Island (Crawley & Wilson 1976, Cawthorn et al. 1985, Boren 2001, Harcourt 2001, Boren 2005, Goldsworthy & Gales 2008). New Zealand fur seals are also found in South and Western Australia, Victoria, Tasmania, New South Wales, and Queensland (Shaughnessy et al. 2001). Breeding colonies have been also established in eastern Bass Strait and on offshore islands around Australia's western and southern coast (Goldsworthy & Gales 2008).

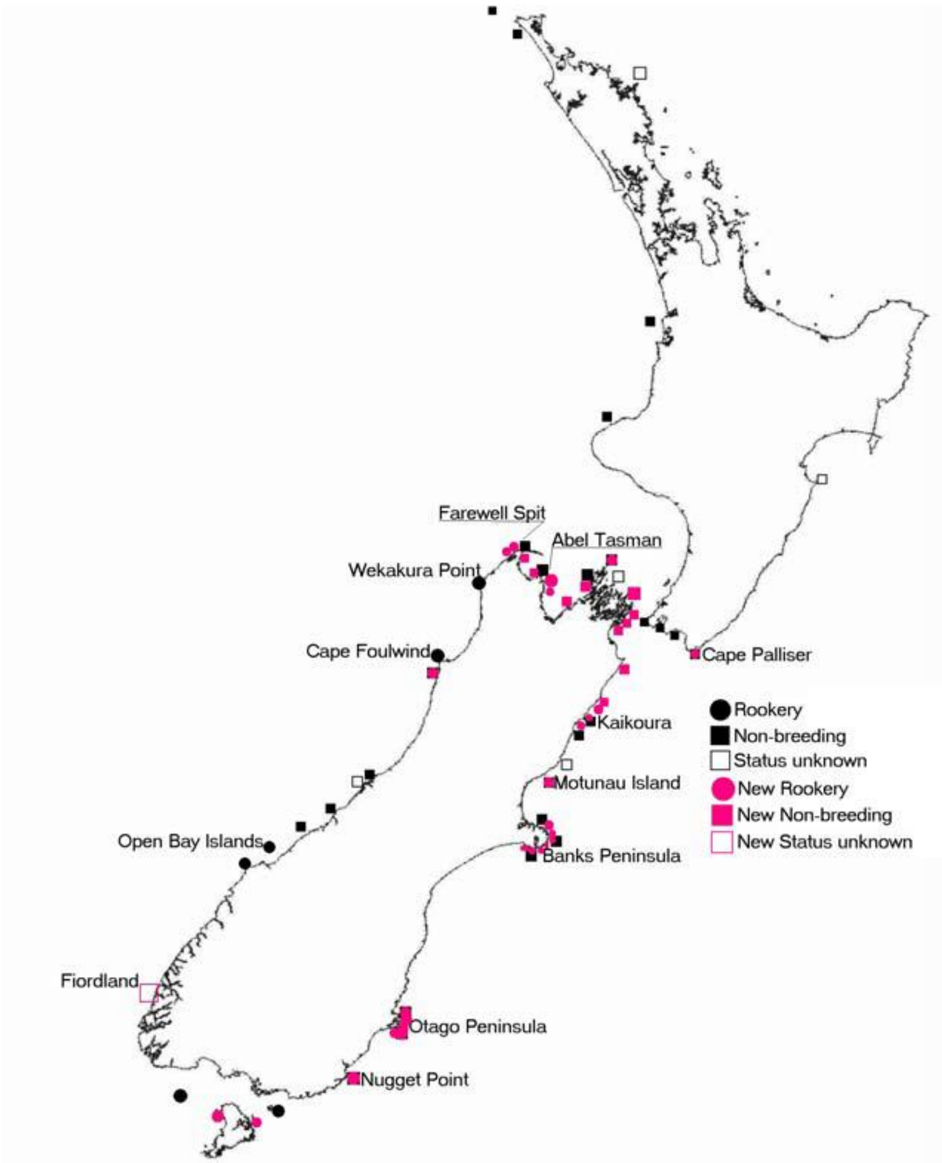

Figure 1.1. Distribution of *A. forsteri* in a comparison of older breeding colonies (in black) (Wilson 1981) with more recently established colonies from Boren (2005) (in pink), confirming an increase in range. *Map from Boren (2005).*

Natural history and colony dynamics

The natural history of the New Zealand fur seal is fairly well documented (Stirling 1970, Crawley & Wilson 1976, Mattlin 1978a, Mattlin 1978b, Cawthorn et al. 1985, Mattlin 1987, Boren 2005, Boren et al. 2006). From September to November, breeding males come ashore to claim territories and the sub-adult male population declines because they disperse from the beaches. Females follow later and begin to haul-out by mid-November to late-December at rookeries (breeding colonies) to give birth (Stirling 1970, Crawley & Wilson 1976, Mattlin 1987, Boren 2005, Boren et al. 2006, Goldsworthy & Gales 2008). Within a few days to a few weeks after giving birth, females enter oestrus (Miller 1975, Mattlin 1978b, 1987, Boren et al. 2006, Goldsworthy & Gales 2008). Some adult males have been seen to stay at breeding colonies year round, however the majority tend to leave after they have mated (Stirling 1970, Taylor et al. 1995, Bradshaw 1999, Boren et al. 2006). Around May, the number of sub-adult males increases as they return to the breeding colony (Stirling 1970, Miller 1975). After females have given birth and mated, they alternate between time at sea foraging and on shore nursing their pups on shore (Miller 1975). The duration of foraging trips will vary depending on the female's preferences and the colony location (Cawthorn et al. 1985, Boren et al. 2005, Meynier 2012). Fur seals only produce one pup per breeding season, although twins have been observed on the rare occasion (Dowell et al. 2008). The average lactation time for New Zealand fur seals is 7-12 months (Goldsworthy 1992) but lactation times can vary across different populations and are more typically 10-12 months (Crawley & Wilson 1976, Cawthorn et al. 1985, Riedman 1990, Boren 2005, Goldsworthy & Gales 2008, Jefferson et al. 2008).

Behaviour as an indicator of disturbance

Assessing the effects of tourism on marine mammals such as seals is commonly accomplished through observations of the animal's behaviour and any subsequent alterations resulting from anthropogenic disturbance (Harwood 2010). For example, grey seals (*Halichoerus grypus)* in the United Kingdom prefer breeding in areas with little human disturbance, consequently changing their breeding regime to periods of the year when tourism was lowest (Lidgard 1996). Similarly, Asian rhinos (*Rhonoceros unicornis)* in Chitwan National Park spent more time alert and less time feeding when tourists approached closely (~ 10 m) (Lott & McCoy 1995).

According to Boren (2001) there are three main areas of concern regarding how tourism may affect wildlife species. The first is a shift in response to a stimulus. These shifts are not always uniform within a species as behavioural responses may be variable between latitudes, colonies, and even individuals within the same viewing area. (Richardson et al. 1995, Lidgard 1996, Barton et al. 1998, Boren 2001, van Polanen Petel 2005). A hypothetical example illustrates this variation: when conducting a controlled approach towards three different herds of bison (*Bison bison*) in the same nature reserve, each herd may react in a different way. The first herd may run from the approaching person, the second may stand still and form a circle to protect young calves, while the third herd might choose to ignore the person altogether. Variable responses are quite common, and usually indicate the presence of differing external influences between study groups (Boren 2001).

The second concern on how tourism may affect wildlife is through habituation occurring within groups that become more tolerant of human activity than “normal”. Over time some individuals learn that there are neither adverse nor beneficial consequences to a stimulus (Thorpe 1963, Barton et al. 1998, van Polanen Petel 2005, Bejder et al. 2006, Jackson 2006, Bejder et al. 2009, Stamation et al. 2010, Streckenreuter et al. 2011). An example of how habituation affects wildlife has been reported in a study of chimpanzees (*Pan troglodytes*) in the Kibale Forest, Uganda (Johns 1996) where the chimpanzees did only reacted towards tourist in groups larger than 10 persons (Johns 1996). Due to a high level of exposure to people, the activity levels of these chimpanzees do not alter when people are present (Johns 1996) and they allowed people to get closer to them than chimpanzees not exposed to tourism. In this type of habituation, there is a risk of harm to either party if the other becomes less tolerant of the other. For instance, a mother chimpanzee would be more prone to protect her baby if a tourist was too close to them. In this example, if the mother chimpanzee threatens the tourist, the tourist may be hurt, and in turn, the chimpanzee may be euthanized.

Lastly, understanding the long-term effects (which may not be fully understood or recognized until years after disturbance) is essential to fully document impacts of tourism on wildlife populations (Boren 2001, Constantine et al. 2004, Boren 2005, Bejder et al. 2006, Bejder et al. 2009, Harwood 2010). Many of the long-term effects are unknown or extrapolated from assessing the short-term impacts over a couple of seasons or years (Boren 2001, Bejder et al. 2009, Harwood 2010). Long-term monitoring of the potential impacts of ecotourism on animal populations is important in areas where there are already identified short-term impacts on productivity, foraging behaviours, or migratory or haul-out regimes (Lidgard 1996, Barton et al. 1998, Boren 2001, Dans et al. 2008, Bejder et al. 2009, Harwood 2010, Lovecraft & Meek 2010).

Previous research on the New Zealand fur seals using behavioural observations, controlled approaches on land and by boat, and interviews with tourists indicates that at least some animals become habituated to tourist disturbances, especially in locations with high tourist volumes (Barton et al. 1998, Boren 2001, Bauszus & Tandy 2002). This earlier body of work also suggests that current regulations are not adequate to minimise the effect of tourist encounters in places with easy access to fur seals, such as Kaikoura, New Zealand (Barton et al. 1998, Bauszus & Tandy 2002, Boren 2005). Boren (2002) suggested extending the viewing distance at Tonga Island from 20 m to 30 m based on observations during controlled kayak approaches. In all of these studies, the common theme was the need to improve the way tourism was being conducted and encouraged modifying the management regime in place.

Objectives

In New Zealand, the main anthropogenic threats to pinnipeds are small vessel traffic (i.e., under 20 m), interactions with farmers, divers, and as by-catch in commercial fishing vessel (Slooten & Lad 1991, Barton et al. 1998, Bauszus & Tandy 2002, Boren 2005). Small vessel and diver interactions occur in the Austral spring – summer period when tourism is at its peak (Ministry of Business Innovation and Employment 2012) where as farmers and fishery interactions occur in the winter time. To help with the future management of marine mammal tourism in New Zealand, specifically seal viewing, I studied the effects of tourism on the fur seal behaviour. Data were collected over three summers to assess seasonal and regional variability in fur seal tourism, how often animals were disturbed by tourists, and how the behavior of both adult and pup fur seals was affected. The potential effects of tourism on fur seals were measured by observing the behavioural reactions of seals as an index of an animals' level of tolerance or habituation towards disturbance. Commercial tourism in this report focuses on that involving motor boats, kayaks, and people walking in the colonies (recommended viewing distance). Specific objectives of this thesis are outlined in the following chapters:

Chapter 2: Effects of different types of tourism on the behaviour of the New Zealand fur seals of the South Island. In chapter 2, I start by examining seal tourism in different geographical locations on New Zealand's South Island. My focus is to compare how seals respond to different types of tourist activities and how this varies across their range in the South Island.

Chapter 3: The effect of tour vessels on the behaviour of New Zealand fur seals at Banks Peninsula. In the next chapter, I measure the short-term behavioural responses of seals to commercial viewing vessels. This chapter focuses solely on data obtained from tour vessels to determine the specific nature of each seal viewing session including: location, duration, vessel activities, and seal reactions. Responses of seals to boat approaches are used to estimate the appropriate minimum approach distances to New Zealand fur seal colonies via motor boat.

Chapter 4: Use of experimentally-controlled boat approaches to determine New Zealand fur seal behavioural responses at three commonly use tour boat viewing distances. In chapter 4, I use a series of experimental approaches, where distance was controlled, to determine differences in seal reactions at specific distances. Since Chapter 3 data were opportunistic, these experimental approaches were conducted in an attempt to determine if the currently permitted viewing distance (20 m) is appropriate in minimising disturbance to the animals. Additionally, I compared the use of commentary at the already permitted viewing distance to silent tours to confirm my finding in Chapter 3. These results have direct implications for modifying currently accepted practice in the tourism industry.

Chapter 5: *Effects of tourist presence on the behaviour of New Zealand fur seal pups at a communal "playground".* In this chapter, the focus was switched from the behavior of fur seals at a rookery to that of seal pups using a fresh-water stream and pool as a social area. This location has attracted large numbers of tourists and, until 2010, was largely unmanaged/ unrestricted. My objective is to determine how this "management free" form of tourism affects the pups and whether better management and controls are needed.

Chapter 6: Conclusions. In this final chapter I put all my findings in the context of the literature, recommendations are made on management issues and suggestions for further research are provided.

Note that chapters 2 - 5 have been written in manuscript style in anticipation of submitting them for publication, and are thus designed to be read independently. As a consequence, a certain amount of repetition was inevitable in order to give sufficient background to each chapter.

Chapter 2

Effects of different types of tourism on the behaviour of the New Zealand fur seals of the South Island

Abstract

In the New Zealand fur seal (*Arctocephalus forsteri*) high levels of human disturbance can have serious consequences on the health of individuals. Such anthropogenic stress can be monitored over the short-term by measuring behavioural responses to disturbance. The aims of this study were to determine whether and how disturbance by tourism affects the behaviour of fur seals on a broad geographic scale. I compared four fur seal colonies around the South Island, three colonies with tourism and one without, to determine how seals react to disturbance and how this differs by type of interaction and location. Observations were conducted using instantaneous scan and all occurrences sampling to record behavioural states during periods with and without tourism. Tourism type and level of disturbance varied over the course of the day. Seal behaviour was also significantly different between the four colonies and there was a shift in behavioural states from times of no tourism to times when people were present. As expected, seal behaviour at the control site was modified when people were present where the seals were exhibiting more active behaviours. This was not the same for the two higher trafficked locations. Seals here exhibited more resting behaviour. Lastly, there were no observable changes in seal behaviour to tourism. The type of tourism had a significant effect on the behavioural state of the seals, with higher levels of activity observed when people were walking in the colonies. All four locations had differing degrees of behavioural shifts of the seals and this was likely the result of differences in the levels of human disturbance between sites. Since each colony

varied in the type of tourism experienced, it is possible that both the level, as well as type of tourism, has a significant role in eliciting short-term behavioural shifts. More specifically, habituation may have been observed at the higher trafficked site, where as desensitisation may be occurring at the lower level tourism location (Damons Bay). For this reason, measures should be taken at all seal colonies used in tourism ventures to mitigate any negative long-term effects on the fur seal populations.

Introduction

How animals respond to disturbances can vary amongst populations (Gunvalson 2011). Allen et al. (1984) documented a 100% occurrence of harbor seals (*Phoca vitulina*) flushing, fleeing from the shore into the ocean, when a disruptive stimulus was within 100 m of the haul-out site; while only 50% of harbor seals on the San Juan Islands fled at a distance of 100-200 m (Suryan & Harvey 1999). Flushing, or fleeing a colony by entering the sea due to an anthropogenic disturbance is a common response amongst cows and younger seals (Barton et al. 1998) and could lead to changes in foraging patterns (Boren 2001), resulting in less time on land and potentially the abandonment of pups. Site abandonment is another concern of increased disturbance as animals tend to leave locations permanently if they are subject to great stress (Jefferson et al. 2008, Bejder et al. 2009). Imperial cormorants (*Phalacrocorax atriceps)* abandoned nests when people were less than 8 m away, resulting in egg predation by kelp gulls (*Larus dominicanus*) (Yorio & Quintana 1996). This is less likely for fur seals because they are central place foragers, who forage preferably using continental shelves and their edges (Boren 2001), but could occur if the pressures are great enough.

Habituation can also occur in colonies with high levels of human presence. This is caused by increased or repeated exposure to a stimulus where the animal becomes accustomed to it, resulting in decreased responses (Boren 2001, Bejder et al. 2009). Habituation can be viewed as a positive behavioural response to the tourism industry, as it potentially makes tour encounters more successful or intimate (Young 1998). Nevertheless, habituation is still a behavioural modification brought on by repeated anthropogenic disturbance and can sometimes have serious consequences (Bejder et al. 2009). For example, increased habituation to humans can decrease resting behaviours (Barton et al. 1998), maternal investment (Mann & Kemps 2003), and cause a breakdown of territorial behaviour (Harris 1973). As seals are wild animals, changes caused by habituation can alter their innate behaviours critical for survival and reproduction (Edington & Edington 1986). For any species subjected to tourism (e.g., New Zealand fur seal, *Arctocephalus forsteri*), one of the main attractions is to observe them in their natural environment and behaving in a normal way. Ideally, this should not include their habituation to humans (Boren 2001).

In many species, anthropogenic stress can be monitored over the short-term by watching for behavioural shifts or changes in reactions. For example, nocturnal whitetip reef sharks (*Triaenodon obesus*) were found to reduce the duration of daytime resting when boats were present (Fitzpatrick et al. 2011). Similarly, sea otters (*Enhydra lutris*) in close proximity to fishing boats on Cannery Row traveled more than those utilizing areas without heavy boat traffic (Gunvalson 2011). In a number of marine mammal species, tourism may force a modification in their behaviour (Barton et al. 1998, Lusseau 2008). In the New Zealand fur seal, such changes in behaviour due to an outside disturbance may cause shifts in the activity budget for an individual seal or even the colony (Boren 2001). A disturbance that significantly raises activity levels could result in a decrease in energy reserves, leading to a decrease in fitness for the individual or the colony (Ward & Beanland 1996, Barton et al. 1998).

Objectives

The objective of this study was to determine how disturbance by tourism is affecting the behaviour of New Zealand fur seals on a broad geographic scale. Most behavioural studies of fur seals tend to focus on one area or colony, and then extrapolate the results to other sites. As seals have only recently begun to re-colonise large areas of the main islands of New Zealand, it is not known how different populations are being affected by the current levels, and potential future growth, of tourism. I used a comparison between four fur seal colonies around the South Island, three colonies with tourism and one without, to determine how seals react to disturbance by the tourism industry and how this differs by type of interaction and location.

Methods

Study sites

This study was carried out between November 2009 and January 2012 at four seal breeding colonies around the South Island of New Zealand with differing types and intensities of tourism exposure. The four colonies monitored were situated in Damons Bay, Ohau Point, Tonga Island, and Cape Foulwind (Figure 2.1). Except during extreme weather, data were collected daily between 08:30 and 18:30 over the duration of each Austral summer and spring. Three colonies were monitored over two summers and one was monitored over three years. Seals are known to have bred in all sites for at least the past ten years (Barton et al. 1998, Boren 2001, Cate 2011, Meynier 2012). All land-based observations at Damons Bay were stopped after March 2011 due to unstable terrain due to the February 2011 earthquake. No observations were conducted at Cape Foulwind in season two or at Ohau Point after May 2011 due to field research in additional locations. Colonies were easily accessible by foot making long-term daily observations practical.

Cape Foulwind (41°45’0” S, 171°28’1” E) is located on the west coast of the South Island. Seals breed on the boulder-laden sections of the coast adjacent to steep cliffs. A high number of people visit this location, including tour buses, on a daily basis. There is a path on the top of the hill running parallel to the coast line which keeps people out of the colony. Along this path are viewing areas roughly 50 m above the seals. Cape Foulwind seals are off limits to the general public; therefore any persons in this colony were in non-compliance of the regulations unless issued with a permit. Seals typically do not appear to notice tourists on viewing areas unless they were unusually loud, or climbed over the fence into the colony. There was a large area for seals to utilize even at high tide; however large waves were observed crashing on the shore for a majority of the observation periods. Due to the low frequency of people disturbing seals, this site was considered the least impacted by people, and therefore acted as a “control” to compare with other colonies which experienced higher levels of disturbance from tourism. Observations here were conducted from the top of the hillside, outside of the tourist barrier, roughly 50 m from the viewing platform. This allowed the observer to remain hidden from view of both seals and tourists yet still see the section of the colony visible to tourists on the platform.

Tonga Island (40°52'60" S, 173°4'1" E), located northwest of Nelson, is one of the five largest islands in Abel Tasman National Park and is a popular site for viewing seals by kayaks, sail boats and motor boat. New Zealand fur seals have been breeding on Tonga Island since approximately 1988 (Taylor et al. 1995). It is roughly in the center of the park and 1.5 km from the nearest camping beach, and access is by boat only. In the park, there are four water taxis, one ferry, one charter boat, and eight kayak companies which offer both guided and independent rentals to the island. One company also provides the opportunity to swim with seals. All of these tour ventures regularly view and interact with the seals at Tonga Island. This island is protected by the Department of Conservation, therefore no persons are allowed on the island itself without special permits, and vessels are not meant to approach within 20 m of the closest boulders; thus, disturbances by tourists are largely limited to areas beyond this perimeter. Any tour vessels viewing within the 20 m distance were also in non-compliance of their permits. The amount of usable area for the seals for haul-outs on the island was small (approximately 1.5 km in circumference with less than 5m at high tide from shore to tree line), especially at high tide. The island is basically a large mound with boulders along the first 10 m of the low tide zone and thick bush from 10 m to the top. Seals were seen in the bush close to the boulder beach, especially on warm days and high tide. Observations were carried out from a kayak situated between 50 and 100 m from shore. Tonga Island is triangular in shape, so all observations were carried out randomly on one of two sides per observation period. In times of rougher weather (i.e. increased wind conditions and higher swells, observations were only made on the lee side of the island.

Ohau Point (42°14’51” S, 173°49’49.5” E) is the largest fur seal breeding colony in the region (Boren 2008) and of this study (more than 4000 seals). It is located approximately 25 km north of Kaikoura on the east coast of the South Island adjacent to State Highway 1. The Ohau Point colony starts from Half Moon Bay and continues north past the lookout point to a rest stop across from the Ohau Stream walk, a total distance of approximately 500 m. People are not allowed in this colony without permits from the Department of Conservation. However due to its easy access, tourism impacts mainly involve people walking into the colony from a car park on the northern periphery of the colony. Along with people in the colony, other disturbances come from people walking above the colony on the highway, cars, and trains. The Department of Conservation has raised concerns regarding the potential for increased human-influenced seal mortality due to the expanding tourism, the close proximity of the colony to the highway, and the fur seal's re-colonization in this area (Boren 2008). Observations were conducted on the northern section of the colony, approximately 150 m from the car park, where people were most likely to enter the colony. Observers were situated on the top of the hillside next to the highway and out of view of both people and seals.

The fourth site, Damons Bay (43°52'60" S 172°58'59" E), is located on the south eastern edge of Banks Peninsula. Damons Bay was only accessible to tourists by boat, and the most commonly seen vessels were commercial nature cruises and recreational fishing boats from Akaroa Harbour. The seal colony lies alongside a 50 m cliff. This seal colony is one of 6 locations used for fur seal tourism that are close to the village of Akaroa. Observations were conducted from the top of the cliffs above the seal colony. This area was selected for observations so as to remain unseen by the seals and by visitors travelling with the tour companies.

Data collection

Data were collected in one of two ways depending on the location of the seal colony. The first method was used at Tonga Island because the seal colony is only accessible by boat. When the weather permitted, the side where observations were conducted was determined by flipping a coin. Here, behavioural observations were conducted using two observers in two different kayaks each using 8x50 Olympus binoculars to aid in visual confirmation of seal behaviour. The first observer paddled the length of the chosen side of Tonga Island and recorded data using a 10-minute scan sampling protocol based on Altman (1974) and Boren (2001). During each scan this recorder would note time, number of seals, behavioural state of each visible seal, number/type of vessel, approximate vessel distances (using an estimation of the approximate length of the observer's kayak and calculating how many kayaks would fit in the space between the tourist vessel and the coast line), and environmental conditions. It took the observer ten minutes to assess the largest scan area and therefore was determined to be the minimal length of time needed between each scan period for all colonies to maintain similarity in the data. Additional data were recorded on an all occurrences basis by the second observer. This person situated their kayak at least 50 m away from the island and would monitor the seal's reactions towards the tourist vessels within 50 m of the colony. This distance was chosen based on Boren et al. (2002) where seals approached at 50 m exhibited minimal responses to kayaks or motor boats. Therefore, viewing from a distance greater than 50 m was thought to limit observer interference with tour boat activity and not induce reactions in the seals by observer presence. If the observer boat did cause a reaction or came within 50 m of the shore, then it was noted as a single kayak group. Due to the high frequency of tourist vessels not every tourist-seal interaction could have been monitored. Therefore the observer would follow a tour group through their session and note the initial reactions of the seals to the approaching vessel, as well as approximate vessel distance to the coast line, and any additional factors that might cause a seal reaction (e.g. loud talking from the boat, banging on the side of the boat, etc.). All of the data were later pooled for final analysis because there were no significant differences between behavioural reactions between the two sides of the island.

The second method of data collection was carried from an elevated platform above the seal colony to maintain a non-invasive approach. Behavioural data was collected in a similar method as at Tonga Island, using a 10-minute scan sampling protocol and focal follows of seals when tourists were within 50 m of a seal or the coastline. Visual confirmation was made using 8x50 Olympus binoculars. Each observation post was within 200 m of the most distant visible seal. Observation periods coincided with the seal mating/breeding season and the height of tourism. A land-based study was ideal in assessing the responses of fur seals to tourist traffic primarily because during the breeding season, New Zealand fur seals spend most of their time on land and this type of platform was a zero-disturbance method (i.e., little or no disturbance to the animals by observers) and has been successfully used for similar research on New Zealand fur seals in the past (Boren 2001; Boren et al. 2002).

All scans were carried out for a minimum of 2 hour periods (totaling 12 scan samples) and the longest scan duration was 8 hours in one day. For each scan, whether instantaneous or focal, seal behaviour was classified as being in one of 4 behavioural states (see Table 2.1). These states were chosen based on the biological importance to the seal, and as categories in which seals were likely to spend a reasonable amount of time (Altman 1974, Boren 2001, 2005). They are also relatively simple behaviours which were easy to define and observe from a distance using binoculars. Flushing events, when seals ran into the water to get away from a disturbance, were recorded as “running” when observed the first time, and then as “thermoregulation” if the seal remained in the water for the following scans. All visible animals were monitored and recorded. Tourist-seal interactions were considered to have occurred when tourists were within 50 m or of the shore line (if via boat) or to the closest seal (if by foot). Seal reactions and tourist activities were therefore monitored once they approached within 50 m of the seals. Control samples were collected at colonies on days without tour visitations, and at colonies without tourism. The total number of visible seals was recorded. Lastly, to determine if behavioural responses of seals were influenced by environmental conditions, meteorological events (temperature, cloud cover, wind direction, and speed) and sea conditions (tide, swell direction and height) were recorded during each 10-minute scan.

Research effort

Observations were conducted at four study sites, over 84 days between November 2009 and March 2011, totalling 1785 observation bouts (one observation bout is one 10-minute scan) (Table 2.1).

Data analysis

Data were entered and queried in Microsoft Excel 2003. All descriptive statistics, calculations, figures and tables were also produced using Excel. Statistical test were conducted using SPSS v. 20. All of the behaviours were placed into one of the behavioural states (Table 2.2). Since one behavioural response represented one seal, these were changed into percentages of behaviour. Data were tested for normality and an arcsine transformation was used to normalize proportional data. Due to multiple variables having the potential to affect seal responses towards tourist, a MANOVA, with a Tukey post-hoc test, was used to analyse the data. Seal behavioural were compared to tourism levels, type of tourism, year, time of day, location, timing relative to tourist approach, and the number of vessels present to test for significant differences in behavioural change.

Results

Tourism levels

Tourism type and level of visitation varied between the four sites (Table 2.3). Vessels were observed within 50 m of the seal colony on Tonga Island 73% of the time, totalling 169 encounters with multiple boats. This was the site with the greatest amount of visitation by tourists. The Ohau Point colony received a medium level of disturbance with people in the colony 24% of the time. Damons Bay was visited by motor boats 84 times over the study period, totalling 11%. Cape Foulwind had the lowest level of tourism coming within 50 m of a seal (10%).

Diurnal patterns of tourism

Tourism levels varied significantly over the course of a day (MANOVA; $F_{421} = 3.3$, $p < 0.001$, df = 4), although the number of people in a particular encounter did not vary significantly with time of day (MANOVA; $F_{421} = 1.1$, $p > .05$, df = 16). Damons Bay was the only seal colony where most of the tourism was by commercial tourist cruises. Cape Foulwind had only a few records of people in the colony, and all of these were due to researchers collecting samples (i.e., no tourist). The remaining two seal colonies however, were not subject to any organised tourism and tourists were allowed to come and go throughout the day. Out of a total of 1785 observations, there were 421 (24%) with persons or vessels within 50 m of the observation area. Most of the tourism-seal interactions included one vessel or person within the 50 m the colony (91%). The highest observed number of people at one time was 20 tourists at the Ohau Point colony.

Effect of different types of tourism on seal behaviour

The frequency of each category of seal behaviour was significantly different between the four colonies (MANOVA; $F_{1785} = 9.9$, $p < 0.001$, df = 3, Tukey: $p < 0.001$). At all colonies, seals were observed at rest more than half of the time (50 % - 77%: Figure 2.2). There was a measurable shift in behavioural states from times when there was no tourism to times when people were present (MANOVA; $F_{1785} = 7.1$, $p < 0.001$). Tonga Island seals exhibited a decrease in all behaviours in the presence of tourism except resting, which increased (6%). Those at Ohau Point increased their resting, and active behaviours, while decreasing the amount of social actions and time spent in the water when people were within the colony. At Damons Bay, seals did not modify their behavioural bouts between times with and without tourism. The Cape Foulwind colony had the greatest percentage of behavioural change when people were within 50 m. They exhibited a decrease in resting (22%) and social (4%), while increasing their active (5%) and thermoregulation (21%) behaviours.

The type of tourism had a significant effect on the behavioural state of the seals (Figures 2.3 and 2.4). Here, colonies with similar types of tourism were compared together. There was no significant difference in seal reactions at Tonga Island to either kayaks or motorboats (Figure 2.3). There were, however, significant differences in seal reactions between Damons Bay and Tonga Island (MANOVA; $F_{985}= 8.0$, $p < 0.001$, df = 3) where seals rested more (77%) when motor boats were present than those at Tonga Island (62%). There was also an increase in the percentage of social behaviour in the presence of motor boats at Tonga Island (23%) than Damons Bay (10%). Seals were less active at Cape Foulwind than Ohau Point, when people were present (MANOVA; $F_{800}= 7.1$, $p < 0.001$, df = 3), which coincided with a decrease in resting behaviours (Figure 2.4). When people were present, 23% more seals thermoregulated (MANOVA; $F_{1785} = 14.6$, $p < 0.001$) at Cape Foulwind. Social interactions decreased slightly when people were walking into the colony at either Cape Foulwind or Ohau Point**.**

Discussion

Observations on the behaviour of seals at breeding colonies on New Zealand’s South Island showed that behavioural changes of fur seals in response to human visits between the four sites were markedly different. Each location was subject to a different type and level of human-seal interactions. My research found that the type of interaction and the specific local of each interaction were important factors how the seals reacted. Unexpectedly, desensitisation in fur seals was probable in the colony with the lower level of tourism (Damons Bay).

Tourism levels

The types and level of tourism varied between the four study sites. Tonga Island, which can only be accessed via boat, had the highest level of tourism. It is located along a heavily trafficked kayak and sea shuttle route and is in a very accessible location in which people can arrive by motor boat within a few minutes. Additionally, the closest beach to the island is part of the Abel Tasman trail where a large number of hikers and campers either arrive or depart the park via boat. Tourism is at its highest between November and March which overlaps with the breeding/mating season, when the seals are likely to be most susceptible to human disturbances.

Ohau Point is considered a colony with a medium level of visitation. This location is popular year round with the adjacent Ohau Point waterfall being a new attraction (see chapter 5). The Ohau Point colony was the most easily accessible in this study, being just meters off the highway. In contrast, Damons Bay received a lower rate of boat visitation, which is a result of the bay's location on Banks Peninsula. The surrounding cliff tops are privately owned, and not open to the public. Additionally, visitation is limited by the number of permit holders, as well as, conditions that specify the number of visits per day, and can only use this bay to view seals when the weather is suitable.

Lastly, Cape Foulwind had the least amount of tourism directly in the colony. This site was heavily visited by people wanting to visit seals; however a walkway and viewing platform were created atop the hill, which helps keep tourists out of the colony.

Differences in seal behaviour during times with and without tourism

It is known from past research that pinniped behaviour varies between locations and species (Wright 1998, van Polanen Petel 2005, Lusseau 2008). This variation may be analogous to accents of people in different geographic locations, orcas (*Orcinus orca*) using diverse feeding techniques and vocalizations when hunting (Weib et al. 2007), or variations in songs of both the humpback whale (*Megaptera novaeangliae)* and fin whale (*Balaenoptera physalus*) in differing geographic locations (Delarue et al. 2009). All of the four study locations had varying levels of human visitation, which as the results showed, elicited different seal behavioural responses. On the whole, seals were utilizing the land for resting, nursing, raising their pups, and mating; however, there were differences between the colonies in the mean percentage of animals resting, especially when tourist were present. For instance, Cape Foulwind seals rested the most, were less active, and thermoregulated the least when there was no other influence (such as people). When comparing all four sites when no tourism was present, there were differences in behaviour suggesting there are underlying differences between seal colonies, which could be attributed to geography, available land space, or other environmental factors. The varying levels and exposure to human disturbance between the four study sites appear to be the most likely factor in the observed behavioural variations.

Taylor et al. (1995) observed that seals rest on land between 70-75% of the time. This suggests that increases in activity levels can be indicative of disturbance and a decrease in activity is evidence of habituation or desensitisation (Barton et al. 1998, Boren 2001). There were shifts in behaviours when tourism was present to times when it was absent. These shifts were not identical between each colony. For example, Cape Foulwind seals exhibited the most behavioural shifts when people were present than at the other locations. Here, seals decreased resting and social behaviours, while increasing active and thermoregulation ones. This expected given that most previous studies of tourism impacts on marine mammals have shown the focal groups to increase activity rather than decrease it (Constantine 1999, Boren 2001, Bauszus & Tandy 2002, Constantine et al. 2004, Markowitz et al. 2009). Cape Foulwind colony experienced the least disturbance by visitors on a daily basis among the four sites; however, the tourist tract is directly above the seal colony, though it is presumably not visible to the seals.

Human activity is not a novelty for fur seals at Ohau Point, but Barton et al. (1998) suggested habituation was not present among the seals in this area in the late 90’s. Human activity observed on the periphery of the colony at Ohau Point caused behavioural changes similar to those observed previously by Boren (2001). In both cases, seals exhibited increase resting, decrease time in the water, and decreased social behaviours. Given the similar behavioural changes in the exact same area between the two studies, seals appeared to react to people in a similar way despite the two studies spanning 10 years. Thus, my study supports the findings of Boren (2001) that seals at Ohau Point, at least near the car park, are modifying their behavioural when people were present. Given the behavioural shifts were minimal, as compared to Boren (2001) it is believed this colony is exhibiting some degree of habituation towards people, most likely with seals on the far periphery near the car park.

Similar to Ohau Point, Tonga Island seals exhibited a measurable increase in resting when tourists were present. Boren (2002) suggested this colony exhibited signs of habituation towards approaches. My results did support this interpretation due to the behavioural shifts only occurring in a small percentage of the study group. Frequent repeated exposure to a stimulus may result in an animal becoming habituated to the stimulus (Barton et al 1998, Boren 2001, Boren 2005, Bejder 2009). Barton et al. (1998) suggest that areas exposed to seal-human interactions most days throughout the year are more susceptible to habituation (such as Ohau Point). This was observed by increased tolerance levels of Hooker's sea lions (*Phocarctos hookeri)* in areas with frequent visitations of humans (Wright 1998).

In comparison of all study sites relative to the presence or absence of tourism, there were clear behavioural shifts among the seals, except at Damons Bay. Damons Bay was unique in that the seals showed no significant changes in behaviour. This could be due to either the lower level of tourism, as compared to the other two tourist sites, or the desensitization of the colony to the daily and yearly routine of the tour boats. If this is desensitization, seals appear to be unresponsive to the presence of vessels. The two tour companies run 3-4 tours a day in the summer months, which leave on schedule between 10:15 to 15:40 each day However, as tourism here is lower than other places (more similar to the control colony), it seems more likely the seals react less due to the very predictable nature of the tour vessel visits and are more likely becoming desensitized to their routine.

Effect of type of tourism on seal reactions

Since each colony varied in the type of tourism it experienced, it is possible that it is not only the level of tourism that is important but also the type of tourism that has a significant role in eliciting short-term behavioural changes. Based on resting, active, and thermoregulatory behaviours, the presence of people in the colony (on foot) was the most disturbing form of tourism to the seals. This was especially the case for Cape Foulwind, though Ohau Point was the most likely location for people to approach close to the resting seals because it was easily accessible and there was no enforcement to keep people away. Active and thermoregulation events were the highest when people were in the colony a result of the seals flushing into the ocean due to the disturbance, and staying in the water for a prolonged period of time (typically until the disturbance was over). Upon comparison of Ohau Point and Cape Foulwind, there appears to be a measurable amount of animals not reacting towards approaching people at Ohau Point. Habituation towards tourism is highly likely here, given the easily accessed nature of this rookery (Boren 2001). It is likely this is localized to those seals hauled out within visual range of the car park. Boren (2001) measured variable reactions of fur seals within Ohau Point where those animals on the periphery of the colony were exhibiting fewer reactions towards approaching people than seals in the central section. This was the original basis of Boren (2001) suggesting the presence of habituation here, and given the recent comparison of this location to the control, it is highly likely habituation has occurred at Ohau Point, but is limited to the periphery edge of the rookery which is closest to the access point for people.

Breeding animals are especially sensitive to human disturbance (Trulio 2005). Most of the data in this study were collected on females and pups at breeding colonies and it has been shown in other animals that reproductive success may be adversely affected by disturbance. For instance, oystercatchers (*Haematopus ostralegus*) reduce incubation time and the amount food delivered to chicks when disturbed (Verhulst et al. 2001). In several studies, and despite the lower noise output, kayaks and canoes caused more disturbance than motor boats as they may have a predator-like appearance to seals (Allen et al. 1984, Henry & Hammill 2001, Fox 2008, Lusseau 2008). This study observed an increase in resting when a kayak was within 50 m of the shoreline. On its own, kayaks are quiet, but they typically travel in groups and are able to get closer to the shoreline than motor being able to approach closer to the animal before they are noticed. They also can stay at a colony for a longer duration because they are not on a timeline that the boat tour is on. The level of inexperience of the kayaker may also play a role in increased responses of seals to kayaks.

The use of motor boats had an effect on seal behaviour as they operate at faster speeds and produce louder sounds than kayaks. Tour vessels typically output ~140 dB re 1μPa at 1 m (Lusseau 2008) of noise when in motion. Marine mammals, specifically cetaceans, are sensitive to this range due to their social nature and foraging strategies (Lusseau 2008). Past studies have shown cetaceans feed and rest less when in close proximity to motor boats (Markowitz et al. 2009, Markowitz et al. 2011). Pinnipeds are also susceptible to engine noise as it can disturb resting and social activities while on land (Barton et al. 1998), and my observations confirm a similar effect on New Zealand fur seals. As fur seal's time on land is primarily spent in one resting state or another, continual disruption of rest can lead to increase energy spent, increased stress (Dawkins 1980, Maier et al. 1994), and a decrease in animal health (Maier et al. 1994). In the long-term, this could lead to malnutrition (Lusseau et al. 2009), decreased ability to thermoregulate, and increased time foraging (Dawkins 1980, Lusseau et al. 2009)

Future consideration

The number of tourist visits within a day and over the seasons could have a direct link to the level of habituation of the fur seals. Boren (2001) noted that the current level of tourism at both Tonga Island and Ohau Point should be regulated so there can be times when humans are not around and thus the seals have an opportunity to recover. If this has been addressed by the tour operators in the Abel Tasman National Park, it has not appeared to make any noticeable difference in seal behaviour as private vessels were still common amongst the tour groups, and they did not appear to be regulated or monitored. Future research suggestions would be to interview tour operators in the Abel Tasman National Park to find out what has changed over the years including guideline, number of operators, number of trips to the seal colony, duration, etc.

The frequency of seal-human interactions is also a confounding factor in measuring levels of habituation as noted by Boren (2001), van Polanen Petel (2005), and Lusseau (2008). Frequency of approach could not be controlled in this study due to the data being collected opportunistically whenever tourists visited a colony; however, it is an important subject that should be considered in future research of the effects of tourism. Short-term, rapid habituation, was noted in Weddell seals (*Leptonychotes weddellii*) in Antarctica (van Polanen Petel 2005) when the approach of a single person was occurring frequently and repeatedly over a 2 hour period. In this situation, habituation was not observed when the approaches were irregular and occurring over a longer time period. Further work is needed to determine whether habituation in fur seals also depends on the frequency and regularity of tourist visits as in Weddell seals.

Management options

Tourism focusing on marine mammals has both positive and negative elements. On the positive side, it has re-focused exploitation of marine mammals from an industry based on hunting for oil, food, and fur, to one where industry gains financially from the healthy, living animal. This increases the opportunities to educate people about the need to help protect and conserver their habitats. Tourism with marine mammals has also made some businesses realise the need to preserve and protect the marine environment, even if only for their own financial gain. On the negative side, the growth of marine mammal tourism puts added pressures on the focal animals' environment, feeding grounds, breeding grounds, and social structures (Boyd et al. 2010). Thus management of the tourism industry is the key to the future growth of both marine mammal populations and the businesses they support.

The first recommendation towards tourism management is to keep the tourism focus on the currently used colonies. Based on the data presented above, seals are already showing signs of being desensitised towards tourism pressures (Damons Bay). Interestingly, this was evident at the colony that had a low level of regular tourism. Rather than allowing pinniped tourism growth to new colonies to alleviate tourism pressures, and potentially modifying those seal's behaviour as with Damons Bay, it is more feasible to continue to allow the controlled tourism at the locations already being utilized. This will keep tourism pressures to a minimal, controlled area, where the seals have already modified their behaviour in a way that they are not exhibiting reactive behaviours. This also will allow for more seal habitat without tourism for future seal growth.

Another suggestion is to allow the wildlife to be accessible while protecting it (Lusseau 2008, Gunvalson 2011). An example of this strategy is employed at Cape Foulwind. Here, fences marked trails and boardwalks are used to redirect the public towards areas that are trafficable and away from the wild animals. They are also a visual reminder for people to stay out of the animal’s environment (Lusseau 2008). In comparison with another colony without a barrier, it is evident that this method is effective in limiting seal exposure to tourism. This method is only viable at other locations which would be trafficable by foot, like Ohau Point. Currently a lookout with fences has been erected on the south end of the colony, which allows people to view the seals from the roadside, but some form of barrier and educational sign also needs to be created to keep visitors from entering the north end of the colony (which is not visible from the south end). This was evident by the seals reactions towards people during this study.

The last option to consider is to limit tourism interactions to one designated site leaving the other haul-outs and breeding colonies free of human encounters (Lusseau 2008). This last option recognizes short-term behavioural impacts while taking into account short-term habituation (Lusseau 2008). A drawback to this option, specifically with Tonga Island, is that animals in a stressful environment are more prone to site abandonment (Bejder et al. 2009). However, given that New Zealand fur seals are central place foragers and prone to site fidelity; this is unlikely (Cawthorn et al. 1985).

Conclusion

Short-term behavioural shifts are immediate, and can lead to long-term changes which are more subtle and less observable in the short-term. Long-term changes can have serious effects and can lead to animal displacement, lower breeding success, or a decrease in fitness due to over exertion (Ward & Beanland 1996, Boren 2001, Bejder et al. 2006). Any one of these could reduce population size. By observing the daily behaviour of four seal breeding colonies on New Zealand's South Island, I found that seal behaviour varied depending on the colony, and that these differences appeared related to differences in tourism pressures between colonies. Each location was subject to varying levels of human-seal interactions and type of interaction. My results also confirmed that the type of interaction was more important to changes in seal behaviour, and was confirmed by comparing multiple seal colonies in differing geographical locations. It also suggests that continual low level pressures are more effective eliciting long term shifts in behaviour.

In general, animals displayed a decrease in response to anthropogenic stressors such as tourism, at Damons Bay Ohau Point and Tonga Island. By comparing the mean activity level of these colonies to periods with tourism, I provide some evidence that human disturbance has affected fur seals at all of these colonies to the point where they were not reacting towards people. This was unexpected at Damons Bay because the tourism regime is controlled by the tourism companies based on the number and time of each trip per day. The commonality between two of these locations was tourist were present on a nearly daily basis, throughout the year. This low-level continuous tourism in close proximity to the seals at Damons Bay is the most probable cause of the observed desensitization towards tourists. There are no previous data on seal behavior at Cape Foulwind or Damons Bay, however, an increase or change in tourism in the future could lead to changes in reactions and increased stress levels. Given this base-line data on seal behaviour, it is recommended that further studies be done over an extended period of time to document any changes in seal behaviour to the changing tourism industry.

Overall, my research confirms that disturbances caused by humans visiting fur seal colonies can lead to changes in the behavior of the animals. The question remains, however, is what can be done to ensure both animal health and population persistence while knowing the tourism industry will likely continue to encroach on these and other wild populations? The two locations classified as being high trafficked colonies, Tonga Island and Ohau Point, appear to be eliciting minimal behavioural shifts towards tourist, which was consistent with observations by Barton et al. (1998), Boren (2001) and Boren et al. (2002). Habituation or at a minimal, desensitization, is exhibited by minimal reactions towards a stimulus. Since this data confirms findings from 20 year previous, habituation is the most likely option. Keeping tourists away from the colony with trails and fences appears to be successful in minimizing disturbance and should be utilized more at places where access into the colony is easy, like Ohau Point. In contrast, seals at Tonga Island are heavily utilized by vessels. Additional consideration should be given towards not increasing tourism ventures to new seal colonies, and continue to utilize the current focal seal colonies. This will alleviate stress towards newly developed rookeries and allow for habitat that is untouched by tourism.

People are visiting these four colonies on a regular basis primarily for the purpose of viewing the fur seals. There is a great opportunity to protect and manage these locations in a way that allows for a positive and educational experience. This, in turn, will increase the positive image of the fur seals and help with the conservation campaign.

Figure 2.1. Study sites of four seal colonies on the South Island of New Zealand.

Table 2.1. Sighting by effort in each of the three study seasons.

	# Observations	# days	Season 1	Season 2	Season 3
Damons Bay	739	33	4 Nov 2009 – 8 Mar 2010	24 Nov 2010 - 7 Mar 2011	~
Ohau Point	435	25	6 Jan 2010 - 17 Feb 2010	28 Dec 2010 – 1 May 2011	~
Tonga Island	266	14	20 Jan 2010 - 27 Jan 2010	24 Feb 2011 – 28 Feb 2011	24 Jan 2012 – 26 Jan 2012
Cape Foulwind	345	12	24 Feb 2010 – 2 Mar 2010	~	6 Jan 2012 – 10 Jan 2012
Total	**1785**	**84**			

Table 2.2. Ethogram, describing fur seal behavioural states.

Behavioural state	Behaviour	Description of behaviour
Resting	Laying down	Seal in a supine position and exhibiting little movement. Typically they were asleep, but occasionally they were awake. All seals in a laying down posture were recorded as such because in some cases, the eyes were not visible and it was not known if these seals were actually asleep.
	Sitting	Thorax, neck and head elevated by extension of pectoral flippers without ambulatory movement.
	Grooming	Scratching of the body in any position. This was considered a calm behaviour.
Active	Walking	Seal actively moving from one place to another the colony at a slow pace.
	Running	Seal actively moving from one place to another in the colony at a fast pace. Also documented when seals were disturbed and ran into the water (e.g., flushing).
Social	Nursing	Pup actively receiving milk from mother's teat. This included movements prior to nuzzling the teat such as repositioning of animals to allow nursing or pups nudging mother for milk.
	Fighting	Aggressive engagement between two or more seals. Primarily seen during mating season between males and females or sub adults. Additional behaviours included in this were biting, lunges towards another seal, vocalizations associated with fighting. No pups were considered in this category.
	Playing	Two or more pups engaged in playful fighting, chasing, running, playing with an object, and biting. Generally seen amongst pups and sub adults and the rare female.
	Bark or call	A vocalization from a seal. These were not recorded if an animal was also fighting.
Thermoregulation	Swim in pool/ocean	Seal was seen in a pool or the ocean floating or moving under the surface. Commonly seen with fin(s) in the air above the waterline. This was common after a flushing event due to disturbance on the shore where seals would stay in the water until the disturbance subsided or left.

Table 2.3 Tourism levels observed within 50 m of each of the four study colonies.

	%Time tourists in colony	**Number of tourist – seal interactions**	**Type of tourism**	**Time of year for highest tourist numbers**	**Tourism level**
Damons Bay	11%	84	motor boat	December - February	low
Ohau Point	26%	110	people	Year round	medium
Tonga Island	73%	194	motor boat and kayak	November - February	high
Cape Foulwind *	10%	33	people**	Year round	low

* Cape Foulwind is the control for this project.

**The people were researchers working in a small section of the colony for two days

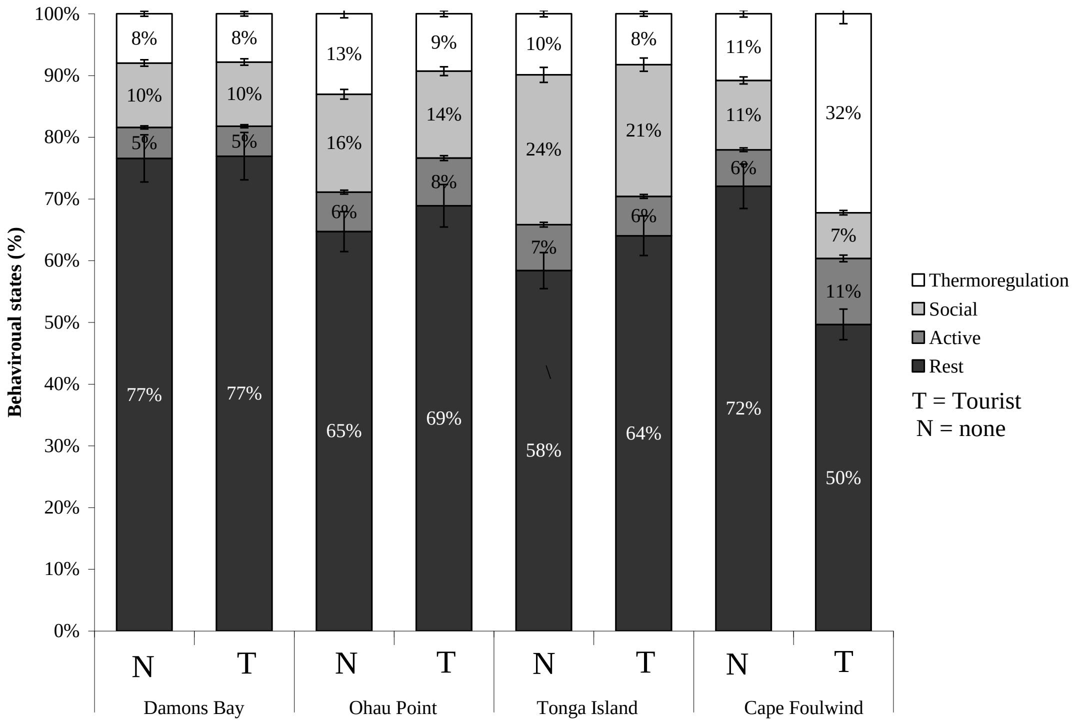

Figure 2.2. Mean behavioural states of seals at the four seal colonies compared during times with (T) and without (N) tourism. Data were taken from a total of 1785 observation bouts (se = 95% ci); Damons Bay (n = 739): low visitation, motor boat. Ohau Point (n = 435): high visitation, people. Tonga Island (n = 266): high visitation, motor boat and kayak. Cape Foulwind (n = 345): low visitation, no visitors except for a couple of instances with people.

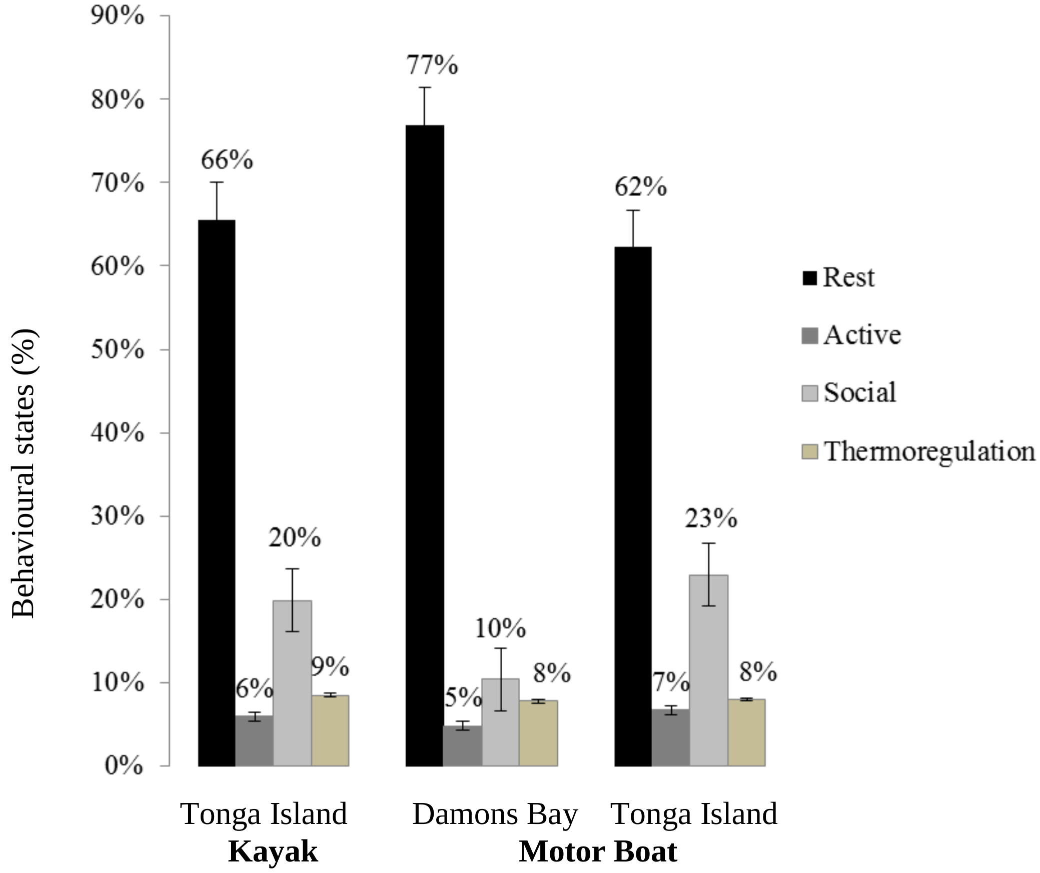

Figure 2.3. A comparison of fur seal beahvioural reactions towards vessel by type at Tonga Island and Damons Bay (se = 95% ci); Damons Bay (n = 739 Tonga Island (n = 266).

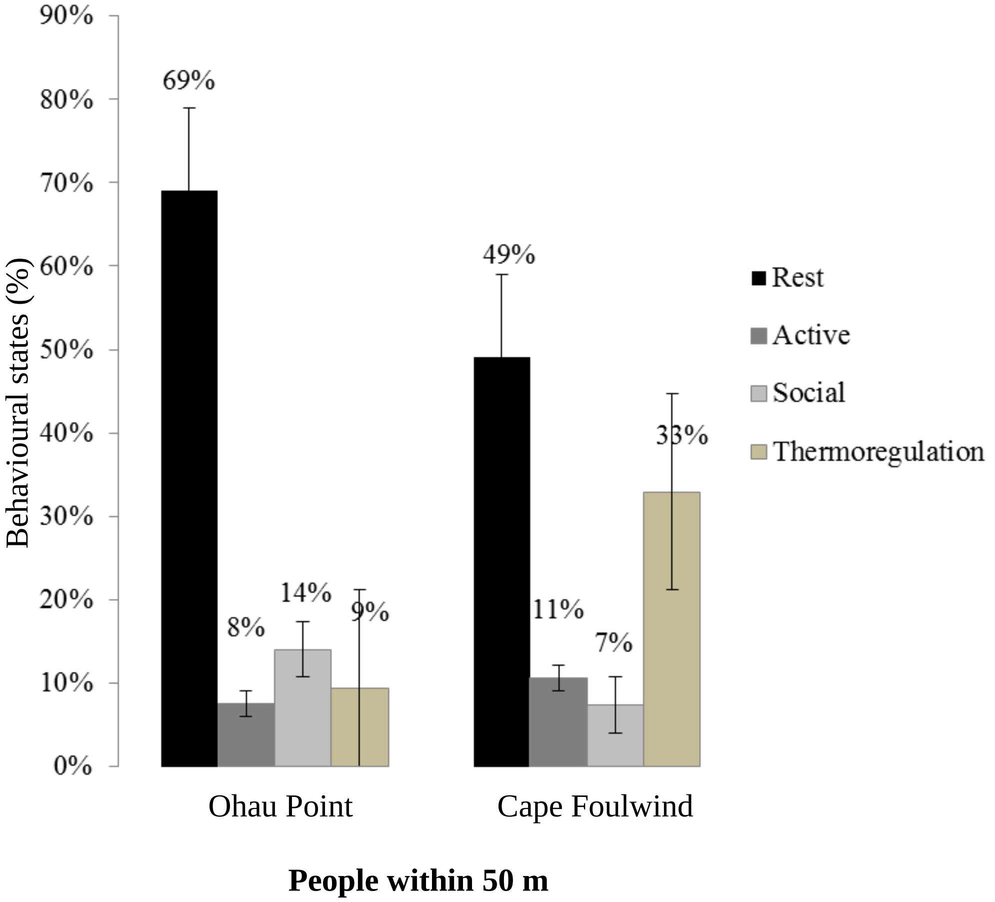

Figure 2.4. A comparison of fur seal beahvioural reactions towards people within 50 m of seals at Ohau Point and Cape Foulwind.Bay (se = 95% ci); Ohau Point (n = 435) Cape Foulwind (n = 345).

CHAPTER 3

The effect of tourist vessels on the behaviour of New Zealand fur seals at Banks Peninsula

Abstract

Marine mammal tourism is one of the main sources of income in Akaroa, New Zealand and seal viewing is a regular part of these tours. The objective of this chapter is to examine the effects of disturbance on New Zealand fur seal (*Arctocephalus forsteri*) behaviour as a result of visits to colonies by tourist cruises. Observations were conducted using an on board observer to collect data on seal reactions to boats in relation to vessel distance and tour duration. Tour vessels visited eight locations with seals spending an average of 6 -10 minutes of their tour viewing seals. Factors were examined in this analysis included tour company, year, month, distance, noise and the sex and age classes of seals. Seal reactions increased when vessels were closer to the shore. Seal behavioural reactions also increased when tours were conducting commentary over the loud speakers. When compared together the effect of tour commentary was significantly different than distance ($p < 0.001$) and sound overrode the effect of vessel distance. When functionality of site (breeding colony or haul-out) was compared to vessel approaches, seals at haul-outs were reacting to vessels significantly more ($p < 0.05$) than those at breeding colonies. Due to the overlapping of peak New Zealand tourism with that the fur seal breeding season, these animals are at their most vulnerable to disturbance when companies are in peak operation. The results presented in this chapter suggest such visits are not without consequences and that animals can be disturbed by commercial tourist visits. However, it should be possible for tours to continue to view seals in such a fashion that disturbance is minimised.

Introduction

In areas in which marine mammals have been protected from hunting and commercial harvesting, many small towns have switched towards marine mammal tourism as a means of obtaining income (Harwood 2010). In these areas, the wildlife is typically easily found, the animals are close enough to be viewed within a reasonable time interval, and there are people willing to pay for the service (Harwood 2010). For most marine wildlife, however, the only way to view them readily is with a boat, the most popular being motor boats, including those run by commercial operators. Such "eco-tourist" industries have well documented benefits including an increase in local income (Lindberg 1991, Boren 2001), greater community pride and better education of conservation efforts (Ryel & Grasse 1991), but what are the costs and do these come at the expense of the focal animals? To satisfy patron expectations, tour vessels typically seek the best viewing opportunities, which may be times when the animals are feeding, sleeping, nursing, or in some other potentially sensitive activity. The presence of vessels in close proximity to marine mammals has been shown to cause shifts in normal behavioural indicating stress, and agitation, or at least disruption (Barton et al. 1998, Boren 2001, Cassini 2001, Bauszus & Tandy 2002, Gunvalson 2011). Anthropogenic disturbance has been found to lead to decreased maternal investment (Boren 2005), decreases in resting (Constantine et al. 2004), cessation of foraging (Williams et al. 2002), and in some instances, abandonment of habitat (Bejder et al. 2009).

Disturbance by tourism can involve both distance effects, where animals alter their behavior as a result of closeness of approaches, as well as noise effects, where novel or extraneous noise can alter an animal's activity patterns (Yorio & Quintana 1996, van Polanen Petel 2005, Small et al. 2011, Streckenreuter et al.

2011). Extraneous noise has been found to impact marine mammals (Richardson et al. 1995), with loud anthropogenic noises potentially seriously injuring them. Lesser intensity sounds such as noises from boat engines have been shown to elicit behavioural responses in both pinnipeds and cetaceans (van Polanen Petel 2005, Markowitz et al. 2009, Tripovich et al. 2012). The New Zealand fur seals (*Arctocephalus forsteri*) spend a large portion of their time on land. Tour boats tend to visit fur seal rookeries and haul-outs as these are places where seals are easily visible. Engine noise may be audible to resting seals, including when the engines are in neutral during the viewing periods. Additional noise can also be created through commentary from tour boats and this could further contribute to short-term behavioural shifts of fur seals on shore.

Banks Peninsula, and its surrounding waters on the east coast of the South Island of New Zealand, is home to an assortment of marine life. As a result, the area attracts people from all over the world. The economic life of the region is dependent on the seasonal influx of visitors eager to see the wildlife attractions including the New Zealand fur seals. Akaroa is the largest town on Banks Peninsula. The population of the town increases in the summer periods due to an increase in tourism levels resulting in peak boat traffic. This is also the breeding/mating season for fur seals (Stirling 1970, Crowly and Wilson 1976).

Given the importance of the marine wildlife to the economic well-being of this region, it is critical the resources are managed properly and levels of disturbance are minimised to ensure wildlife populations do not decrease. The objective of this chapter is to examine the effects of disturbance on New Zealand fur seal behaviour as a result of visits to colonies by tourist cruises in Akaroa Harbour. Using the tour vessel platform, a detailed account of seal and boat interactions, including a “focal tour” examination of vessel movements, interactions with seals, and actual approach distances could be performed. As observations were conducted on board tour vessels, information regarding seal behaviour before or after encounter could not be determined; however, this approach has been used in several other studies with success (Dans et al. 2008, Markowitz et al. 2009, Markowitz et al. 2011). An advantage of this method is that it allowed complete sampling of details related to the “focal tour boat” operations and gave a closer vantage point to determine individual behaviour (Bejder & Samuels 2003, Wursig et al. 2007, Markowitz et al. 2009) of seals previously exposed towards tourism, Additionally, these focal tours are being conducted towards potential habituated seals and this data can be used in future studies examining tourism impacts and habituation.

Objectives

The objectives of this research were threefold. Firstly, I characterised the nature of vessel tours during their seal viewing sessions by documenting the locations, duration, and total number of trips at each colony or haul-out per day. Secondly, I monitored tour vessel activity during the tour in order to determine the closest and mean distances of vessel approaches. During these observations, I also monitored if commentary using external speakers (a potential source of noise stress) within 100 m of a seal colony was used. Finally, I assessed the effects of tour vessels on seal behaviour including any differences between haul-outs and breeding colonies. I also examined the effect of visit duration and timing of tour between the months and years.

Methods

Study sites

This study was conducted using tour operators based in the small town of Akaroa, New Zealand (43°48'25.11"S, 172°58'8.65"E). There are several tour operators in the area which conduct tours in and around Akaroa harbour. Most tour vessels are small, holding 20 or fewer patrons. The two largest companies have larger vessels which can take out the most patrons per day/year, and have a dedicated harbour tour that regularly include seals as part of the experience. The first tour company has 4 boats, with one 20 m catamaran with an elevated viewing deck, solely for nature cruises, while the other owns two boats, but generally operates only one per day (a 15 m catamaran with an elevated viewing deck). Between these two main tour companies, there is a potential effort of 537 trips per year per company. Fur seals are not the primary attraction, but they are part of each harbour tour. A variety of other ventures (including two sail boat cruises, fishing charters, and any number of private recreational vessels) have the potential to view seals during their trips. The potential effort of these other ventures is less than the harbour tours mainly because their primary focus is not on the wildlife. Harbour cruises departed from the village of Akaroa and travelled south (Figure 3.1) where they visited one of eight locations to view seals. Locations labeled A, B, and H, were breeding colonies and the remaining 5 locations were haul-outs.

Data were collected aboard the two major nature cruises departing Akaroa Harbour by two observers. Upon approaching within approximately 100 m from the shoreline where seals were present, one observer would scan the approaching coast line for seals. All data were recorded in the field using a voice recorder and transcribed at the end of each day so observers could keep their eyes on the seals.

Seal behavior and sex was verified by using Olympus 8x50 binoculars. All visible seal behaviours were monitored as the vessel approached. This was possible because there were typically less than 10 animals in one area that were monitored at one time. An all occurrences scan was initiated in the direction of the boat’s travel and the sex/age class of each seal, the initial behaviour and any behavioural changes that occurred were noted (Table 3.1). Initially all behaviours were recorded as seen in the field (e.g., lying down, sitting up, bark, fight, walk, etc.). Data were also recorded if seals exhibited no changes in behaviour. During the analysis, these behaviours were then placed into one of three categories based on if the seal exhibited no response towards the approaching vessel, if their changes in behavior was more of an alert response, or if it was a reaction towards the vessel that was more energetically expensive (e.g., fleeing or aggression). Other sources of noise, apart from the use of the motors while in a slow forward motion or neutral were also noted (e.g., talking over the intercom system or loud talking by passengers). Noise was recorded as having either occurred or not. As the vessel passed in parallel to the coastline, seals that were towards the aft of the vessel were not monitored.

The second observer was dedicated to determining distance of the vessel to the coast line, and noting environmental factors such as wind speed, swell height, and weather conditions. Additionally, time of arrival and departure of the boat at the colony/haul-out, tour location, and the distance of boat to shoreline were recorded for each trip. Distance was measured using a calibrated Bushnell Yardage Pro Sport 450 Rangefinder (accuracy +/- 1 m). The rangefinder was calibrated and tested for accuracy before each day of field use by placing poles at known 5 m increments and using the rangefinder to determine observer distance from each pole. Lastly, any additional vessels in the area were noted, as well as general boat operations.

Each location was defined as a haul-out or breeding colony. Breeding colonies were defined using the definition from the New Zealand Department of Conservation as a location with 10 or more pups over 3 successive years where offspring return each year to the same site. Haul-outs were locations that did not meet these criteria; primarily, lacking breeding females, pups, and not being used continually over successive year. Haul-outs typically had fewer seals, most of which were males and sub adults. Occasionally there would be a mother/pup pair at haul-out sites, especially after the pups were old enough to start swimming in the ocean.

Tour operators were restricted by the weather as to where they could visit and, in some instances, how close they could maneuver their boats to the seals. A Beaufort wind force scale (from 0 – 12) was estimated to categorize the sea state and visibility conditions, which also included wind speed. No tours were held in any conditions above a Beaufort 4. Air temperature was measured with a thermometer on the boat.

The two companies I monitored staggered their departure times primarily to accommodate dock space. Therefore out of 272 observed trips, only 10 involved encounters with another boat within 100 m of the seal colonies and the tour vessel. Of these ten, 5 were recreational boats fishing and 5 were another tour company. These data were not sufficient to compare behavioural reactions of seals when multiple vessels were present, although the low number of trips on which multiple vessels were present suggests that most tour vessel interactions with fur seal colonies and haul-outs in this area at present involve a single vessel at one time.

In addition to these observations, each tour company maintained a vessel log that included tour time, if they visited seals, where, and for how long their tour lasted. Most of the data logs included the trip number (time) if they visited seals, and where; however, some of the information was not always filled out. For instance, trip duration was missing in most accounts as was information for some of the locations visited. Therefore these data were only used to estimate monthly tour counts, especially when observers were not present. Data from these logs were from the periods between August – December 2008 and July 2010 – April 2011. The gap was due to daily logs being lost in the Christchurch earthquake, February 2011.

Seal Behaviour

Seal behaviour was recorded once the tour boat was within 100 m of the shore line. Seals in the ocean prior to the visit were noted, but their behaviour was not included in this portion of the study because their reactions to the vessel could not always be determined. Behavioural reactions due to the vessel's presence were noted as the boat first approached. If the boat lingered in one section of the colony then the initial behaviour and subsequent behavioural changes of the seals (i.e., their reactions to the vessel) were documented. They were then ignored until the vessel moved on. If multiple behaviours were exhibited by the same seal, only the most intense reaction was used during analysis, as not to re-count behaviours or animals and avoid pseudo-replication.

Behavioural reactions of seals were categorized into three categories, some of which were a grouping of multiple behaviours, as summarized in the Table 3.1. These categories are presented in order least energetically expensive to most. An individual's reactions or behavioural shifts were documented until it stopped moving as long as there was no pause in its movements, using only the most energetically expensive behavioural change as the seal's reaction. For instance, if a female was nursing her pup upon arrival then looked at the boat, sat up, and walked behind a rock, each of these were recorded in the order they happened. For the purpose of analysis, the behavioural shift would have been catalogued as a "direct response" due to her walking away from the vessel. Direct responses included a number of behaviours that, in concert, indicated the "fight or flight" responses of seals (Orsini 2004).

Data analysis

Data were entered and queried in Microsoft Excel 2003. All descriptive statistics, calculations, figures and tables were also produced using Excel. Statistical tests were conducted using SPSS v. 20. The behaviours categories (Table 3.1) were used for statistical analysis. Since one behavioural response represented one seal, these were changed into percentages of behaviour. All percentages were calculated from the entire number of seals seen on the trip, excluding those seals located in the ocean. Data were tested for normality and an arcsine transformation was used to normalise proportional data, which were then analysed using a MANOVA with a Tukey post-hoc. For this analysis, seal behaviour was analysed for statistical significance against all independent factors. As several interacting factors potentially contributed to variation in a seal's response (i.e., distance, location, sound and timing are not independent of each other), a MANOVA (SPSS) with a Tukey post-hoc was performed on the proportion of reactions and the frequency of seal responses to determine if there were interactions between distance, functionality of site (i.e., rookery or haul-out), and the presence of noise. Air temperature and the Beaufort wind force scale were analysed against type of behaviour using a MANOVA to determine if a seal's behavioural responses were also a function of the weather conditions. To assess if timing of the tour was a factor in seal responses to vessels, yearly and monthly means were analysed using general behaviour data which allowed a long-term comparison using all years of this study.

Behavioural data from 2010 through 2012 were categorised by seal sex and age class, and analysed as above using a MANOVA with a Tukey post-hoc test. Age and sex were not recorded in data prior to November 2010. Therefore, these earlier-collected data were omitted from any analysis related to sex or age. Males and subadults were combined because most subadults were males, although some individuals were hard to identify correctly as they were not mature enough to show physical sexual dimorphism. There were fewer males and subadults present in the colonies than females and pups.

Noise was defined as either having occurred or not (1/0) in respect to seal behavioral changes. Distance was pooled into 10 m increments (rounding up). For the purpose of analysis, and ease of comparison between chapters, distance is represented as the vessel being 10 m, 20 m, 30 m, 50 m and 100 m from the coast line. 40 m is not represented because there was not enough data at this distance to include this into analysis without skewing the results. The data suggest there were no significant differences in mean behavioural responses towards tour vessels at distances greater than 50 m, therefore, the 100 m distance was only used and represented in the overall comparison of behavioural responses to vessel distance with all extraneous factors (i.e., all data combined including silent, noisy sessions, and all locations).

Analysis of behavioural reaction to vessel distance were compared using mean percentage of no responses, alert, and direct responses to the respective distance of 10 m, 20 m, 30 m, 50 m, and 100 m to determine what behaviours were significantly different between the viewing distances. These trips were then separated into two categories: silent trips and trips with a running commentary during the tour. From here, the silent trip data were analysed to determine distance effect and compared to functionality of the site (breeding or haul out). Viewing sessions with a running commentary (noise) were analysed independently and responses were compared to vessel distance to determine if the noise effect overrides the effect of vessel distance.

Results

Vessel activity based on logbooks

Out of 967 logged tours by boat captains in both 2008 and 2010/11, there were a total of 676 recorded viewings of seals. There were a possible maximum of 4 trips per day for one tour company (TB 1) (2 in winter months and 4 in the busy summer months) and 3 for the second company (TB 2). Of this, the TB 1 harbour cruises recorded 315 trips in which seals were visited as part of the tour (93% of all tours) and TB 2 recorded 361 trips with seal visits (63% of all tours). The difference in rates of seal visits was partly due to TB 2’s having a more completed daily log, which encompassed tours from more months than the logs of TB 1. More tours occurred from October through February in both 2008 and 2010/11, coinciding with the height of tourist season. TB 1 tours doubled the frequency of their trips from winter to summer months, and TB 2 increased their tours by 3.5 times for the same period. From November through February (the months with the most trips), both companies recorded visiting seals, on average, 79% (SE +/- 17.9) of their tours.

Tour locations were variable, even on a daily basis. Seal Bay was visited the most frequently by TB 1 and Damons Bay had the highest visitation by TB 2. The maximum number of tours in a given day at the same colony was six, where both companies visited Damons Bay three times on 15 November 2008. Given optimal conditions each colony/haul-out had a 12.5% chance of being used by either company.

Vessel activity based on observational data

Observational data were collected between November 2009 and February 2012. The reactions of seals to visiting vessels were monitored from a total of 273 trips at 8 different locations. Mean duration for these visits was 7 minutes (SD +/- 0:04 minutes; Table 3.2) and the mean observed distance between the boat and the nearest seal was 25 m (SD +/- 9.9 m). From 2009 to 2011, mean viewing distance increased from 16 to 37 m, while the duration of visits increased by 2 to 3 minutes (Table 3.2).

Two companies exhibited some differences between their tours, specifically in the duration of their trips (Table 3.2). Tours from TB 1 were more likely to view seals for longer periods of time (> 10 minutes) at a greater distance; while the maximum time spent viewing seals in TB 2 tours was not more than 14 minutes. Both vessels spent between 5 – 10 minutes, on average, viewing seals. Since there were no significant differences in seal reactions between the two vessels (as seen in Table 3.3), these were treated as the same boat.

Seal reactions

Using a MANOVA there were significant differences in the behavioural reactions of seals in response to visits by tourist vessels (Table 3.3). These included significant differences in the number of alert responses between the locations.

Reactions to vessels with commentary were significantly different for both "no reactions" (MANOVA; F_{229}= 5.76, p = 0.003, df = 1) and "alert" responses (MANOVA; F_{229}= 6.86, p = 0.001, df = 1). The functionality of the location (i.e., breeding colony or haul-out) was significantly different for both "no reaction" (MANOVA; F_{273}= 2.86, p = 0.09, df = 7) and "alert" behaviours (MANOVA; F_{273}= 18.21, p < 0.001, df = 7). Additionally, seal reactions to vessels were significantly different when compared to distance (MANOVA; F_{273}= 1.88, p < 0.001, df = 47), month (MANOVA; F_{273}= 2.78, p = 0.01, df = 5), and year (MANOVA; F_{273}= 22.14, p < 0.001, df = 2). Tours were heavily weather dependent, therefore most of the weather data were similar (i.e., wind speed, temperature, etc.). When analyzed against seal behaviour the only environmental conditions where behaviours were significantly different was Beaufort wind scale (MANOVA; F_{273}= 2.49, p < 0.001, df = 3).

Overall, when a tour vessel was within 100 m of the coast line 50% of the seals exhibited no reaction towards the boat, 38% were alert, and 12% directly responded (Figure 3.2). When this was broken down into sex/age classes, females were less likely to directly respond (2%) than males (27%) or pups (8%) (Figure 3.3). However, females were seen exhibiting alert behaviours more than males and pups (10%, 2%, and 2% respectively).

Responses to tour boat approaches varied significantly between haul-outs and rookeries (MANOVA: F_{273}= 24.93, p = < 0.001, df =1), (Figure 3.4). When type of reaction was compared, alert was the most prominent behaviour and was significantly different. However, seals directly responding were seen more 2% more frequently amongst haul-outs than breeding colonies.

The mean behavioural responses of seals to tour vessels varied depending on the distance of the vessel distance to the viewing site (MANOVA $F_{273} = 1.88$, $p < 0.001$, df = 47) (see Table 3.3 and Figure 3.5). The percentage of no responses decreased steadily (60% at 30 m to 42% at 10 m) when vessels decreased their distance from 30 m to 10 m off the coastline during a tour. The decrease in the percentage of no responses from 30 m to 100 m was only 4%. The opposite was true for alert response, which increased steadily from 30 m (27%) to 10 m (45%). At 50 m there was no change in alert behaviours (27%) as compared to 30 m, though at 100 m the percentage of alert seals increased (42%). Direct responses were more stable (13% to 11%) during viewings at both 30 m and 10 m, decreasing when vessels were at 100 m (3%).

There was a significant difference in reactions when vessel distance was analyzed against tour location (MANOVA: $F_{273} = 1.13$, $p = 0.02$, df = 3). Seals at breeding colonies exhibited similar alert behaviours (44% at 10 m decreasing to 30% at 50 m) when compared to mean behavioural responses (Figure 3.6). Alert reactions of seals at haul-outs decreased from 47% at 10 m to 0% at 50 m. This followed the general trend that alert responses decreased as vessel distance increased. Direct responses at breeding colonies were more variable as vessel distance increased (16% at 10 m, 4 % at 20 m, 4% at 30 m, and 10% at 50 m). Seals at haul-outs increased the percentage of direct responses as vessel distance increased from 11% at 10 m to 50% at 50 m, which is greater than the mean responses observed.

Vessel approaches with commentary running were classified as noisy viewing sessions. These data were analysed independently of silent approaches and mean percentage of behavioural responses were obtained (Figure 3.7). In general, 47% of the observed seals did not react to vessels with running commentary. Of those that did exhibit behavioural changes, 42% were more alert to the approaching vessel, and 11% directly responded.

When comparing seal reactions during silent and noisy tour sessions by distance, there were significant differences in the two types of tours (Figure 3.8). Alert responses decreased with increasing distance during a silent tour. When compared to noisy tours, there were an increased percentage of alert reactions, regardless of distance. Additionally, alert responses were similar between 10 m (45%) and 30 m (46%), and decreased to 34% when vessels were 50 m from the shore line. Direct responses during silent trips increased with increasing distance (11% at 20 m to 20% at 50 m). However, when they are compared together, noise overrode the effect of distance, as seen in Figure 3.8 (MANOVA: F_{273}= 5.92, p = <.0.001, df = 1). For trips with commentary, direct responses were 11-12% at 10 m and 30 m, respectively; decreasing to 6% at 50 m. More than half the seals observed were reacting in some way to an approaching noisy vessel at each of the 10 m, 20 m, and 30 m distances.

Seal responses to tour vessels were significantly different between the years of the study (MANOVA: F_{273}= 22.14, p = <.0.001, df = 2). The mean percentages of “no reactions” to vessels increased from November to January (Figure 3.9), which also coincided with the breeding and tourist season. Also, a variety of reactions were significantly different between months (F_{273} =1.66, p = .01, df = 5). When analysed by age/sex classes, responses were significantly different ($p < 0.05$) for females and pups.

Discussion

My observations on the responses of New Zealand fur seals, that were already exposed to tourism, is derived from data collected from two tour companies that represent how seals were being utilized as part of the tour industry on Banks Peninsula. Together, these companies carried out most of the nature tours involving seals in the region. They both use the same locations and spent on average 6 -10 minutes of their tour watching seals. Their viewing location varied by day and sometimes by trip. Some locations were visited more than others (e.g., Seal Bay and Damons Bay) which were decisions made by the tour leader based on weather, timing, other animals in the area, and patrons.

Based on the information gathered, it was evident that tour boats were eliciting behavioural reactions from seals at both haul-outs and breeding colonies. When additional factors were examined, such as distance and noise on the reactions of seals, the data suggested that both have an effect on the reaction of seals. During a silent tour, distance of vessel is an important factor in understanding what elicits seal reactions. When compounded with noise, these reactions vary consistently between the distances, providing evidence that noise during a tour has a stronger impact on seal behaviour than distance alone.

Seal responses varied between sites. The data suggest how the area was utilized (breeding colony or haul-out), influenced the variation of responses of seals to tour vessels. Haul-outs were primarily utilized by males, sub adults, non-breeding females, and females resting between foraging trips (Boren 2005). Although haul-outs act as a rest-stop between feeding trips, seals were not necessarily bound to stay at one haul-out location and increased disturbance may lead to animals moving more frequently than they otherwise would. Haul-outs are likely to be important for the survival of fur seal populations as they are utilized by animals on foraging trips as a place to rest and recuperate. From this study it was evident that there were traditional haul-out locations as seals were present at these sites throughout the years. The five sites documented in this project were only a handful of the places inhabited by seals on Banks Peninsula, but these were the ones utilized by the tourism industry on an almost daily basis. Seals at haul-outs apparently have a greater option to leave in response to disturbance as they are not bound by mating/breeding processes as seals are at colonies; however, as they use haul-outs for resting from energetically expensive foraging trips, disturbance could still detrimentally affect their energy budgets (Meynier 2012). These haul-outs were concentrated on the section of Banks Peninsula that acts as a safe shelter from inclement weather. Being located on the most south facing section of Banks Peninsula, they were presumably also an easy access for seals to rest that were travelling along the eastern shore or foraging. This was seen by Meynier (2012) who documented a female seal travelling for 3 weeks in January from Kaikoura to the Otago Peninsula, spending a portion of her time resting on Banks Peninsula.

During the breeding season, males holding a territory, pups, and females with a pup were primarily recorded at known breeding colonies such as Damons Bay, Timu Timu, or Scenery Nook. Sighting these individuals at a haul-out was a rare occurrence. Breeding seals typically exhibit site fidelity and are central place foragers. Those at breeding colonies are more likely to remain given their time on land is typically to rest, breed, feed their young and mate (Cawthorn et al. 1985, Boren 2001). Therefore, any imposed stress could result in decreased resting (Barton et al. 1998, Boren 2001, Cassini 2001, Bauszus & Tandy 2002, Gunvalson

2011). This negative impact on the animal's health and rest is a concern because their time on land is allocated primarily to restore energy reserves and, for females with young, feed their dependent pup.

Seals at a haul-out, where the total number was typically less than 10 individuals, exhibited reactions that were significantly higher than at a breeding colony. One explanation for this pattern could be that the area of a haul-out was new or less familiar to an individual seal and that it was not accustomed to vessels being close and this elicited a higher flight reaction. Additionally, other animals might have been more prone to respond by following a fleeing individual. The influence of such vigilant individuals has been noted during land based behavioural studies (See Chapter 2). Also, individuals at haul-outs may flee more readily because they are not tied to the location by territorial needs (such as males holding territories at a breeding colony) or by the presence of young that cannot flee as readily (as with nursing mothers at a breeding colony). Another plausible, theory includes the idea of safety in numbers. Seals in larger colonies, typically those centrally located within a rookery, are less vigilant than those on the periphery, or in small colonies.

Tour vessels were allowed to approach a seal on the shore up to 20 m which was a rule not always adhered to. In the first study season, the mean distance of tour vessels was < 20 m to the shore line, although this distance increased to > 20 m in seasons 2 and 3. This was most likely due to the tour companies being more stringent with their viewing distances, but could have also been a result of the continual presence of an observer onboard. Each vessel's mean viewing distance fell within the permitted limit by the second study season.

According to my observations, distance was not necessarily the most important factor determining if a seal reacted to an approaching vessel or not. Having a running commentary on the boat (speaking through the boat speaker) elicited more seal reactions at greater distances. Most of the increased reactions were alert behaviours such as looking, head lifting, and sitting up, which meant the animal was not at rest conserving energy or their attention was being drawn away from other activities such as nursing. Whether such changes have any long-term impact is not clear, but even small changes in some behavior, such as disrupted rest, could be important in long lived species, where the long-term effects of reduced resting on the animal's fitness, reproductive success, and eventually, population size might not be evident for 20 -30 years (Constantine et al. 2004).

During a silent trip, vessels appeared to elicit fewer behavioural reactions (alert responses) beyond the 30 m distance. At distances 30 m or closer, if a seal changed its behaviour it was more likely to elicit an alert response. In this case, these seals were most likely less habituated to vessels. Less habituated individuals were more common at haul-out, as suggested by the data presented in Figures 3.4 and 3.6. When noise was factored with distance, higher levels of alert reactions were observed at each distance. Tour commentary typically began upon approach of the seals (~100 m) and usually was present during the duration of the session. Including a loud noise into a viewing session alerts the animal of the approaching vessel at a greater distance. However, data from the silent tours provided evidence that the least disruptive approach is without tour commentary.

There appears to be little variation between seal reactions when vessels were at a distance of 30 m or greater from the coastline, except at the 100 m distance, as seen in Figure 3.5. However, most of the data collected at 100 m included vessels using the loud speaker for commentary, which could have skewed the data. Using only data from silent trips, reactions to vessels were more frequent at 50 m than at 30 m, which is similar to findings by Boren (2002). As vessel distance decreased, percentage of reactions increased. One explanation for this could be that tour boats would either sit in a calm location in idle for an extended period of time viewing seals or drive along the length of the colony for the tour session, maintaining a constant distance from the shoreline. Therefore, there was the potential to record a higher percentage of seals exhibiting behavioural responses at one distance. Ideally, all data should have been collected as the boat approached the colony; however, because tour trips were very similar in where they approached the seals for viewing at each location, the data would have potentially shown the reactions of the same small group of seals (especially at a breeding colony) and would not have been inclusive of the entire colony. Vessels with commentary presumably alert seals of their presence when at greater distances; however, this may not be the only reason. Markowitz et al. (2009) describes dusky dolphins (*Lagenorhyncus obscurus*) altering behavioural stared from feeding to milling when vessels were at a distance greater than 50 m. Though fur seals were on land, the sight of the vessel could have a predator like appearance. One of the tour boats was painted black and white and might resemble the coloration of and orca (*Orcinus orca*), which would elicit greater reactions at further distances.

Duration of viewing session was not a significant factor in seal reactions. However, observations indicated seals typically responded to prolonged visits in one of two ways: either seals that had reacted to the vessel initially would become accustomed to the boat and resume their normal activity, or seals that did not react initially were more likely to leave the area the longer the boat was present. Since behaviour was only recorded once per animal, the effects of duration on behavioural changes could not be analyzed in this project, but should be considered in future research on this subject.

Time of year, with respect to the breeding and pupping season, was the primary cause of the differences in the reactions of males/sub adults, females, and pups to approaching vessels. Females and pups were more likely to respond to an approaching vessel overall. Males put a lot of effort into holding their territories and mating, they appeared to be more concerned with those duties and not the approaching vessel. Pups tended to mimic their mother's reactions, possibly because they were in an early stage of development or highly dependent on their mothers for reaction cues (Bjorklund and Gardiner 2011). Between January and February (the end of breeding season) direct responses increased from 7% – 20%, with a decrease in no responses and alert behaviours. A higher tendency to react towards a vessel occurred in March and April when males were less present and not territorial at breeding colonies. Additionally, this time period is when pups are becoming more mobile and potentially reacting more towards the tour boats.

Three of the eight study sites were breeding colonies. These rookeries tended to have seals with less reactive responses to approaching vessels. Animals utilizing breeding colonies were mostly males/females from November through December and female/pups from January through October (Crawley & Wilson 1976). Seals in breeding colonies were bound to their colonies for breeding (Bejder et al. 2009), and thus were energetically and historically invested to these areas. Once a female bears a pup, they will be more likely to tolerate external pressures because moving location can result in the loss of their young (Bejder et al. 2009). As found in previous studies of marine mammals (Constantine et al. 2003, Bejder et al. 2006, Bejder et al. 2009), females with young, which were a consistent focus of tour vessels, exhibited more tolerant behaviour towards approaching vessels. The tendency for females to flee less suggests they would be more likely to habituate desensitise to the presence of humans (Constantine et al. 2004, Bejder et al. 2009) in order to focus her energy on rearing her pup.

Conclusion

The opportunity to view seals in the wild is an important component of tours offered by the marine tourist industry at Banks Peninsula and should be conducted to minimize negative impacts on the seals. This is because fur seals are readily seen at all times of the year and were an alternative attraction when other wildlife was not in the area. However, due to the overlapping of peak New Zealand tourism with the fur seal breeding season, these animals are at their most vulnerable when companies are in peak operation. The results presented in this chapter suggest such visits are not without consequences and that animals can be disturbed by these visits. However, it should be possible for tours to continue to view seals in such a fashion that disturbance is minimized if some precautions are taken.

Approaches following the current minimum approach distance still caused some animals to modify their behaviour, similar to findings of Boren et al. (2002). The data suggest the distance where seals react towards vessels was greater than the currently permitted viewing distance of 20 m. The primary concern for the fur seals on Banks Peninsula is the shift in resting behaviours when tourist vessels were present. This added stressor to the population could lead to site abandonment or negative impacts on physical health (i.e., decreased body mass) (Boren 2001, Bejder et al. 2009) and maternal care (Gentry and Kooyman 1986, Boren 2001). For example, it has been suggested that Fjordland bottlenose dolphin (*Tursiops* *truncatus*) population declines are linked to the stress imposed by tourism (Currey et al. 2010). To decrease the anthropogenic pressure on these seals colonies, and thus presumably decrease stress levels, it is recommended, based on the data given to increase permitted viewing distance limit to 30 m, as was suggested by Boren (2002) for Tonga Island. There were significant changes in seal responses to vessels between 10 m and 30 m, but not between 30 m and 50 m. Therefore, the data suggest that extending the viewing distance to a minimum distance of 30 m will alleviate energetically expensive responses that were observed at closer viewing distances (Boren 2002). Additionally, it is recommended that vessels restrict the use a running commentary on external speakers when vessels when viewing seals. Using the loud speakers during viewing sessions elicited reactions from seals at all locations, regardless of distance. Noise impacts from anthropogenic sources have been noted as a very influencing stressor on seals (Tripovich et al 2012) and should be excluded from all tours

The second concern is that seals at the breeding colonies, visited by harbour tours, appear to be more habituated to the presence of vessels based on their lower reaction and increased resting levels. One potential issue would be the desensitization passed down through generations which would be indicative of a long-term behavioural shift of the population due to boat presence (Bejder et al. 2009). Potential effects of tourism on the seal population around the peninsula are more than likely localized to colonies within close proximity to the Akaroa Harbour heads. The current viewing area for all vessels operating out of Akaroa Harbour includes all shorelines inside Akaroa Harbour and those extending south of the harbour heads towards Scenery Nook and east towards Damons Bay. This distance from the launch sites naturally protects most of the seal colonies and haul-outs on

Banks Peninsula, at the same time limiting the number of location where seals can be viewed by the tour vessels. Given the difference in seal behaviour and reactions between the various sites, it would be prudent to keep the habituation level to these already disturbed areas. This should not be a concern for population growth, as a whole, as all sites within this viewing area have shown increases in fur seal abundance since 2007 (Cate 2011); however, these individual colonies should be monitored every few years to confirm this positive trend continues, with the growing tourism levels. The full protection of some sites from disturbance will also be critical for assessing the long-term effects of tourism, which would not be possible without some areas to act as controls.

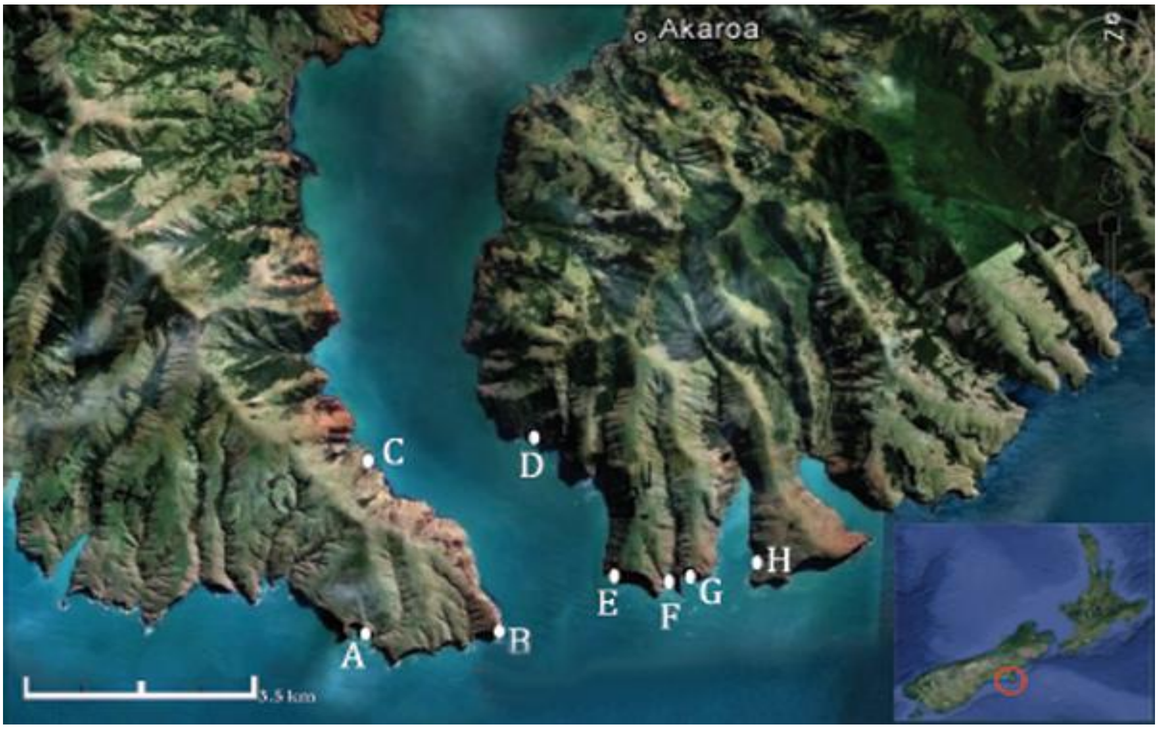

Figure 3.1. Akaroa Harbour and associated locations where tour vessels conduct seal viewing tours: A) Scenery Nook, B) Timu Timu, C) Seal Bay, D) Cathedral Cave, E) Akaroa Head, F) Haylocks Bay, G) Amphitheatre Head, and H) Damons Bay.

Table 3.1. Ethogram of New Zealand fur seal behavioural reactions to approaching vessels on Banks Peninsula.

Category	Behaviour	Description as it pertains to an anthropogenic stimulus
No Response	No response	No changes in behaviour due to vessel or loud noise (i.e., the seal was sitting before approach and remained sitting during the boat approach). The animal did not appear to look or notice the approaching vessel. This category also includes, grooming, thermoregulation, nursing, feeding, mating, fighting, laying down, sleeping, etc., as long as they were present before approach and did not change due to the vessel.
Alert Response	Look	The seal had a direct line of sight towards the vessel and was visually aware of its presence. This could be done from any position and combined with other behaviours. If this behaviour was seen while the seal was lying down, then the behaviour was written as look.
	Head lift	The seal lifted its head from a prone position to obtain a better view of the boat.
	Sit	Thorax, neck and head elevated by extension of pectoral flippers without ambulatory movement.
Direct Response	Walk	Seal actively moving from one place to another along the colony at a slow pace.
	Flee	A flight reaction of the seal where they fled from vessel. This was either into the ocean or into a hiding place.
	Bark	A vocalization generated from the seal towards the vessel. In this situation, it was perceived as a threatening behaviour. Also seen in pups in response to approaching boats.

Table 3.2. Number of observed trips aboard vessels from each of two tourist cruise companies, the locations where seals were viewed, mean viewing distance, and the mean duration of each visit. Data are provided for each season separately between 2009 and 2012. (n = 273 trips)

Study season and Company	# Observed trips	# Bays visited	Mean distance (m) (min - max distance)	Mean duration (min) (range)
2 Nov 2009 - 10 April 2010				
TB 1	42	8	19 (3 - 50)	6 (1 - 14)
TB 2	73	7	14 (3 - 50)	6 (1 - 16)
22 Nov 2010 - 9 April 2011				
TB 1	53	8	25 (5 - 150)	7 (1 - 20)
TB 2	51	6	17 (5 - 80)	5 (1 - 12)
11 Nov 2011 - 18 Feb 2012				
TB 1	30	7	38 (8 - 100)	9 (1 - 22)
TB 2	24	5	35 (12 - 100)	8 (4 - 14)

Table 3.3. Summary of the MANOVA analysis comparing the behavioural reactions of the New Zealand fur seals to visiting tourist vessels. P values were analysed for all individuals without accounting for sex and age classes. Sex/age class column describes females, pups, and males/sub adult observations that were significant amongst the independent factors. * indicates $p < 0.05$

	Behavioural response	df	F	p value	**Sex/age class** Female (F), Pup (P), Male/sub adult (M)
Location	No reaction	7	1.47	0.15	F*, P*, M*
	Alert	7	0.98	0.01*	F*, P*, M*
	Direct response	7	0.89	0.55	F*, P*, M*
Noise	No reaction	1	5.76	0.003*	F*, P*, M*
	Alert	1	6.86	0.001*	F*, P*, M*
	Direct response	1	0.44	0.64	F*, P*, M*
Haul-out vs. Breeding	No reaction	1	2.86	0.09*	F*, M*
	Alert	1	18.21	<0.001*	F*, M*
	Direct response	1	2.39	0.12	M*
Distance	~	47	1.88	<0.001*	P*, M*
Month	~	5	2.78	0.01*	F*, P*
Boat	~	1	2.72	0.11	
Duration	~	19	0.98	0.49	
Year	~	2	22.14	<0.001*	F*, P*, M*
Temperature	~	12	1.07	0.25	
Beaufort wind scale	~	3	2.49	<.001*	

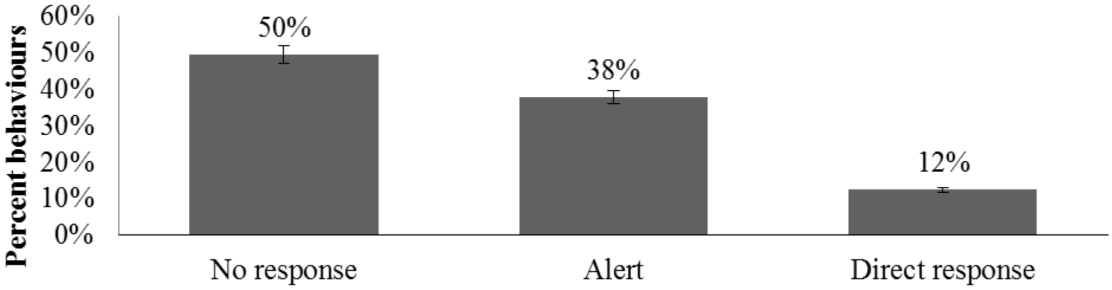

Figure 3.2. Mean behavioural reactions of fur seals to tour vessels. “Alert” reactions are inclusive of all looking, head lifts and sitting (n = 273 trips, se: 95% ci).

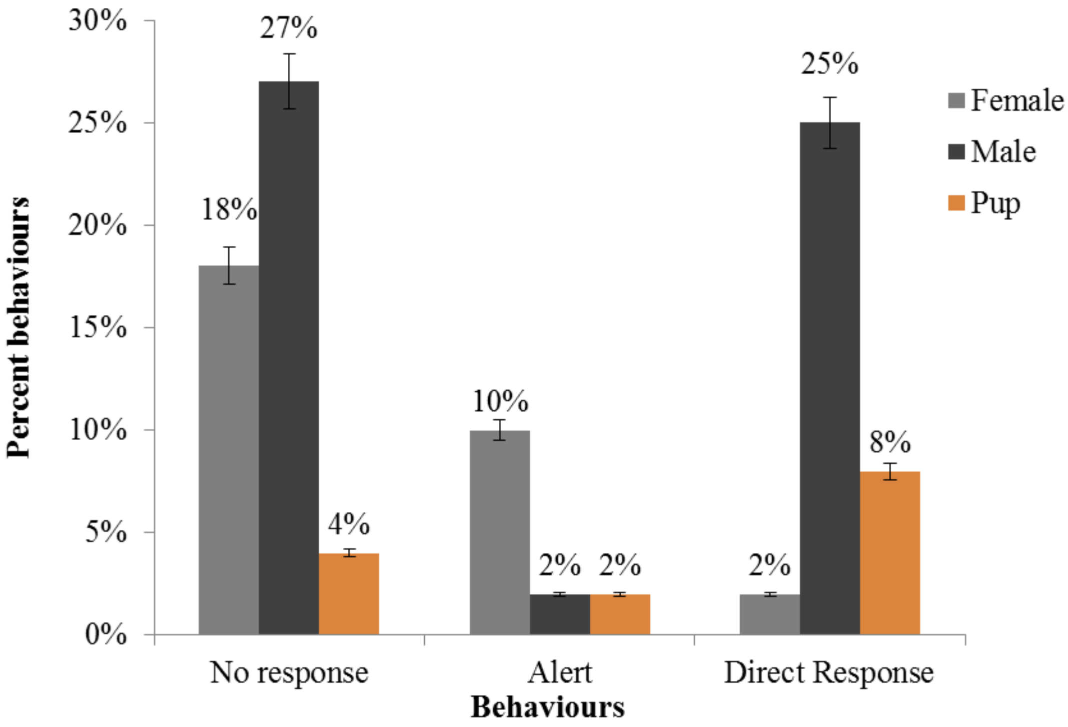

Figure 3.3. Mean behavioural reactions of fur seals towards tour vessels represented by sex/age class. The values percentages represent the percent of each sex/age class out of the entire study. (n = 2773 seals, se: 95% ci). The 2% not represented in this graph were those animals whose sex/ age class could not be determined.

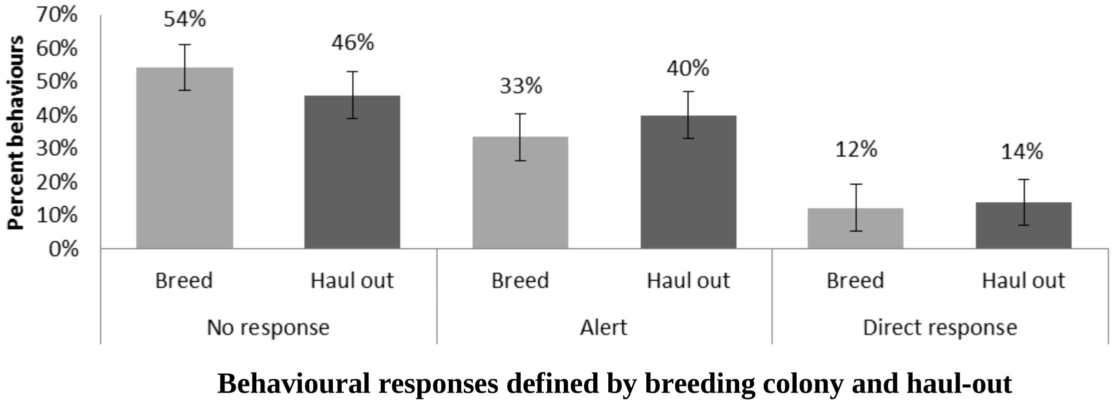

Figure 3.4. Behavioural reactions of seals towards vessel compared to functionality of site (i.e., breeding colony or haul out). (n=273 trips, se: 95% ci)

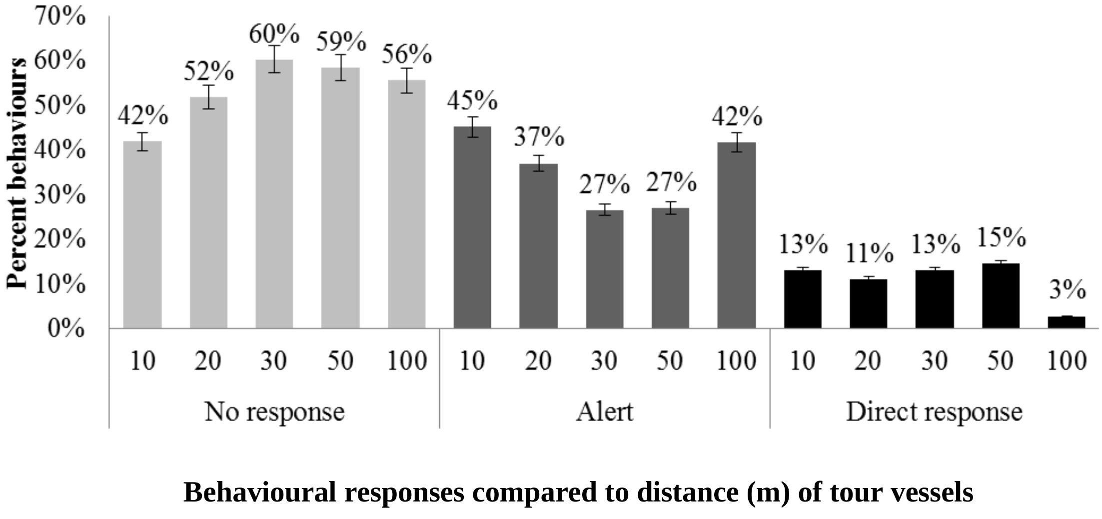

Figure 3.5. Mean Seal behavioural responses to vessels as compared to distance (10 m, 20 m, 30 m, 50 m and 100 m of the coastline). These data include all appraches with and without commentary. (n = 273 trips, se = 95% ci)

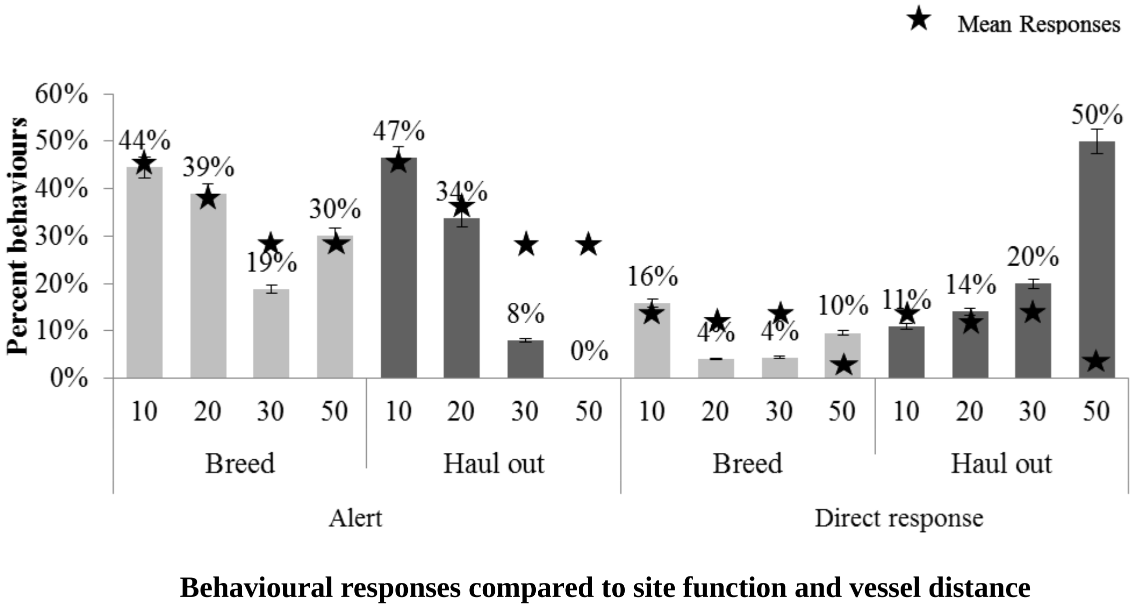

Figure 3.6. Behavioural reactions of seals to vessel presence compared to site functions and boat distance (m). These data are only a comparison of the silent approaches. Stars represent the mean behavioural responses of seals during all tours as a comparison to silent tours. (n = 44 trips, se: 95% ci)

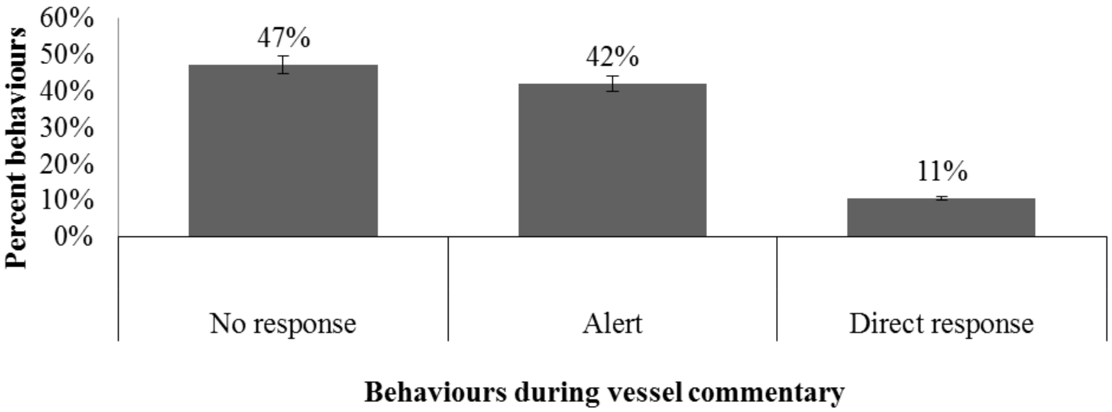

Figure 3.7. Mean behavioural responses of seals to tour vessels that were running commentary during tour session. (n = 229 trips, se = 95% ci)

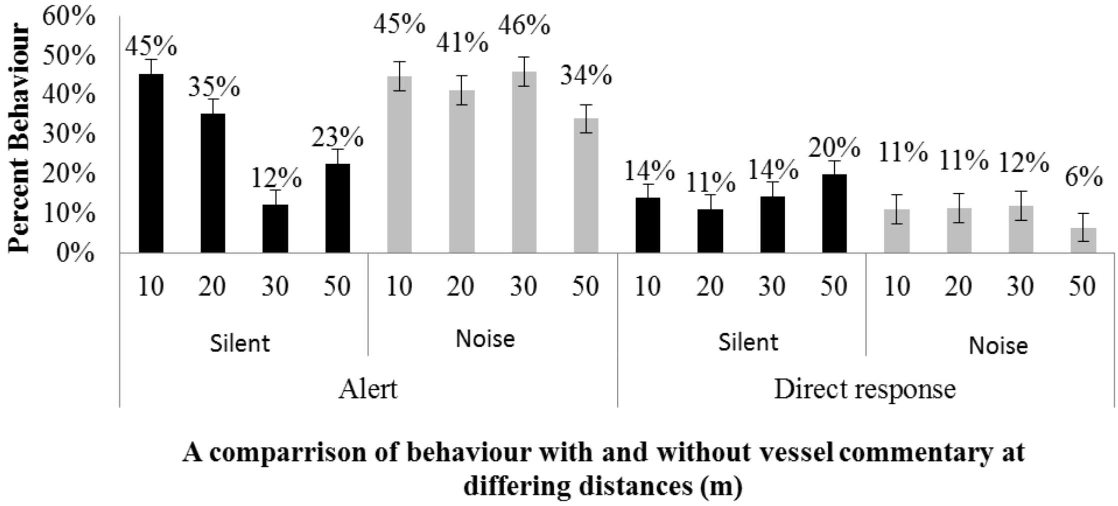

Figure 3.8. Mean behavioural responses of seals to tour vessels during periods with and without commentary as compared to vessel distance. (n= 273 trips, se = 95% ci)

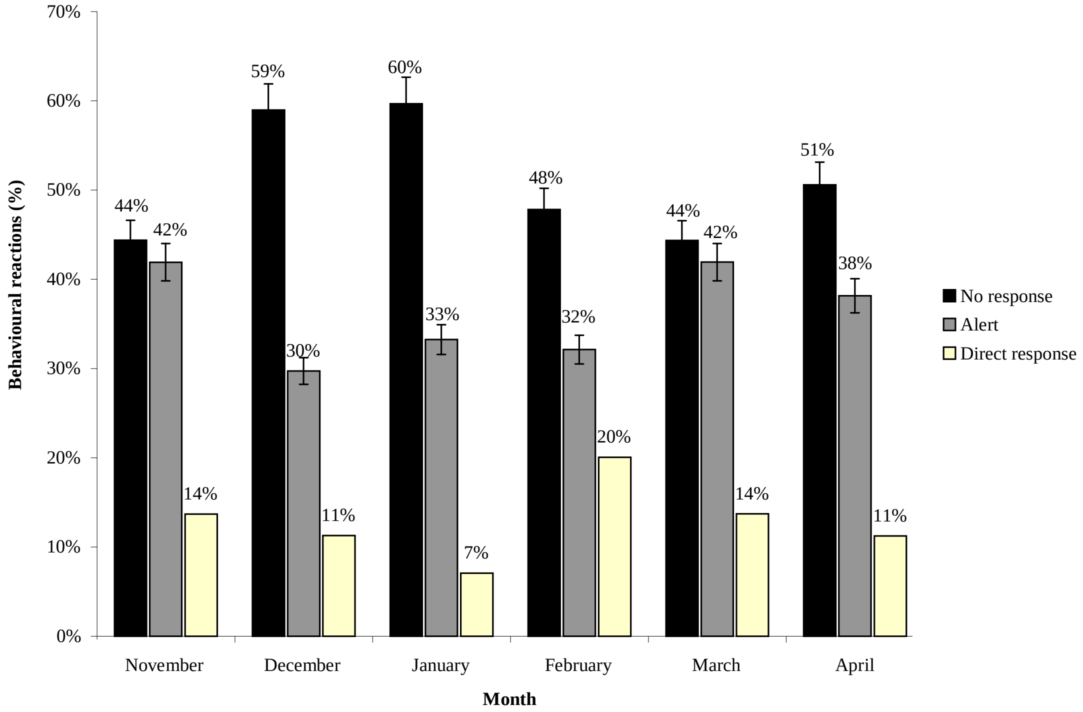

Figure 3.9. Mean behavioural responses of seals to tourist vessels compared by month. Note there were fewer animals present after January coinciding with the end of breeding season (n = 273 trips, se = 95% ci).

CHAPTER 4

Use of experimentally-controlled boat approaches to determine New Zealand fur seal behavioural responses at three commonly use tour boat viewing distances

Abstract

Boats used for eco-tourism can have the potential to have a large impact on an on the behaviour of marine mammals. Boat approaches, coupled with extraneous noise, can cause stress and behavioural disruption, including or decreased resting time. To test the response of New Zealand fur seals (*Arctocephalus forsteri*) to tourist boats, experimental boat approaches were conducted using a before, during, and after instantaneous scan sampling method at two breeding colonies (one with high vessel traffic and one with low). These were conducted at three pre-determined distances based on the current permit of 20 m, permitted cetacean viewing distance 50 m, and a non-invasive 100 m. Noise was created using a loud speaker at the 20 m distance to determine if/how this exacerbates seal reactions. All approaches mimicked those of local harbour tours. Distance of vessel played a significant role in the proportion seal responses ($p < 0.05$). There was an increase in the percentage of seals showing behavioural reactions in the presence of anthropogenic noise ($p < .05$). The effects of both distance and noises were significantly different between the high and low trafficked colonies ($p < 0.05$) and noise overrode the distance effect. When comparing viewing distances, there were a greater number of seals not reacting to boats at a distance of 50 m or further. This result contrasts with the currently permitted 20 m viewing distance. Behavioural responses to boat approaches varied between the two study sites which could be due to a degree of habituation to human

activities. My results confirm that close approaches by boats can elicit behavioural changes in New Zealand fur seals but that such effects can be minimized by reducing noise levels and increasing permissible minimum distances.

Introduction

Anthropogenic disturbance of marine mammals has become a topic of much recent research (Bejder & Samuels 2003, Constantine et al. 2003, Constantine et al. 2004, Orsini 2004, Tripovich et al. 2012), including studies on the effects of increased utilization of the marine mammals for ecotourism (Bejder & Samuels 2003, Bejder et al. 2009, Markowitz et al. 2009, Markowitz et al. 2011). Quantifying the impact of these disturbances is a difficult process, but it is unlikely marine conservation will progress without a greater understanding of the impact of human activities and how to ameliorate the negative impacts. The development and implementation of regulations to help protect the marine mammals is one obvious way to better protect marine resources (Richardson et al. 1995, Constantine et al. 2003), though this can only be effectively done with a current scientific understanding.

One step towards the creation of science-based regulations is to understand how our presence affects the behaviour of marine mammals. Since all marine mammals live at least half of their lives in the ocean, boats used for eco-tourism have the potential to have a large impact. Indeed, studies have shown that the presence of a boat can alter the behaviour of some species. Bejder et al. (2006) found that Indo-Pacific bottlenose dolphins (*Tursiops* sp.) increased pod cohesion as a form of group protection against approaching vessels. Constantine et al. (2003) reported that tour vessels reduced resting behaviour and fitness of New Zealand bottlenose dolphins (*Tursiops truncates).* They also determined that permitted tour boats had the highest impact on bottlenose dolphin behaviour above any other boat (Constantine et al. 2003). Furthermore, polar bears *(Ursus maritimus)* (Lunn et al. 2002), bottlenose dolphins (Constantine 1999, Constantine et al. 2003), dusky dolphins (*Lagenorhynchus obscurus*) (Markowitz et al. 2009), orcas (*Orcinis orca*) (Williams et al. 2002), New Zealand sea lions *(Phocarctos hookeri)* (Jackson 2006), and New Zealand fur seals, *Arctocephalus forsteri* (Boren 2001) have been seen to exhibit behavioural changes while in the presence of tourist operations. An additional concern is that mammals exposed to high levels of tourism become habituated or tolerant of the stimuli (Bejder et al. 2006), which has been seen in decreased reactions of chimpanzees, *Pan troglodytes,* to tourist when compared to other wild chimpanzees (Johns 1996). Certain habitats may be critical for the animals and they may have no choice but to stay and tolerate the intrusion if there is no alternate feasible location.

Anthropogenic noise has become a concern for the conservation of marine mammals (Richardson et al. 1995). Cetaceans, in particular, appear to be susceptible to anthropogenic noise in the marine environment as it can mask communication and echolocation (Markowitz et al. 2011). Though fur seals spend a portion of their life outside of the water, sounds from a vessel might also interfere with their activity levels by decreasing resting periods on land (Tripovich et al. 2012), which could potentially lead to a decrease in fitness, energy reserves, and maternal investment (Boren 2001). Most tour companies use a speaker system to communicate interesting facts regarding the natural environment to their patrons. The noise produced is loud enough to travel beyond the boat and create an echo within the confined areas of a seal colony. Such noise might cause reactions in some seals or minimise resting time. For example, Tripovich et al. (2012) documented stronger reactions of the Australian fur seal (*Arctocephalus pussilus doriferus*) to motor boats as the engine noise became louder. The extent and effect of noise disturbance to New Zealand fur seals is not known, however, it was observed in Chapter 3 that seals were reacting more often, and at further distances, towards tour groups using the boat speaker system.

Since data in Chapter 3 was opportunistic and neither the location nor vessel distance could be controlled, this study attempts to re-create a tour boat approach at an exposed fur seal colony (one commonly used by the nature cruises) and a non-exposed site (a colony with no previous record of tour boat approaches). By doing this, specific approach distances could be controlled and repeated multiple times to determine the overall effect of tour vessels. In New Zealand the permitted viewing distance of tour vessels to fur seals is 20 m (Boren et al. 2002). However, 50 m is more commonly used for tour vessel –cetacean encounters in New Zealand (Markowitz et al. 2009). An increased distance of 100 m is a recommended minimal viewing distance in whales (Sironi et al. 2005) and is more commonly thought to be less invasive towards marine mammals (Sironi et al. 2005). Additionally, since commentary was utilized during most tours, the effect of noise at one specific distance (the permitted 20 m distance) could be determined in this experiment. I used colonies of fur seals on Banks Peninsula to determine how approaching vessels and anthropogenic noise affected fur seal behaviour.

Objectives

The objective of this project was to examine if boat distance and the presence of extraneous sounds, specifically the use of loud speakers aboard vessels, were factors in eliciting behavioural reactions in New Zealand fur seals on Banks Peninsula. a series of controlled experimental approaches designed to mimic tourist ventures currently in operation were used. Thus, the results of my study will directly aid managers in designing concise marine guidelines for these and future tourist operations. Specifically, this project’s aims were three fold. First, I attempted to determine the relationship between distance of a boat at commonly permitted marine mammal viewing distances and the reaction of fur seals to the boats. Secondly, I compared differences in the reactions of fur seals to approaching vessels between an exposed and a non-exposed colony. Lastly, I tried to determine if using commentary while approaching a colony elicited or enhanced the reaction of fur seals at the currently permitted viewing distance.

Methods

Study Sites

The reactions of fur seals to tourist approaches were studied in the 2011-2012 Austral summer at two breeding colonies: Damons Bay and Island Bay (Figure 4.1). Both Island Bay and Damons Bay are located on opposite sides of Akaroa Harbour on Banks Peninsula, South Island. Damons Bay (as described in Chapter 2, study sites) was the exposed colony. Island Bay was the non-exposed site. Island Bay is located approximately 4 km beyond Akaroa Harbour and is approximately 10 km away from Damons Bay (43°53’21.6”S, 172°51’31.62”E). The terrain and shoreline is similar in make topography to Damons Bay, comprised of large boulders along a flat, wave washed shelf. The colony extends the entire distance of the bay (~ 0.5 km), and is broken into two main sections, the north end and the south end, divided by a break in the coastal shelf. Island Bay is also situated at the base of a cliff, similar to Damons Bay.

Each bay was divided into two sub-sites for the approaches due to the long extent of the bays and the bimodal distribution of the seals. Each sub-site were considered independent within each bay as seals in one area were separated by approximately 0.8 km, with steep cliffs and sea caves creating barriers between the sub-sites. Damons Bay was frequented by tour vessel visits and therefore was classified as an area of high visitation. Island Bay was used as the control for the experimental approaches as this site does not receive tourist visits. The division of each site into two areas allowed me to limit the exposure of seals as the approach experiments might have resulted in the desensitisation of the animals. Weather conditions were similar between the two main breeding colonies as each approach type (20 m, 50 m, and 100m) were conducted on the same day at both colonies. Experimental approaches were conducted in a controlled fashion, mimicking the approach behaviour of the tour vessels, to help determine if there were any differences in seal behaviour towards boats between Island Bay (little vessel traffic) compared Damons Bay (more vessel traffic).

Data collection

Data were collected on Banks Peninsula between November 2011 and March 2012 using an independent research boat. All data from Damons Bay and Island Bay were collected during these experimental approaches using a 4 person team. The first person was the boat driver. The second member of the team continually checked the distance of the boat to the shore using a calibrated laser range finder (Bushnell Yardage Pro Sport 450 Rangefinder). The other two team members collected behavioural data.

Observations were conducted using scan sampling at a five minute interval for the “before” and “after” phase and an all occurrences sampling during the approaches. Upon the approach of the boat to a colony, the age class and sex of seals, distance of vessels to shoreline, time, weather conditions, the presence or absence of extraneous sound (i.e., loud speaker) and any additional vessels in the area were recorded. Behavioural observations, distance of approach, location, and duration of visit were recorded during each controlled approach.

The behavioural responses to the stimulus were categorised and defined in Chapter 3, Table 3.1. Any behavioural changes not a result of the vessel or loud speaker (i.e., the animal moving without looking at vessel in a non-hurried fashion, grooming, nursing, fighting with another animal, laying down, etc.) were recorded, but marked as “No Response”.

Experimental approaches

Experimental approaches to fur seal colonies were conducted from two smaller vessels; a 6.2 m Niad with twin 130 hp two-stroke Yamaha out board engines, and a 5.2 m Stabicraft with a single 125 hp twin stroke out board engine. Only one vessel was used at a time and another vessel was never present during our approaches, therefore the effects of multiple vessels could not be tested. Loud speaker systems and set up was similar between the vessels and was similar to that used on the Banks Peninsular wildlife cruises.

Confounding factors of this experiment were tide levels, weather, sea state, and availability of boats to use when conducting experiments. Fur seals can be more easily viewed during conditions of high tide, calm seas and fair weather. Tour companies operate under a schedule that does not account for all of these factors. To minimize variations in these conditions, a randomized block design was implemented for both distance and location. All approaches were conducted based on boat availability and appropriate weather conditions for sea travel. Three approach distances were tested; 20 m, 50 m, and 100 m. Distances were chosen based on marine mammal viewing permits and personal observations of approach distances used by the tour vessels. The farthest distance (100 m) was the distance that was not expected to elicit any reactions and is commonly used for whale watching tours (Sironi et al. 2005), while 50 m was the next closest viewing distance that some boats are permitted to view marine mammals in other areas of New Zealand, and elsewhere in the world (Parsons & Scarpaci 2010, Streckenreuter et al. 2011). The closest distance (20 m) was the actual permitted viewing distance in Akaroa. Since most of the tour companies conducted commentary whilst viewing seals, the level of noise at the permitted viewing distance could compound the effect of close approach and thus I used my observations to determine if reactions were exacerbated by the seals at the 20 m distance.

At the beginning of each day, location and distance of approach was randomly determined by rolling a dice. A roll landing on 1 represented an approach at Damons Bay at 20 m, 2 was Damons Bay at 50 m, 3 was Damons Bay at 100 m, 4 represented Island Bay at 20 m, 5 Island Bay at 50 m, and 6 was Island Bay at 100 m. Which sub-site to use, was determined by flipping a coin. Approaches at 20 m were then conducted in two ways, with the level of sound being "quiet" or "loud". A coin was flipped to determine which type of 20 m approach would be conducted. Loud approaches were conducted by talking through the onboard external speaker (83 dB +/- 3 dB) set on the high volume level. The sound level and duration was the same for all approaches, mimicking that used during the tours boats approached towards seals. Approaches using sound (talking through the external speaker) began once the vessel was 20 m from the shore and lasted until the boat passed by the last visible seal.

Approaches were carried out using a Before/During/After (BDA) approach method (Bejder & Samuels 2003). Upon arrival to a location, the boat anchored at a distance more than 100 m from colony and the engines were turned off to eliminate external noise. General behavioural was collected at 5-minute intervals for a period of 30-minutes; the 5-minute period was the maximum time needed to conduct one scan of a 200 m section of the largest breeding area. All visible seal behaviours were recorded once per 5-minute scan. Next, the boat would approach the colony starting from the edge of the most southern portion of the study area and move north, parallel to the shore at one of three distances (20 m, 50 m or 100 m). All observable behavioural changes were monitored from seals in a similar fashion as on the tour boat (See Chapter 3, seal behaviour). Finally, the boat would return to the original anchor site and data were collected for an additional 30-minutes in the same fashion as the "before" scans. During the 20 m loud approaches, the vessel's intercom system was used for the "during" scan and mimicked the dialogue aboard tour vessels.

In an attempt to mitigate habituation to experimental approaches, if performed more than once per day at the same location the boat would leave the area for a period of at least one hour before attempting a second approach. No more than four approaches were carried out in one bay per day. However, repeat visits to colonies were unavoidable on some days, though this simulated the multiple disturbances created by tourist visits. Based on data from Barton et al. (1998), Boren (2001), and personal observations, seals appear to resume pre-visitation behaviour within 20-minutes of a stimulus (i.e., approaching person or vessel).

Data analysis

All data were analysed using Microsoft Excel and SPSS. v. 20.0. Behavioural data were first converted into percentages. Data were tested for normality and an arcsine transformation was used to normalise proportional data, which were then analysed with a one way MANOVA to test for significance differences in behavioural change. Any change in behaviour was compared both within control sites and between colonies for variation due to distance and noise.

The data from the two sub-sites within each bay were analysed using an MANOVA to determine if there were any differences in seal behaviours due to site (i.e., Island Bay A and B). It was determined that there were no significant differences in seal behaviour, therefore, for each bay, the data were combined yielding one set of data for each of Damons Bay and Island Bay.

Due to vessel limitations, approaches could only be conducted when conditions were pristine (< 1 m swell and Beaufort 4 or less). There were no significant variations in behaviour due to environmental conditions. There were no significant differences in sex and age class, therefore they were pooled together and treated the same. The data were broken down into three phases: 1) before boat approach (B), 2) during the approach (D), and 3) after boat approach (A). Each section of the experimental approach (B, D, and A) was analysed by calculating the proportion of active and resting behaviours per time period and comparing the percentages to each phase within each colony (as seen in Chapter 3, Table 3.1).

As several interacting factors contributed to variation in seal response (i.e., distance and sound are not independent of each other), a MANCOVA with a Tukey post-hoc comparison (SPSS) was performed on the proportion of reactions and the frequency of seal responses to determine if there were interactions between distance, B/D/A, site (control or not), and the presence of noise. The data was first analysed without including noise level as this would indicate the response of seals during a tour group in which the patrons remained silent.

Results

Data were collected from a total of 69 approaches between 2 November 2011 and 22 February 2012 (see Table 4.1). Mean viewing time was 30-minutes for the “B” and “A” phase and 10-minutes (range 5 to 12 minutes) for the approaches

(D phase). The mean number of visible seals, between both locations, was 33 (range from 6 to 60).

The reactions of seals toward approaching vessels were variable between the two sites (Figure 4.2.). Distance of vessel played a significant role in eliciting greater seal responses. The closer the vessel, the more responses observed (such as looking, head lift, sitting up, and directly responding) and thus, a decrease in the percentage of no reactions. The behavioural reaction of looking was observed most frequently and varied significantly between the two colonies (10% more at Island Bay: $F_{31} = 6.9$, $p = 0.01$). Direct responses were significant between the two sites (MANOVA: $F_{31} = 3.9$, $p = 0.05$), and were observed more at Damons Bay (mean 6% increase), independent of distance.

There were differences in seal responses and behaviour between the three phases of the controlled approach (Table 4.2). Overall, percentage of behavioural responses increased as the vessel distance decreased. More seals changed into alert or direct response behaviours the closer the vessel approached. More specifically, mean colony behaviour during the “B” phase changed significantly during the “D” phase (MANOVA: $F_{31} = 8.1$, $p = 0.001$). Seal behaviour during the final “A” resumed to percentages similar to the “B” phase. No responses decreased (mean 43%) during each controlled approach. The percentage of no responses was directly tied to approach distance. An increase of alert (25%) and direct responses (10%) was also correlated to vessel distance. Comparing the two locations, Island Bay seals exhibited more alert reactions and Damons Bay seals were more prone to elicit a direct response during the approaches (7%, $p = 0.04$).

Using the external speakers to generate noise appeared to induce a significant change in behaviour when compared to approach location (control site)

(Figure 4.3). When sound was present, regardless of location, there was an increase in the percentage of seal responses (MANOVA: $F_{28} = 9.00$, $p = 0.004$), specifically in the number of direct responses and looking. More seals at Island Bay changed their behaviour when sounds were present as well. Since noise was only created in the approach (D) portion of these experiments, timing was not considered in these analyses B/D/A analysis. "Looking" was the most common reaction of seals towards approaching vessels at Island Bay and was significantly different between the two colonies, when sound was a factor (MANOVA: $F_{31}= 7.7$, $p = 0.008$). The percentages of direct responses were also significantly different when sound was present (MANOVA: $F_{31} = 8.1$, $p = 0.007$) and between the two tests sites (MANCOVA: $F_{31} = 6.4$, $p = 0.015$) where Damons Bay seals had significantly more direct responses to approaching vessels (20.6% at Damons Bay and 11.1% at Island Bay). The remaining behavioural reactions did not show any significant differences ($p > 0.05$) between sites when sound was a factor; however, sitting appeared to decrease at both colonies with sound, and was recorded the least often at Damons Bay.

Testing for interactions between factors (MANCOVA) revealed that distance of vessel (MANCOVA: $F_{69} = 5.8$, $p = 0.004$), the B/D/A (MANCOVA: $F_{69} = 9.6$, $p = 0.001$) and the difference between a control and a non-control site (MANCOVA: $F_{69} = 9.2$, $p = 0.003$) were all significant factors in explaining variation in seal reactions. There was a significant interaction between B/D/A (MANCOVA: $F_{69} = 6.6$, $p = 0.019$) and distance (MANCOVA: $F_{69} = 5.8$, $p = 0.004$). Specifically, a 20 m ($p <0.05$) approach yielded higher percentage of responses than a 50 m ($p = 0.053$) or 100 m ($p < 0.001$) approach. An increase in vessel distance from 50 m to 100 m yielded a non-significant level of responses ($p > 0.05$).

Discussion

Distance, as the sole factor (i.e., a quiet vessel) elicited more reactions in fur seals when boats were closer to shore. Boat distance has been noted as a major factor in causing behavioural shifts with other marine mammals (Bauszus & Tandy 2002, Streckenreuter et al. 2011). Bauszus and Tandy (2002) reported increased activity in fur seals on land from their predominate behaviour of laying down when tourist approaches were over the seals' tolerable threshold. Based on Chapter 3, I predict the tolerable threshold for seals on Banks Peninsula to be between 30 m and 50 m Humpback whales (*Megaptera novaengliea*) (Stamation et al. 2010) and resident killer whales off the San Juan Islands (Lusseau et al. 2009) fed less when vessels were < 1000 m away. Southern fur seals (*Arctocephalus australis*) were seen to abandon habitats permanently due to the close proximity of humans (Stevens & Bonnes 2003).

There were differences in behaviour between the two breeding colonies which appeared to be related to their previous levels of disturbance. The control group, which had little prior anthropogenic disturbance, showed an increased level of alert reactions when the boats were closer, especially in the proportion of seals that engaged in "looking." Damons Bay exhibited more direct response towards the vessel at all approach distances. In fact, these data suggest this colony is not habituated to vessels as was previously thought by Figure 2.3. Additionally, this experiment provided evidence that Damons Bay seals may not be as desensitised towards tour vessels given they were more reactive, specifically in the percentage of direct responses. However, tour vessels are routine in their viewing times.

Approaches in this study conducted at times when there was no tour vessel, therefore, the modification of viewing time could attribute to the seals responsive nature towards our vessel. Another theory for this unexpected result could be the experimental approaches might have been conducted a short while after the tour vessel had visited the colony. In this scenario, the seals at Damons Bay may have been less tolerant of out approaches and more likely to exhibit the direct responses that were observed where Island Bay seals were more likely to be “alert” while assessing the approaching vessel. If the vessel was perceived as non-threatening, this would explain the increased alert behaviours as compared to Damons Bay.

Distance of vessel had an effect on seal behaviour. During silent approaches, seals at both the exposed and control colony reacted less to vessels when they were further away. This was similar to observations made in Chapter 3. Vessel distance was a contributing factor to the percentage of seals reacting, and they were reacting at every distance, though a higher percentage was observed at 50 m and 20 m. If seals are reacting to vessels at the 100 m distance, then the currently permitted 20 m viewing distance may not be adequate to minimise the effects of an approaching vessel on fur seals. Data from these approaches confirms seal at both locations reacted significantly more (in both alert and direct responses) at 20 m versus 50 m. Vessel presence could have altered resting behaviour, contributing to increased energy expenses while remaining alert towards the vessel, thus leading to the potential loss of fat reserves (Bejder 2009) and maternal investment (Boren 2001). Boren et al. (2002) conducted controlled vessel approaches towards seals at Tonga Island, New Zealand, and determined 20 m to be too close for vessels, recommending an increase in viewing distance to 30 m to maximize energy conservation of seals at rest.

When speaker noise was considered as an additional factor in approaches, a larger percentage of seals reacted, and presumably expended more energy in the process. Similarly, hauled-out Australian sea lions (*Neophocea cinerea*) (Orsini 2004) and Florida manatees (*Trichechus manatus latirostris*) (Miksis-Olds et al. 2007) responded more to boats with external sound sources. The general sequence of behaviours seen from a resting seal were to first look, head lift, and sit, and then to react further (i.e., flee) or to resume their original behaviour (Bauszus & Tandy 2002). Some seals only reacted by fleeing, which was also observed at haul-outs (see Chapter 3). With the experimental addition of noise, direct response behaviours were higher at Damons Bay, although the behaviours classified as other responses were higher at Island Bay (i.e., these seals were more alert, but less prone to directly respond). Noise was only considered at the permitted 20 m distance. Additional studies need to be conducted to determine noise effects at further distances.

It was apparent from the Before/During/After experiments that there were differences in behavioural responses and the percentage of animals reacting to vessels between the two study sites and this varied by distance. Damons Bay had more seals directly respond by fleeing, moving, or showing aggressive behaviour than the Island Bay colony. Those at Island Bay were more alert to the approaching vessel. These results were not expected. One theory to explain the higher direct response level at Damons Bay is those seals could have developed a lower tolerance to approaching vessels. They are accustomed to tour vessels visiting them on a nearly daily basis. Therefore, if the seal's tolerance threshold was lower they might not exhibit alert behaviours, but instead, would just move away from the vessel. In contrast, Island Bay seals had no previous exposure to vessels, and were more prone to watch the approaching boat, thus exhibiting more alert behaviours to determine if the approaching boat is a threat.

Behavioural levels 30-minutes after the approach returned to levels observed before the approach. This was similar to finding of Barton et al. (1998) showing short term behavioural shifts are not initially long lived, however if continued, could lead to an onset of a more energy-expensive long-term behavioural shift (Bejder et al. 2009). Such shifts could lead to a decline of populations, as was seen in the Hawaiian monk seal (*Monachus schauinslandi*) (Gerrodette & Gilmartin 1990), shifts in habitat use as noted in Australian sea lions (Orsini 2004) and yellow–blotched map turtles (*Graptemys flavimaculata*) (Moore & Seigel 2006), or increased tolerance to disturbance due to historical and maternal traditions at a location (Bejder et al. 2009).

Anthropogenic noise elicited behavioural responses in both my study and that of Tripovich et al. (2012). In a noisy environment (e.g., 75-85 dB), (Tripovich et al. 2012), a seal at rest was more likely to wake or move in response to the auditory cue. Seals not at rest would look at the vessel and then either ignore (i.e., return to their previous behaviour) or react to it (move to gain a better view, move away, or pose in a defensive behaviour). To put the noise levels experienced by seal during a tourist approach in context, normal human conversation at 1 m is 50 dB, loud conversation is 50-65 dB, thunder ranges between 90-100 dB, and a ship's engine room at full speed is approximately 120 dB (Richardson et al. 1995). Loud speaker intensities vary depending on the sensitivity of the speakers, however, the range being used aboard these tour boats was estimated to be about 83 dB (+/- 3) (Richardson et al. 1995). Thus, the level of noise used in my study showed clear evidence of disruption of resting seal behaviour causing seals in an area of higher traffic to either flee or become more aggressive and should be used with caution.

Conclusion

Vessel traffic had an impact on the short-term behaviour of seals at their breeding grounds. Distance and the presence of levels were both important factors in the type of seals. Seals were able to resume "normal" colony behaviour within 30-minutes of approach. Additionally, there were differences between the two sites which can indicate the current tourism pressures on Damons Bay are influencing seal behaviour and may be and there may be some level of habituation at that colony.

According to Bejder et al. (2009), in the simplest scenario an animal with continual anthropogenic stressors may choose to switch from continual short-term behavioural avoidance to long-term area avoidance. This would only occur once the cost of staying and tolerating the disturbance exceeds the cost of leaving and finding a more desirable habitat. The decision for an animal to move would first present itself as individuals leaving, typified as fewer individuals in the habitat, and lower average responses to the disturbance compared to those that choose to stay and are more tolerant (Bejder et al. 2009). Those that choose to stay may be obliged for one of three reasons. Firstly, they may not have the excess energy to expend (need to rest and regain fat stores), the area may be a critical habitat (breeding or feeding ground), or they are socially obliged (territory holder or too young and would not be able to assess new habitat) (Bejder et al. 2009). New Zealand fur seals are central place foragers, and are thus less likely to abandon a critical habitat. They rely on the close proximity to the continental shelf for their food source. Site abandonment would be energetically expensive, and could potentially add to a longer foraging trip. However, behavioural shifts and energy loss could impede colony growth and animal health.

Pinnipeds spend a good proportion of their lives on land for four reasons; to rest, mate/breed, give birth, and nurse (Cawthorn et al. 1985, Bradshaw 1999, Boren 2005). They are also a popular and reliable source of entertainment for tourists on the nature cruises. Therefore, proper planning and management needs to be in place for the continued growth of tourism expected in New Zealand in order to maintain a healthy relationship between tourism and fur seals.

Figures and Tables

Figure 4.1. Aerial photograph of the Island Bay and Damons Bay seal colonies used in this experiment. North is at the top of the photo.

Table 4.1. List of study sites and total number of recorded visits, including the mean number of seals seen during these observations. Sampling occurred between November 2012 and February 2012. All repeated approaches towards one colony in the same day were given a minimum of one hour recuperation time.

Location	# visits	Mean # seals	Range: # seals (min-max)
Damons Bay		25 (SD 11.9)	6 - 60
A	18	27	20-60
B	18	22	6-35
Island Bay *		39 (SD 11.5)	16 - 55
A	16	42	16-45
B	17	35	22-55

** control colony*

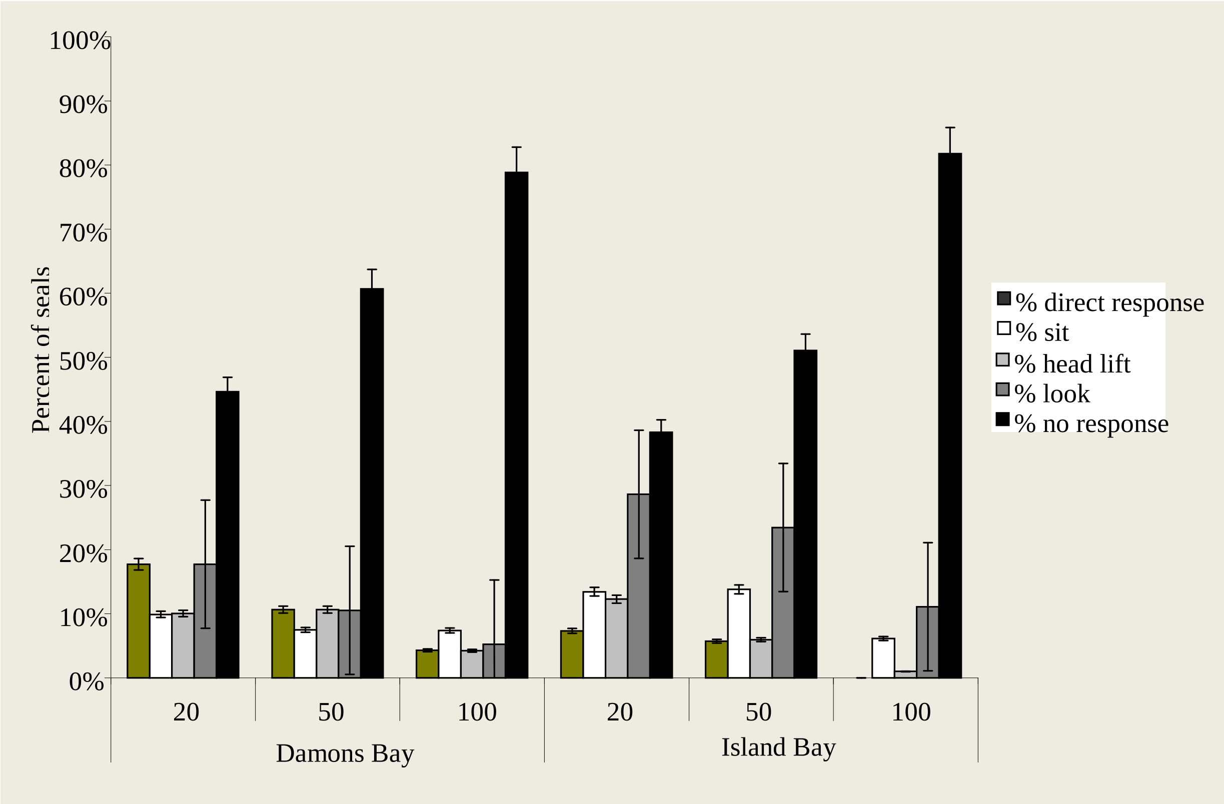

Figure 4.2. Effect of boat distance on the mean behavioural reactions of fur seals at Damons Bay (high vessel traffic) and Island Bay (low vessel traffic). Note: 20, 50, and 100 represent distance of boat from the seals in meters (n = 31, se: 95% ci). See Chapter 3, Table 3.1 for a description of each behaviour.

Table 4.2. The percentage of fur seals responding to approaching vessels at varying distances based on timing of approach (Before/During/After). The approach timing was from data taken before, during, and after controlled approaches. The reaction data has been pooled into no responses, alert, and direct responses. Data recorded during the "before" and "after" phases were recorded from a distance of greater than 100 m. The percentages are the means of each category and the range is given in parentheses.

	Approach time and distance		**% No Response*** (min - max)	**% Alert*** (min - max)	**% Direct Response*** (min - max)
Damons Bay	Before		83 (64 - 93)	11 (5 - 25)	6 (0 - 18)
	During	20 m	47 (32 -79)	26 (5 - 50)	20 (3 - 52)
		50 m	53 (30 -70)	28 (10 - 50)	15 (0 - 33)
		100 m	59 (44 -100)	18 (0 - 33)	9 (0 - 22)
	After		91 (82 - 100)	8 (0 - 14)	1 (0 - 9)
Island Bay	Before		75 (52 - 95)	14 (0 - 28)	7 (0 - 15)
	During	20 m	31 (13 - 43)	40 (23 - 55)	9 (1 - 17)
		50 m	37 (29 - 46)	24 (11 - 41)	5 (0 - 12)
		100 m	36 (25 - 43)	16 (9 - 32)	6 (2 - 9)
	After		77 (46 - 97)	16 (3 - 36)	8 (0 - 22)

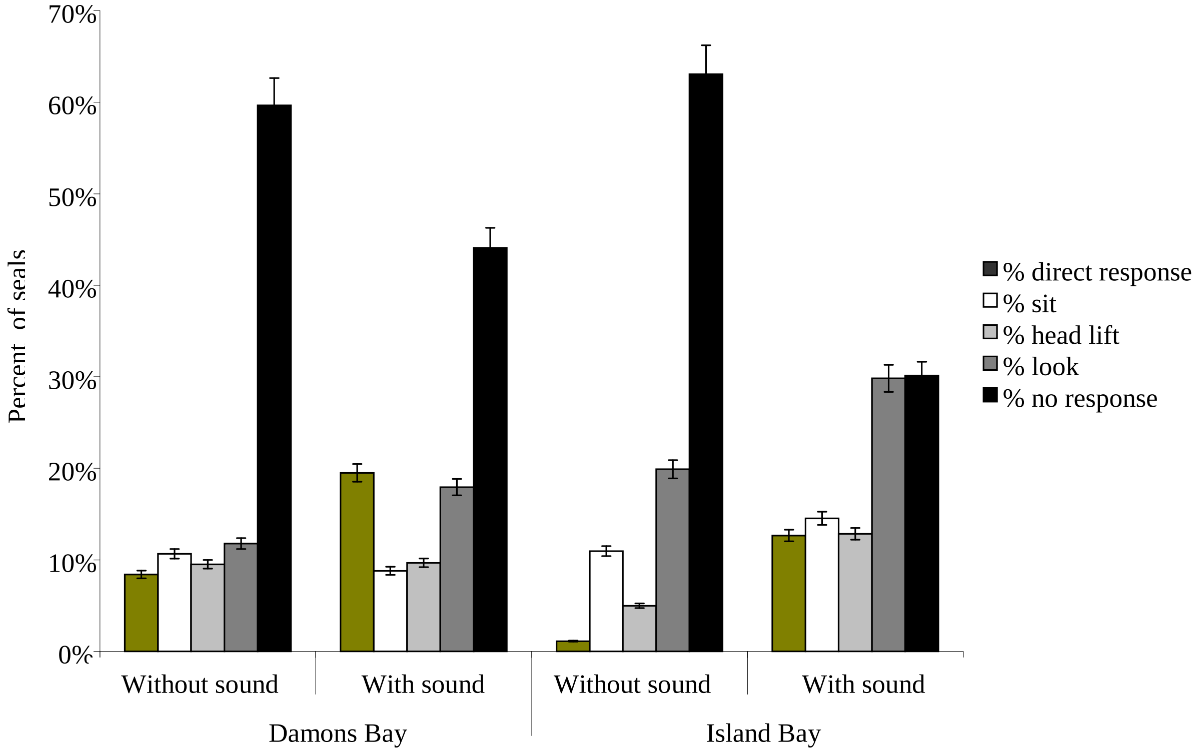

Figure 4.3. Comparison of mean behavioural reactions of fur seal to approaching vessels between Damons Bay (exposed) and Island Bay (non-exposed) when sound is a factor at 20 m (n = 31, se: 95% ci).

CHAPTER 5

Effects of tourist presence on the behaviour of New Zealand fur seal pups at a communal “playground”

Photo courtesy of lostateminor.com

Abstract

Interactions between tourists and seal pups have not been well studied except when pups are with their mothers at natal colonies. Within the past 20 years, seal pups near Ohau Point, New Zealand, have started to use a freshwater stream and waterfall as a communal “playground”. The site is more than 200 m from the south side of the Ohau Point rookery and is not attended by adults. It has also become a focal point for tourists, enabling the effects of unregulated tourist visits on these young fur seals to be studied. Behavioural observations using all occurrences sampling were made over 5 months during the Austral winter – spring to record pup behaviour, number of tourists, and tourist behaviour. Overall, the presence of tourists significantly affected seal pup behaviour. Seventy-five percent of the time people were present they exhibited actions beyond quietly watching the seals. The type of actions by visitors significantly affected how seals reacted. The main effects observed were that bouts of pup inactivity and awareness increased when people were present, which is indicative of disruption of “play” behaviour. The Ohau waterfall is a predator-free place for pups to play while their mothers are feeding at sea. The ability to engage socially with other pups is beneficial for enhancing agility, muscle growth, and life skills. This study provides evidence that fur seal pups subjected to human disturbance alter their behaviour, shifting from active (when people are not around) to inactive and aware (with increased disturbance). If no further management is implemented, then the potential for long-term negative effects on the fur seals increases as does their eventual habitation to humans.

Introduction

A number of behavioural studies have been conducted to determine short-term behavioural effects of anthropogenic disturbances, including disturbances due to tourism. The responses of New Zealand fur seals (*Arctocephalus forsteri*) to tourism pressures has been the subject of a wide range of research, including how tourism can alter maternal dependencies (Boren 2005), feeding strategies and habits (Bejder 2003), colony preference (Bejder et al. 2006), and changes in distribution and behaviour (Bauszus & Tandy 2002, Boren et al. 2006). However, there is still a lack of understanding how interactions with people affect the behaviour of juvenile seals and whether this could have any lasting impact on their adult life.

Pinniped lactation and maternal investment varies and can last between 4 days to 3 years depending on the species, location, and food source (Gentry & Kooyman 1986, Trillmich 1990). As smaller otariids living in a temperate climate, female New Zealand fur seals generally lactate for 8-10 months (Stirling 1970, Miller 1975, Mattlin 1978b, Goldsworthy 1992, Harcourt 2001, Baylis 2008), though nursing at the Ohau Point rookery has been observed to last an average of 9 –11 months (Boren 2005). Prior to weaning, pups are mostly dependent upon their mothers for food, starting to eat solids at 6 – 8 months (Baylis 2008). Since significant neurological development and differentiation occurs in the early growth of an animal (Markowitz et al. 1998), environmental influences can have profound lasting effects on their ensuing behavioural competence (Rosenzweig 1984). Similar to domesticated animals (Rushen et al. 1999), it is presumed that until this time, their anti-predator behaviours are not fully developed and recognition and "fear" of potential predators, including humans, are developed by witnessing a reaction by the parent (or older individual). It is uncertain how a dependent animal’s exposure to humans on a regular basis may affect the development of their recognition and fear tendencies, or if they instead will become desensitized to humans. Seal pups are energetic and curious by nature, and when in close proximity to humans (and without older seals around), they have been observed to walk up to people and sniff them, or bring an object to the edge of a pool in the same manner a dog returns its ball.

When their mothers are away foraging, pups form social groups consisting up to 4-5 individuals (Crawley & Wilson 1976). For most mammals, play groups provide an opportunity for juveniles to perfect skills and learn valuable social information (Bender 2012), independent from their mothers, which aids not only their social cognition, but also their learning of important life skills. For example, dolphins (*Tursiops spp*.) have been observed in herding play, similar to the behaviour an adult male will use in mating with a female (Mann & Smuts 1999). Other social behaviour amongst young mammals includes chasing games, pushing games, and play fighting (Crawley & Wilson 1976, Mann & Smuts 1999, Kuczaj & Highfill 2005).

Interactions between pups and tourists have not been well studied except when pups are in the presence of their mothers at natal colonies (Boren 2001, Boren 2005, Tripovich et al. 2012). Within the past 20 years, seal pups at a colony near Ohau Point, New Zealand, have started to use a freshwater stream and waterfall as a communal “playground”. This site is more than 200 m from the north side of the natal colony and is rarely attended by adults (nor within visual or auditory range of adults) but has become a focal point for tourist visits, enabling the effects of tourist activities on juvenile fur seals to be studied in detail. As this site was already popular with tourists before the seals started using it, there were no guidelines or signs in place regarding proper etiquette and there are no barriers to keep people from climbing the sides of the pool or entering into the water. In extreme cases, people have been seen attempting to touch the seals, pick them up, get into the pool to swim with them, feed them, and bring balls for the seals to play with (in most cases, these balls were left at the waterfall as trash). New Zealand marine mammal viewing regulations recommend people remain more than 20 m away from marine mammals on land; however, that is not an option at this specific location due to the close proximity of the seals to the trail (i.e., most seals are less than 5 m from the trail). On one hand, the seal pups, and their appearance in large numbers at the waterfall, represent population growth, and the opportunity for the public to see and enjoy seals at close range. To maintain a healthy population of a recovering species, there is a need to examine the effect of people in such close proximity to the pups. This site is also good for increasing the positive image of seals versus the negative perception that many people have. Therefore, it is important to be able to sustainable manage this site.

Objectives

The objective of this study was to determine if seal pups in the Ohau Stream and its waterfall exhibit short-term behavioural changes in the presence of tourists. Since the juvenile stage is a vital time in the learning process (Rosenzweig 1984, Markowitz et al. 1998, Bender 2012), it is unknown what long-term effects the close presence of people will have on seal pups, or whether this experience will cause the eventual habituation to people. Specifically, this project monitored pup behaviour at the waterfall to determine: (1) whether it differed between when people were present or not present, (2) how the number of people affected the behaviour of pups and, (3) the behaviour of tourists in the presence of pups.

Methods

Study site

Ohau stream and waterfall (Figure 5.2), is located 25 km north of Kaikoura on New Zealand's South Island at the base of two large hills. The waterfall and associated pool is a ~200 m walk along a path through a patch of native regenerating forest, and starting at a parking lot adjacent to the highway. There is one trail that follows the stream and ends at a waterfall observation area approximately 1 m from the pool's edge. The pool is surrounded by steep hills on three sides. It is a popular tourist destination at all times of the year, including stops by tour bus operators with large groups (>15 people). The Ohau stream flows year round and empties into the ocean on the northern edge of a well-established fur seal breeding colony (Boren et al. 2006). Young fur seals, especially pups (i.e., younger than 1 year of age) from this colony venture up the stream and have been seen in the waterfall pool as early as 11 April, although they can be found in the stream earlier in the year. The trail terminates at the waterfall at a small cement platform (~40 m^2) roughly 200 m from the Ohau Point seal colony. Interactions between people and seals can happen anywhere along the stream but the most frequent opportunities for interaction occur beside the pool at the base of the waterfall (Figure 5.3). For this reason, this study focused only on seals within and beside the waterfall pool.

Behavioural observations

Behavioural observations on seal pups were made over a period of approximately 5 months during the Austral winter – spring, in both 2009 and 2011. Observations were conducted 30 days in 2009 and 15 days in 2011. Seals did not arrive at the waterfall until April in both 2009 and 2011, and observations commenced shortly after. Information on the seal behaviour was collected between

0800 and 1700 (NZST). The minimum duration of an observation period was 2 hours. All observations were conducted from an elevated site where the observer could see into the waterfall pool and surrounding area, but remained out of view from most visiting tourists. Data were collected using all focal follow of seal behaviour and instantaneous scan for tourist numbers/behaviour at 2-minute intervals. At each interval, the number people present at the pool, tourist behaviour (i.e., talking, throwing objects, using flash photography, touching seals, swimming with seals, and any other notable behaviour) was recorded, as was their location in relation the waterfall pool (i.e., on the path, up the hill where seals sleep, in the waterfall pool). Pup behavioural data (Table 5.1) were recorded as the number of behavioural occurrences displayed by up to 10 pups within each 2-minute interval. For example, if a pup started out floating, then went to the edge of the pool and sat up, leaped through the water, and finally went back to floating within the 2-minute frame, the observer marked each of these four behaviours (floating was counted twice as it occurred as two separate events within the time segment). In this manner, observed behaviours could be analyzed as a percentage of occurrences within a time frame since seal pups frequently changed from one behavioural event to another and moved in and out of the pool area. Due to the active nature of seal pups within the pool a maximum of 10 individual seals were followed for each scan.

Tourist counts

The number of seals along the stream and at the waterfall pool was collected between October 2008 and April 2011. Counts were conducted at least once per day when seals were present tallying the number of seals in the Ohau stream starting from the highway bridge and ending at the waterfall. These counts were conducted by multiple parties including the researcher, A. Acevedo, Department of

Conservation, and the Department of Conservation volunteers. These data were used to compare seal presence with tourist numbers.

The total number of tourists visiting the Ohau waterfall was collected by a counter on the underside of a bridge by the Department of Conservation (DOC) to monitor tourist numbers. The total visitor count was divided by two as each person visiting the waterfall would be counted twice; once upon arrival, and once upon departure. Gaps in total tourist numbers were due to a malfunctioning counter and therefore visitor totals in those months were not included in this study. Tourist counts used to compare with seal behaviour data were of the actual number of people in the viewing platform of the waterfall pool during each 2-minute scan sample.

In order to better quantify the level of disruption potentially caused by tourists, tourist behaviour was recorded during each 2-minute scan interval. In the first week of observations, a pilot study was conducted to identify the range of behaviours of both people and seal. From this, 5 behaviours were observed to be relatively frequent and appeared relevant for assessing changes in pup behaviour due to the presence of people (see Table 5.2 for human behavioural descriptions). All tourist activities were recorded as either having occurred or not. Least disturbance was only recorded if the entire 2-minute segment was incident free, but people were present.

It was likely that tourist behaviours were not mutually exclusive, such as people talking and throwing an object into the pool. This made determining if one specific action played a significant role in modification of pup behaviour difficult. Therefore, categories of human disturbance were created using combinations of behaviours taking into account the number of incidences within one sampling period (i.e., number of flashes, loudness of people talking, etc.). Four disturbance levels were created and are described in Table 5.3 (i.e., none, low, medium and high) based on how they fit in with the pre-described categories. Tourist behaviour was classified at the highest disruption levels they fell into. For example: people that stayed on the viewing platform, talking in a normal voice, and took pictures without a flash would be placed into the medium disruption category because they were talking louder than a whisper.

Data analysis

Behavioral data were transposed to Microsoft Excel spreadsheets, with focal follow tallies of behaviour samples, number of tourists present, tourist behaviour per sampling period, and total seals. These were used to calculate proportions of intervals in which behaviors were observed and mean values per 2-minute interval for all samples. Seal behavioural data were arcsine transformed to reduce heterogeneity of variance (Lehner 1996). All behavioural event data were pooled into one of 5 categories (active, inactive, play, aware, and social) during the analysis phase, which better described the overall type of event (Table 5.1). They were then tested for normality. Means for variables with a normal distribution and homogenous variance were compared by MANOVA, using Tukey tests for post-hoc comparisons As several interacting factors contributed to variation in seal response (i.e., tourism presence and tourist behaviour are not independent of each other), a MANOVA comparison (SPSS) was performed on the proportion of pup behaviours to determine if there were interactions between the presence of people and their behaviour.

Results

Data were collected between August – October 2009 and April – May 2011. Observations were conducted over 45 days, for a total of 93 hours (Table 5.4). In 2009, there was a mean of 3 tourists present during the observations (range from 0 – 36) and 4 tourists in 2011 (range from 0 - 24). The number of seals also varied over the study period: the mean number of seals was 7 (SD = 12.2) in 2009 and 32 (SD = 5.3) in 2011 ranging from 1 to 58 between the two seasons.

Timeline of pups and humans

Tourism numbers peaked in the winter months of June – October. Between 2009 and 2011, the number of people visiting increased (R^2 = 0.13) by more than 1000 per month (Figure 5.4). At least some seal pups were always present in the stream and pool between April and November. Seal pups were absent during the Austral summer (mid-November – March). The mean number of seal pups increased slightly from 2009 through 2011 (R^2 = .009).

Increased behavioural events were always consistent with greater abundance of pups (MANOVA: F_{45} = 5.50, $p < 0.001$). For this reason, all events were analyzed as percentage of occurrence within the 2-minute sequence to correct for group size effects on the activity levels.

Behavioural changes in seal pups due to tourism

The presence of tourists had a significant effect on seal behaviour (MANOVA: F_{45} = 11.5, $p < 0.001$, df = 1). Specifically, inactive (F_{45} = 7.14, p = 0.01) and aware (F_{45} = 41.2, p = 0.001) behaviours increased when people were present (Figure 5.5). Active, social and object play behaviours did not significantly vary between times with and without people ($p > 0.05$).

How human behaviour affects seal behaviour

Seventy-five percent of the time people were present they exhibited actions beyond quietly watching the seals. People were not observed swimming or feeding seals while observations were in progress, however on three separate occasions, visitors reported they had witnessed people swimming in the pool while seals were present. Additionally, on two occasions, chicken legs that had been left in the shallow section of the pool. Figure 5.6 illustrates the mean percentage of the five common tourist actions observed when at the waterfall. Camera flashes were seen most frequently (28%) followed by talking (27%). Touching seal pups and climbing the hill where pups rest was observed less than 2% of time. In total, humans were not present 34% of the time.

The actions of visitors significantly affected how seals reacted (Figure 5.7). There was a significant difference in seal behaviour when people were talking (MANOVA: $F_{45} = 45.8$, $p < 0.001$, df = 6), using flash photography (MANOVA: $F_{45} = 2.5$, $p = 0.001$), throwing objects into the pool (MANOVA: $F_{45} = 11$, $p < 0.001$) and climbing on the adjacent hill (MANOVA: $F_{45} = 5$, $p < 0.001$) as compared to times without these activities. Some of these human actions occurred simultaneously. In those instances, inactive behaviours increased to 75% while active decreased to 17%. Play, social, and aware also dropped to 3%.

Human activities combined with group numbers were used to determine the effect of different levels of disruption (as described in Table 5.3). Upon analysis, the occurrence of the 5 types of seal behaviour was significantly different depending on the type of human disturbance (MANOVA: $F_{45} = 125$, $p < 0.001$, df =

2). The most frequent event observed was inactivity followed by active, social, play, and lastly, aware (Table 5.5). Inactive behaviours were the only ones not to change significantly (MANOVA: $F_{45} = 1.26$, $p = 0.29$) when looking solely at tourist disruption levels. Aware, and play behaviours increased between 2.5% and 3.7% from times with no and high disturbance, whereas active and social events decreased 6.5% and 1.8%, respectively.

Discussion

Timeline of interactions between fur seal pups and humans

Seals at the Ohau waterfall were consistent in their arrival and departure from the waterfall area between 2009 and 2011. They would begin to venture up the stream in April and leave by mid-November. Data collected on the behaviour of the fur seal pups at the Ohau waterfall exhibited behavioural changes when people were present. More specifically, seals became more aware of people when they were talking, moving around, and using their camera.

Since receiving full protection, fur seals have begun to re-colonize historic breeding grounds (Harcourt 2001, Boren 2005, Goldsworthy & Gales 2008). In 1950's – 60's seals were first reported along the eastern coast north of Kaikoura in low numbers (Sorenson 1964). This colony has been growing, an average of 20% per year (Boren et al. 2006). A consequence of this population growth has been the expansion of the colony further along the coastline. According to local residents, Ohau stream has been a popular stopping place for people for a long time and the presence of juvenile seals in the waterfall pool is a relatively recent event (exact time is unknown, but probably within the last 20 years) (Acevedo-Gutierrez et al. 2010b). In the past few years, the waterfall has become a more popular stopping place for people because they want a close encounter with the pups in a unique and intimate environment. Initially, the presence of the seals was not advertised and the growth in popularity of the site was presumably been by word of mouth and social media.

It is pups of the year that can be found in the waterfall, and not the sub adults. The arrival and departure of seals in the Ohau stream and waterfall is centered around the breeding season at the Ohau Point seal colony and the individual animal’s growth (Acevedo-Gutierrez et al. 2010b). Pups are born between the end of November and mid-January. Mothers spend long periods with their pup in the first few weeks, taking only short feeding trips (Crawley & Wilson 1976, Bauszus & Tandy 2002, Boren 2005). As the pups grow and become more mobile, females increase the duration and frequency of foraging trips and decrease their time spent on land nursing (Crawley & Wilson 1976, Boren 2005). When their mothers are away on feeding trips, pups form loosely-knit groups, usually of four or five animals (Crawley & Wilson 1976). As pups grow older they wander more widely from where they were born, and soon extend their activities to the rock pools and channels. During this time, they are prone to behave in an inquisitive manner (Crawley & Wilson 1976). Their inquisitive nature is potentially how they find the stream each year. Once weaned, pups have to find food on their own, and typically leave the colony for a few years (Crawley & Wilson 1976), and thus are not found at the waterfall after this time, and are rarely re-sighted in subsequent years.

The reason why seal pups utilize the Ohau stream and surrounding areas is unknown. Most pups presumably find the stream on their own without the assistance of adults or by following other pups. The presence of adults in the stream or waterfall is rare and it is unlikely they are led to the site by their mothers. In April, the first pups can be seen in the stream close to the colony. It usually takes a few weeks, but eventually they make their way to the waterfall. At first there are only a few individuals in the pool, but by the end of April there are over 40 seals and the seals continue to utilize this location until November.

Though pups are the most frequent age class found at the waterfall, they are not the only ones to utilize this location. A seal pup tagged in the Ohau stream/waterfall area in 2009 was observed playing in the pool in 2011. This sub adult was noted to be more aggressive towards people, lunging at them when they were within 2 m of it on land. Adults have also been seen a few times in the stream, closer to the colony, but never at the waterfall itself. Adults have been seen along the stream, but not in the waterfall itself.

In the first seasons of this study, advertisement regarding the Ohau waterfall and seal pups was primarily word of mouth. In 2009, most tourists had no previous knowledge that seals could be in waterfall. In 2011, this had changed to most people coming to the waterfall because they had seen it on the news and on Campbell Live. Since being covered by the media, tourist levels increased 25%. In 2011, educational signs were posted at this location explaining this phenomenon and advising people to keep their distance. A comprehensive comparison of seal and human behaviour a couple of years pre and post sign would useful to help sustainably mange this site.

Behavioural changes in seal pups due to tourism

Anthropogenic disturbances to wildlife have been documented through short-term behavioural shifts (Constantine 1999, Boren 2001, Bejder & Samuels 2003, Beale & Monaghan 2004, Bejder et al. 2006, Dans et al. 2008). Specifically, since resting is important to any mammal, a reduction in this activity is likely to have negative effects on both physical health (Constantine et al. 2004) and psychological well-being (Anch et al. 1988). Marine mammals, when observed in their natural environments, have been seen to exhibit reductions resting behaviour when people were within close proximity (Boren 2001, Constantine et al. 2004, van Polanen Petel 2005, Markowitz et al. 2009, Tripovich et al. 2012). Adult seals become more aware and active, usually moving away from the tourist (Boren 2001, Boren et al. 2002). When undisturbed in the colony, the most prominent behavioural state of adult seals is resting (Barton et al. 1998, Bauszus & Tandy 2002, Boren 2001) whereas, at the waterfall, the pups were more prone to decrease their activity levels and increase their aware behaviours waterfall pool. Therefore, in contrast to the behavior of adults, disruption of pups was most likely shown by their increased inactivity behaviours and vigilance.

At the waterfall, periods of inactivity increased when there were people, as compared to no visitors. Pup inactivity and vigilance events increased significantly when there were higher levels of human disturbance (Table 5.5). This may be better interpreted as "wary" given they were active in the absence of disturbance. This switching from active to inactive when in the presence of people, and more importantly when there were higher disturbance levels, was best interpreted as disruption of play (presuming most active behaviour exhibited was a form of general play) rather than promotion of rest. The occurrences of seal inactivity was the highest when groups of tourists were exhibiting multiple disturbing behaviours, such as talking, flashing a camera, touching the seals, and climbing the hill. The waterfall area is, for all intents and purposes, a dead-end for both seals and people as the only exit is via the same route to the site. It is also an intimate area with one route for the seals to retreat back to the colony, which is parallel to the walking track. Therefore, if seals wanted to retreat from the tourists, but felt the path was too close, then they may have stayed in the pool (where people were not) and waited for the tourists to leave, thus floating and watching the tourists, which would explain the increase in inactive behaviour. However, the effects of more than 2 of these disruptions happening simultaneously should be studied further.

The percentage of playing with an object increased when human disturbance increased, potentially a result of people throwing objects into the pool, about which the seal pups are curious and engaged with the object. Figure 5.7 shows playing with an object to be the most prevalent when tourist were throwing objects into the pool. However, play is a term that is used without knowing its effects on the animal as what appears to be "playing" could actually be a sign of something else (such as stress). Unfortunately this was not something that could be examined fully by this study.

Tourist activities

Only a quarter of tourists quietly watched the seals. At the waterfall, the most common activities of tourists were talking and taking photos. Many questions regarding the negative effects of eco-tourism are being asked for conservation reasons (Fennell 2007). Some benign activities such as conversations and taking photos have been shown to alter animal behaviour (Huang et al. 2011). For instance, the hoatzin (*Opisthocomus hoazin*) showed an increased state of agitation when people were talking near it (Karp & Root 2009).

Animal behaviour can alter when cameras are used within close proximity. Huang et al. (2011) found that display rates of the West Indian anole (*Anolis cristatellus)* were altered when cameras were used, with shutter noises as well as the flash increasing disturbance. Nesting sea turtles (family Cheloniidae) are disturbed (limiting laying time and increasing agitation behaviours) by gatherings of people, specifically when they were carrying flashlights or flashing cameras in close proximity to the turtle (Waayers et al. 2006). Many ecotourism areas encourage photography, using the common phrase “take only pictures, leave only foot prints”. Photographs encourage people to preserve the environment, but give the false illusion that pictures are harmless to the animals being viewed (Huang et al. 2011). There is a common trend among tourists to seek the perfect photo and presume that because they are shooting cameras rather than guns that the activity is harmless. This misconception leads people to directly approach the focal animals within touching distance and cross barriers all to try to get that perfect photograph. Such activities have caused reductions in, or abandoning of, foraging activities of water birds adjacent to wildlife observation trails (Klein 1993).

Why is the waterfall a good location for seals?

The Ohau waterfall is shaded, cool, and a predator-free place for pups to occupy and play while their mothers are away feeding. The ability to engage socially with other pups is beneficial for enhancing agility, muscle growth, and life skills (Bender 2012), including fighting, fleeing, biting, and predation (Barber 1991). This study used the term play when describing the seal engaging in an inanimate object such as a rock, stick, leaf, or ball. However “play” has a more robust and deeper connotation towards development, that is quite common among many animals (Byers & Bekoff 1998), and becomes more complex with age (Bender 2012). It can be purposeless (Bender 2012); however it often has many benefits which do not manifest until later in life. For example, while engaged in “play”, juvenile and adult animals exercise more bodily movements and spend more time with objects while socially engaging another (Bender 2012). This can increase agility and help in the development of social partnerships that become important for survival. Play has been seen in many mammal species like dogs playing tug of war (Fagen 1981), birds diving at objects (Diamond & Bond 2004), humans with toys, dolphins with sea weed (Herzing 2005, Bender 2012), pinnipeds engaging in mock battles (Crawley & Wilson 1976), and primates chasing each other (Matsuzawa 1997, Ramsey & McGrew 2005, Bjorklund & Gardiner 2011).

Disruption of play in early life stages, similar to that of the pups in the Ohau Waterfall can have long lasting effects on the seal's survival. Theoretically, play is an innate behaviour where life skills, social engagement, and active practices are developed and fine-tuned. Interruption of play could have more biological implications in the long run. For instance, if these life skills are not created and practiced, the animal will not be adequately prepared for survival after weaning. In this case, they will have to expend more energy later on in life to lean and adapt survival skills they would have developed as a pup.

Short and long-term consequences

When people were around, there were clear short-term effects on the pups that included shifts in behavioural occurrences. More specifically, there were increased inactive and aware behaviours and a decrease in active behaviours. This could be interpreted as a shift from active to vigilance. Exposure to tourists during this growth period, at a location without adult seals, could be aiding in the desensitisation of seal pups towards humans, which may carry on into adulthood and be passed on to their progeny, as has been recorded in Atlantic spotted dolphins (*Stenella frontalis*) (Bender 2012). Desensitisation may sound great from a tourism standpoint. A habituated seal would be easier to approach and give a more satisfying encounter; however increased tolerance towards humans proves not always to be beneficial to either group (Boren 2001, Bejder et al. 2006, Bejder et al.

2009). For example, grizzly bears (*Ursus arctos horribilis)* and polar bears (*Ursus maritimus*) looking for food may wander into towns and become habituated to humans. Some can be relocated to remote areas or zoos, but others that become aggressive are shot to protect the town's people (Herrero & Fleck 1990). Seals already have a negative reputation among the fishermen and local communities. Having a close interaction with a pup might improve overall perceptions about seals and is therefore beneficial for conservation. If not managed well, these tourist-seal interactions could actually become a negative encounter where seals that were impacted by tourist early in life are very aggressive as adults. This could be one explanation as to why the juvenile seen at the waterfall was more aggressive towards the tourist than the pups. The more protection we can offer these pups, the better off both parties will be in the future.

Given the current (and increasing) high levels of tourism, in such a close proximity, the question remains as to what the longer term effect will be if actions are not taken to limit human disturbance to the seals. Bender (2012) noticed most learning of new born calves was from mother to calf in the Atlantic spotted dolphins. Once the calves became older and formed juvenile play groups, the learning was more horizontal being transferred from one juvenile to the next (Herzing 2005). This type of information transfer works well for human children in play and therapy groups (Harper et al. 2008). Hypothetically, without the direct influence of the adult seals, pups that are more habituated to tourists could teach each other the same habits, which could lead to desensitisation to human disturbance. Markowitz et al. (1998) found that relatively brief early experience with humans during sensitive periods in development can have profound and lasting effects on animal temperament well into their adulthood. For example, lambs in contact with humans during the first three days of life establish strong affinity towards the human (Markowitz et al. 1998).

Conclusion

The Ohau waterfall/stream has great potential for the New Zealand fur seal. It provides a protected, temperate space, with adequate water flow. It also allows these pups to create play groups in which social learning can manifest and important life skills will be harnessed. However, this study provided evidence that fur seal pups at the Ohau waterfall, when in the direct influence of human disturbance will alter their behaviour, shifting from active (when people are not around) to more inactive and aware (with increased disturbance). If no further management is implemented, then the potential for long-term negative effects on the fur seals increases as does their possible habitation to humans.

Each year, the visiting pups are newborns from the rookery, and thus have no previous experience with tourists in close proximity. They are potentially susceptible to anthropogenic pressures, and therefore the increased pup number over time is likely indicative only that the rookery is growing in population, not that human impact is unimportant. For that reason, the Marine Mammals Protection Regulations (1992) should be adhered to and proper measures taken to create a safe environment for the New Zealand fur seal pups. This could involve limits to the times and number of people visiting the waterfall to no more than 8-10 in the middle portions of the day. Barriers could also be put in place along the trail discouraging from approaching the seals too closely. The viewing platform itself could be elevated and fully fenced, making it more difficult for people to climb into the pool or stream and completely separating people from the wildlife. Lastly, banning flash photography and throwing of objects into the pool should be enforced. The current recommendation is to remain a minimum of 20 m from any fur seal on land. This rule is not applicable at this location due to the intimate viewing areas; therefore additional measures need to be considered to encourage people to be better environmental stewards when in close proximity to fur seals. Having a more official presence would help to limiting the number of people, enforce no flash photography, and educate the public (Acevedo-Gutierrez et al. 2010b). These changes can help ensure a safe encounter for the fur seals along with a good tourist attraction for the people.

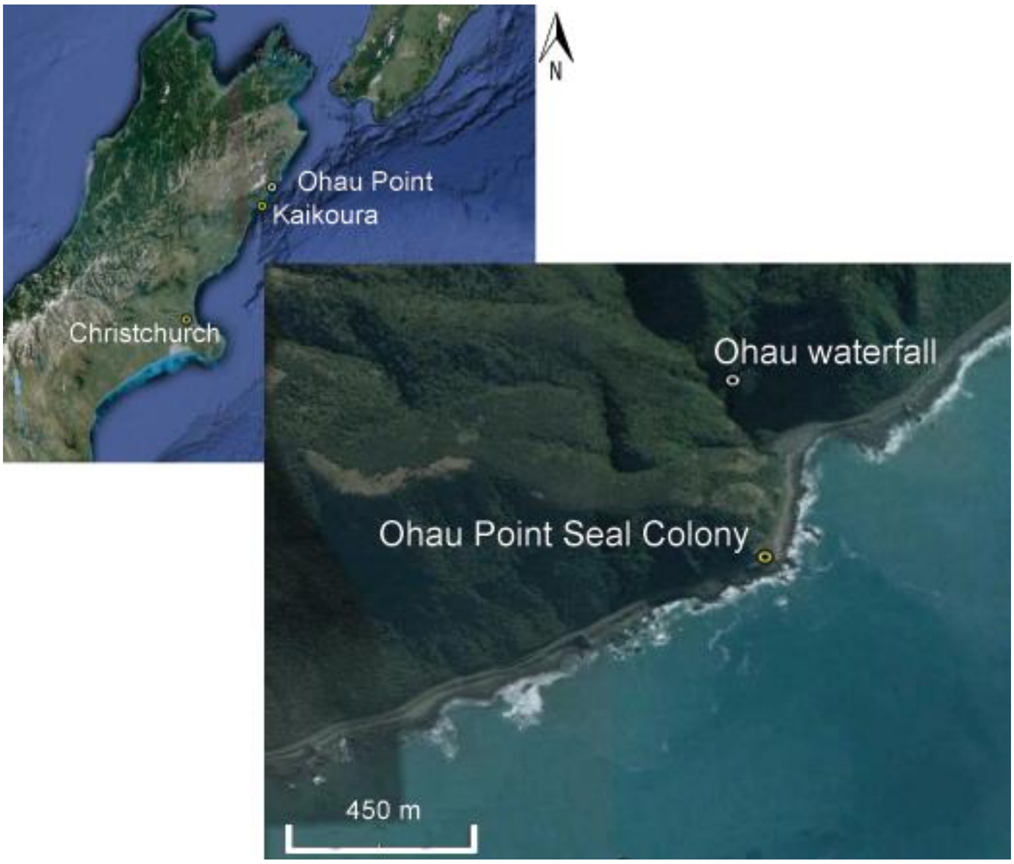

Figure 5.1. Aerial photograph showing the location of the Ohau waterfall and Ohau Point seal colony.

Figure 5.2. Ohau stream waterfall pool with seal pups. Note: The view is from a rock on the south side of the pool. The waterfall is located on the far left of the pool and the stream outlet and walkway are on the right, just out of view.

Figure 5.3. Tourists at Ohau Point waterfall attempting to get a seal pup to come closer. Note they are 1 m from the pup.

Table 5.1 Ethogram of seal pup behaviours.

Categories	Behaviour	Description
Active	Leap	Jumping out of the water with a noiseless re-entry
	Noisy leap	Jumping out of the water and twisting body so there is a very large splash upon re-entry
	Speed burst	A quick and forceful movement of the fins to increase forward swimming motion.
Inactive	Float	Positively buoyant on surface of the water without any additional movements.
	Spin	Floating on the surface while turning 360° from left to right
	Sit	Thorax, neck and head elevated by extension of pectoral flippers without ambulatory movement.
	Sleep	Seal in a supine position and exhibiting little movement on the edge of the pool with eyes closed
Social	Bite	Seal biting another while in pool.
	Bark	Vocalization of one seal towards another
	Contact	Two seals embracing in the water
Play	Play with Object	Seal is engaged with an object such as a leaf, stone, ball, stick, etc., such behaviour includes carrying object, throwing it, chewing, and swimming with it.
	Flippers up	Butt up out of the water and the seal's focus is typically on an object underwater
Aware	Head up	Head up out of the water looking at people or towards the trail.

Table 5.2. Definition of categories of human behaviours most commonly observed when pups were in the Ohau waterfall.

Human behaviour	Description
None	No people at the waterfall observation area
Least disturbance	Times when tourists were observing seals quietly with very little movement around the area. These people did not use a flash with their camera, did not throw objects into the pool, and did not attempt to touch seals. On the rare occasion, a pup would come up to people and sniff them. If these person allowed that to happen without making any sudden movements, noise, or exciting gestures, then it was recorded as no disturbance.
People talking	Talking from people that I could hear from my observation position. This was any talking above a whisper where the observer could hear words above the roar of the waterfall. Yelling and screaming were noted during each incident and are included in the human disturbance section.
Camera flash	Using the flash of a camera when taking a photograph.
Throw objects	Persons taking an object such as a stick, ball, or rock and throwing it into the pool when pups were present. Typically seen when people were trying to get the pup's attention or to get them to “play” with the object.
Touch seal	Tourist instigated touching of a seal pup. This event was only recorded if it was initiated by the person and not the seal. However, if the seal touched the person first and the person reached down to touch the seal, it was considered touching a seal.
Climb the hill	Persons walking off the viewing platform and climbing up the hill across the stream. Seal pups were often seen sleeping up this hill when not in the waterfall pool. If a person climbed this hill, there was high potential to scare the pups and create a chaotic rush down the hill towards the waterfall pool.

Table 5.3. Criteria for disruption level categories used to assess the behaviour of tourists visiting a fur seal pup play area at Ohau Stream.

Disruption level	Tourist presence (yes/no)	Talking	Camera flash	Observation type
None	No	None	none	No one present
Low	Yes	Quiet/ whisper	none	Quietly observing, slow movements around viewing area, inaudible conversations
Medium	Yes	Moderate level	< 5	Talking in a normal audible* voice and moving around only on observation platform
High	Yes	Very loud, yelling	> 5	Making large movements around entire waterfall area including in the stream, up the hill, throwing objects into pool, and/ being very loud (including screaming, yelling, crying, etc.)

*Audible noise defined as talking that the observer could clearly hear and make out from observation post 15 m from the visitor platform.

Table 5.4. Observational data from two study seasons at the Ohau waterfall from 2009 and 2011. Table depicts the total number days, hours, actual observations, mean persons, and mean seals from the two seasons.

	2009	**2011**
Dates	7 August – 31 October	14 April – 12 May
# Days	30	15
# Hours	52	41
# Observations	836	705
Mean persons	3	4
(min-max)	(0 - 36)	(0 - 24)
Mean seals	7	32
(min - max)	(1 - 36)	(13 - 58)

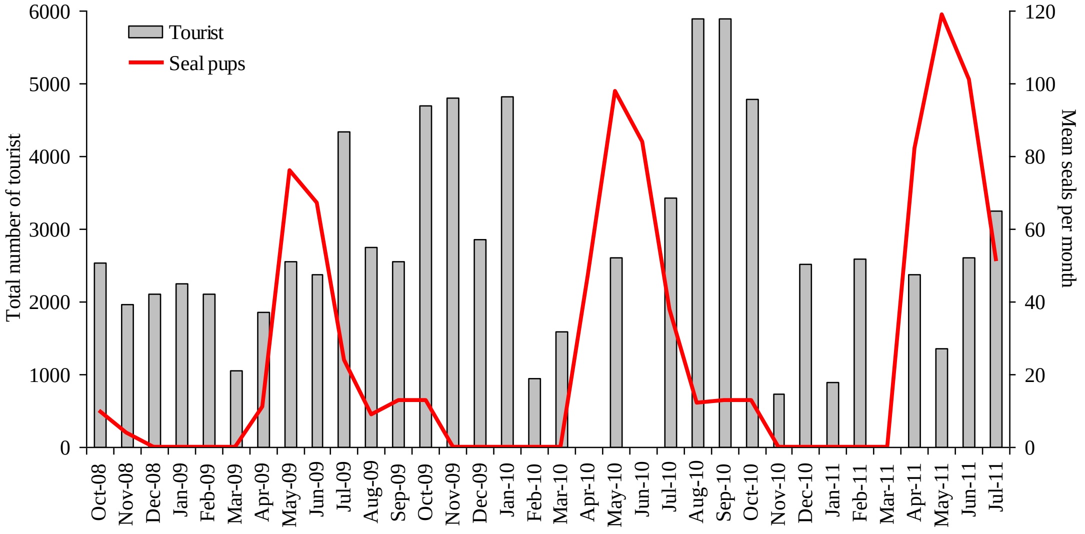

Figure 5.4. Actual numbers of tourists compared to the mean number of pups observed each month along the Ohau Point stream from October 2008 through August 2011. Pup counts were conducted from the mouth of the stream up to the waterfall pool. Note tourist traffic was collected year round and gaps in tourism data were due to a malfunctioning counter.

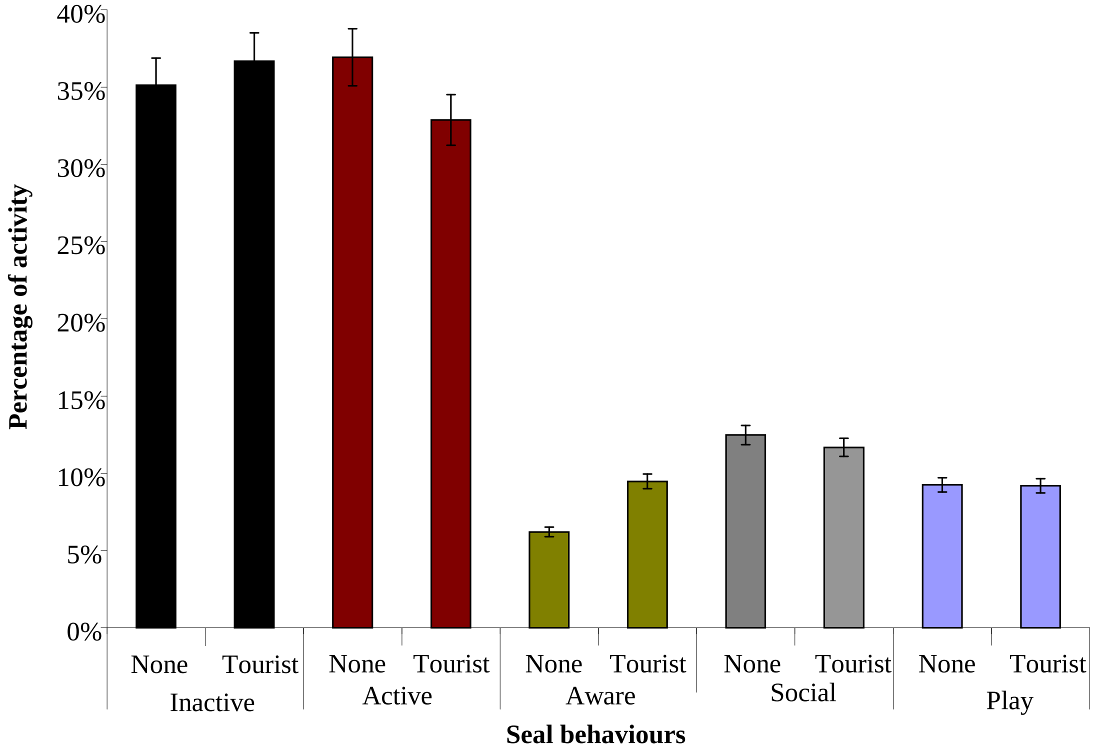

Figure 5.5. A comparison of mean frequency of each behavior exhibited by fur seal pups at times with and without tourists present. Note that “play” indicates animal was engaged with an inanimate object (n = 1365 observational segments, se: 95% ci).

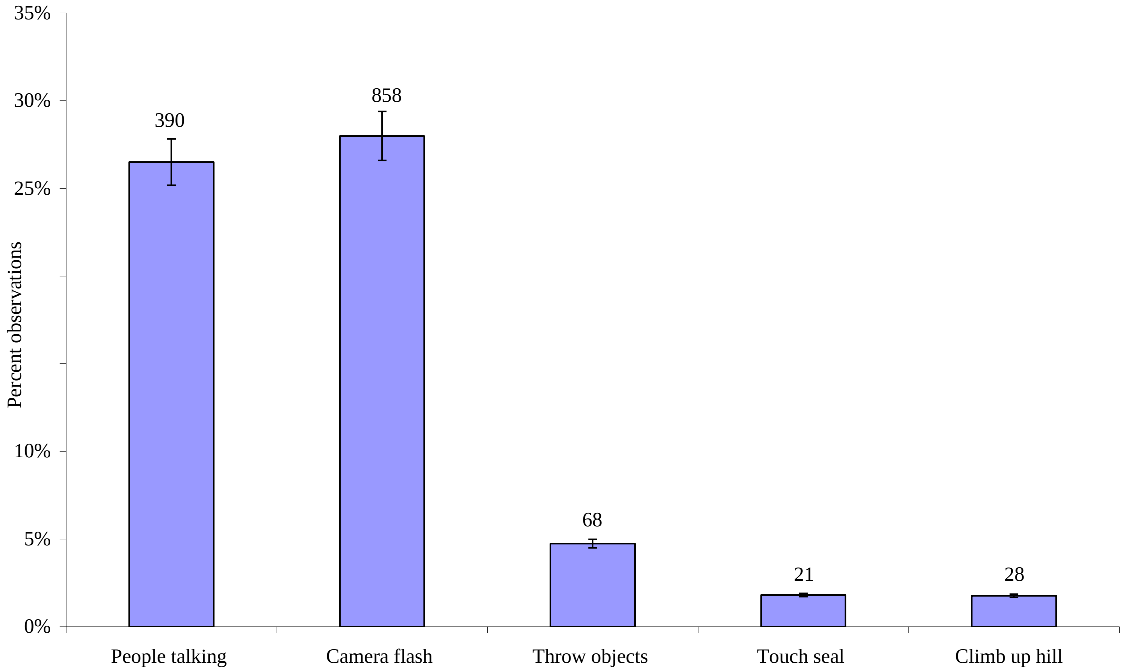

Figure 5.6. Mean frequency of human behaviours observed per hour at the waterfall. The number above each bar is the actual count of time each behavior was observed (n = 1365 observational segments, se: 95% ci).

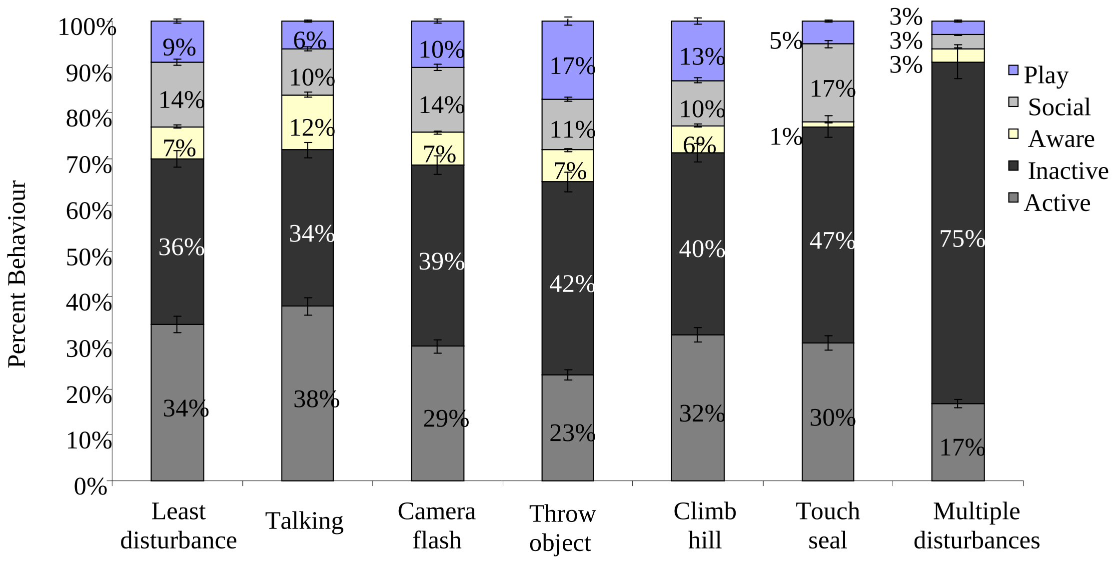

Figure 5.7. Percentage of behavioural occurrences of fur seal pups at Ohau waterfall when compared to different types of human behaviours (n = 1365 observations, se: 95% ci).

Table 5.5. Statistical comparison using a MANOVA (SPSS) of behavioural events compared to the level of human disturbance.

	Behaviours				
Disturbance	Active	Inactive	Aware	Social	Play with object
None	36.9%	35.1%	6.2%	12.6%	9.2%
Low	32.0%	36.7%	8.5%	13.0%	9.3%
Medium	31.3%	37.2%	9.2%	12.2%	10.1%
High	30.5%	37.6%	9.9%	10.7%	11.3%
SE	0.5	0.4	0.2	0.3	0.3
F value	4.6	1.3	3.8	13.3	3.9
P value	0.001*	0.3	0.004*	<0.001*	0.004*

*indicates $p < 0.05$, N = 45 days

CHAPTER 6

Conclusions

In this dissertation I investigated how tourism is affecting the behaviour of the New Zealand fur seal. To have a better understanding of the situation facing the mainland population of this species, I monitored breeding colonies around the South Island of New Zealand which are being subjected to a variety of differing types of tourism, observed operations on board tourist vessels, conducted controlled approaches from a boat, and observed a popular tourist location which was not subjected to any form of tourism management.

Chapter 2 showed that seals exhibit variability in behavioural responses between colonies subjected to varying types and degrees of tourism influence. This study was conducted to obtain more current base-line behaviour data to aid in determining the overall effect tourism is having on fur seal behaviour. The data were as expected, at the highly tourist sites (Ohau Point and Tonga Island). When tourism was within 50 m, seals were resting more indicating a level of habituation towards tourism. This was similar to findings of Taylor et al. (1995), Barton et al. (1998), and Boren (2002). The two additional study sites had no previous records of behavioural data; however, seals at Damons Bay did not exhibit the expected behavioural reactions. In fact, there were no observable changes in overall colony behaviour during times with boats and without. At Cape Foulwind, the control site, seal reactions towards people were as expected for a colony with low disturbance levels. Here, seals were exhibiting decreases in resting behaviours when tourist were within 50 m, which leads to the assumption they are not habituated and this colony can be used as a good baseline for comparing exposed and non-exposed colonies. This supports the view that tourism not in the direct line of sight of seals and conducted at a more distant location from the rookeries, has less impact on seal behaviour. There were significant differences between the four colonies reactions, potentially attributed to the type, nature of each encounter, extent, and repetitious nature of the specific approach type. For instance, seal-human interactions were both conducted via motor boat at Tonga Island and Damons Bay; however resulting behavioural responses were significantly different. It is theorized that, even though Damons Bay has not been a tourism location for as long as Tonga Island, these seals may be desensitised towards approaching vessels. Here, tours are conducted by the same boats throughout the year, not just seasonally, and routinely. This continual, low-level tourism may have affected the Damons Bay rookery more significantly than a colony with high levels of tourism.

In the next two chapters I studied seal responses to tour vessels from on board the boat (**chapter 3**) and documented what happens on the vessels including duration of viewing, distance to the shore, locations visited, and any other influences that might affect seal behaviour. Due to the opportunistic nature of data collection in Chapter 3, I wanted to determine how seals react towards vessels in a more controlled way. Therefore, I conducted controlled experimental approaches in a way to calculate distance effect on seal behaviour and compare this to past literature (Baton et al. 1998, Bauszus and Tandy 2002, Boren 2002) (**chapter 4)**. Here, a control and an exposed colony were approached at three specific distances based on the current regulations of viewing fur seals (20 m), permitted viewing distance of cetaceans (Constantine et al. 2004), and a distance where fur seals were not thought to react towards the vessel (control, 100 m). Additionally, since tour vessels were giving tour commentary using an external speaker which could be heard from anywhere on the boat and in the colonies themselves, I incorporated this "noise" into the 20 m approach to see how much of a difference there was between quiet and loud vessels approaches. I found that overall, the farther away the vessels were, the less seals reacted. Seal reacted more significantly to vessels, independent of location, when they approached within 30 m or closer. Commentary during a tour also had a significant effect on the percentage of seal reactions, which overrode the effects of vessel distance. In Chapter 3, I discovered tour boats were alternating visitations between colonies and haul-outs and the responses were variable and highly dependent upon additional factors such as how the area was utilized (breeding colony or haul-out) and distance of the vessel. These reactions were exaggerated further when there was commentary during a tour. Seal responses towards tour boat approaches were similar towards experimental controlled approaches (Chapter 4). The differences of reactions were noticeable between the control (no tourism) colony and the exposed breeding colony. Damons Bay (exposed site) seals tended to demonstrate the flight reaction more than those at Island Bay (control site); however, seals were more alert at the control site. Approaches following the current minimum approach distance still caused some animals to modify their behaviour, similar to findings of Boren et al. (2002). Given there were more behavioural responses from greater vessel distances, the current permitted viewing distance is too close. From the data (Chapter 3), a minimum approach distance of 30 m is recommended for motor boats; findings similar to Boren et al. (2002).The use of commentary was a greater factor in behavioural changes than distance, and therefore it is recommended this aspect be removed from each seal visitations.

Finally, I observed seal-tourist interactions from an alternative perspective by monitoring pups (< 1 year) at an inland waterfall that was previously only visited by people (**chapter 5**). This is a unique site because pups venture away from their breeding colony following a stream that terminates in a pool, fed by a waterfall. The trail was built when only people were visiting the waterfall, and therefore there is no boundary between the viewing platform and the pool/stream. Here, pups are without the direct influence of other, older seals, and therefore are left to their own when in direct influence of people. The impact from such intimate human-seal interactions may have long-term effects that are more significant on the pups when they are adults than those effects seen when tourism is geared toward a colony. I found that pups altered their behaviour when people were present, and depending on what those people were doing. Their behavioural shifts were opposite to that seen in the colony as the percentage of inactive pups increased as well as the percentage of aware events when there were more human-seal interactions. The only time inactive events decreased was when people were talking.

The scope of my thesis was to explore how tourism is affecting the behaviour of the New Zealand fur seal from a conservation prospective. In other words, are the current measures in place adequate enough or should there be modifications to specific tourist locations and regulations? The following section is geared toward the conservation applications of the results presented in the previous chapters.

Biological relevance

On average, fur seals spend 75% of their time on land resting (Cawthorn et al. 1985). A portion of this is used for nursing, mating, and breeding, however, most of their time is allocated to restore energy reserves spent on foraging trips (Boren 2005). This is very important to the survival of the fur seals. The remaining 25% of their life is spent in the water (mean 20 °C in summer and 13 °C in winter). Energy reserves, in the form of fat stores, are important in thermoregulation and foraging trips (Mattlin 1978 a). Reduction in energy or percentage of body fat may be detrimental to the individual animal as they will not be able to maintain their core body temperature or swim as far/long to feeding grounds. This, in turn, could lead to reduced body weight and malnutrition (Mattlin 1978a). For breeding females, reduced energy stores decreased the amount and potentially the quality of milk production for the pup, and could lead to increased pup mortality (either by malnutrition or abandonment) (Mattlin 1978b).

The effects of tourism, here, were measured in fur seal behavioural changes; primarily, changes in behavioural states from resting to active. It was found that tourism is eliciting seal reactions at most locations observed. Tonga Island and Ohau Point were the two colonies with the highest level of tourism, and potential habituation due to their increased resting levels when tourists were present. As this is not necessarily a negative impact, it is a modification of colony behaviour. Resting states decreased at locations not commonly exposed to tourism, therefore, it is recommended to keep tourism to the already effected sites minimizing anthropogenic impacts to non-exposed haul-outs and breeding colonies. As stress may not always be evident by behavioural shifts (i.e., internal biological changes such as increased adrenalin and heart rate cannot be seen by the observer) additional work should be conducted to determine biomass differences from colonies utilized by tourism and not.

The New Zealand fur seal was once on the brink of extinction. Their population has increased since 1978, and their population only about 10% of their historical levels pre-hunting. They were not even a focal animal for tourism until the 1990's (Boren 2001) and have since become a highly sought after attraction. Breeding females will give birth once a year, allowing for the high growth rate since their full protection in 1978 under the Marine Mammals Protection Act

(Goldsworthy and Gales 2008). Fur seals are considered cute, furry, marine mammals that are easily viewable by tourists. Alternately, they are viewed as pests by fishermen and farmers because they think they eat all the fish and interfere with gear and livestock (Boren 2001). It is important for the continued preservation of the fur seals that the negative image of seals by the fishing and aquaculture industry be shifted into a positive one. Tourism can be a bridge to allowing this change in perception. Small towns and villages can benefit from a positive tourist experience. In addition to viewing the seals, or other marine mammals, tourist need to eat, sleep, and other businesses benefit from the increased tourists presence. In turn, this creates a demand for food, including fish, which benefit the fishing industry. Removing the initial draw (marine mammal) will decrease the demand for food hurting the fishing industry. There are roughly four times more tourist in New Zealand than residents (Ministry of Business Innovation and Employment 2012), with the potential to make or break an economy driven by consumer demand.

Conservation of the New Zealand fur seal in regards to tourism

This study provides evidence that tourism does elicit behavioural changes in the New Zealand fur seal. From the results presented, there are four main issues when approaching tourism of marine mammals from a conservation prospective. The first is to *know where the human-seal interactions are taking place*. Then, efforts towards education of people in the area about potential interactions with wildlife management of tourism ventures, and application of mitigation tools will not be wasted on locations of little importance to the focal animals. Secondly, the *type of tourism* is important when considering proper management and conservation of fur seals. Thirdly, a few minor *modification to current boat tourism regimes*, such as increasing viewing distance and not using speakers for commentary when viewing the seals, would greatly reduce the amount of seals reacting towards vessels. Finally, the *proper management of areas* that are clearly being used by the seals during an important time in their growth and development will curb some, if not most, long-term negative effects that could carry on through adulthood.

The importance of location, tourism management, education, and visible barriers

The habituation or tolerance level to tourism of seals at a colony or haul-out is reflected by its behaviour. Similar to other studies, seals interacting regularly with tourist modify their behaviour (Boren 2001, Bauszus & Tandy 2002). On Banks Peninsula, potential effects of tourism on the seal population were likely localised to colonies within close proximity to the Akaroa Harbour heads. There were differences in behavioural reactions and states between areas with high visitation rates and low. However, based on specific reactions to the vessels (Chapters 3 and 4) seals were more alert at the control site (Island Bay), and those close to the harbour entrance responded less. Similar patterns were seen at other colonies around the South Island (Chapter 2). At the Cape Foulwind rookery, which acted as a control site, seals were more active than seals that were other sites, such as Ohau Point when tourists were present. These differences in reactions, specifically the seals not reacting when people were in close proximity, support the view that seals at these highly trafficked colonies may be habituated to the tourism pressures (Barton et al. 1998, Boren 2002). Boren et al. (2002) noted some habituation to controlled approached towards seals at Tonga Island might have been directly related to the amount of previous tourism exposure. Areas with high levels of tourism responded less, with less dramatic reactions, and responded at closer distances. My findings support this where seals were observed reacting less frequently with less dramatic responses at high tourist sites (Ohau Point and Tonga

Island). However, the difference in Tonga Island to Damons Bay is that the latter experiences low levels of continuous, year round tourism (not just seasonally), and this may be resulting in a degree of desensitisation.

Habituation of any wildlife means there has been a modification of the behavioural reactions to the stimulus (Bejder et al. 2006, Bejder et al. 2009). Habituation can reduce the stress of the animals, allowing it to conserve energy by not responding to a non-threatening stimulus (Groves & Thompson 1970); however, habituation of an animal towards humans may be more costly to the population in the long run causing fur seals to become too trusting towards humans (Edington & Edington 1986). This has been documented in a number of studies where new and unnatural behaviours have been observe, such as, begging in bottlenose dolphins (*Tursiops truncates*) (Connor & Smolker 1985).

A recommendation from my research is to consider the potential consequences if tourism towards seals, and marine mammals in general, is to grow and not have detrimental impacts. Part of the solution is to manage tourist visitations appropriately, based on time of visit, number of vessels/people per visit, and the number and identity of locations utilized. Based on observations of Weddell seals (*Leptonychotes weddellii*), staggering visits to haul-outs/colonies was recommended so that some areas were not overwhelmed with tourists (van Polanen Petel 2005). This would be more beneficial at Tonga Island to reduce the continual vessel presence and alleviate pressures that could cause site abandonment. Another recommendation is to have breaks in the season so there is not a continuous audience of tourists at one site (such as Damons Bay and Ohau Point). Without these limits, desensitisation of the seals towards people may develop, as was seen in Weddell seals (van Polanen Petel 2005) and dolphin pods in Bay of Islands, New

Zealand (Constantine et al. 2004) and might lead to more aggressive reactions towards humans, as noted in the juvenile seal at Ohau Waterfall.

Management of foot traffic near marine mammals is essential for proper wildlife conservation in areas of high visitation. Effective barriers have been shown to reduce human-animal interactions by 60% and reduce behavioural responses indicative of stress (fight or flight responses; Cassini 2001). Fences are also effective methods of crowd control (Cassini 2001). The best example of tourism management where there is high-intensity use within a limited area was seen at Cape Foulwind. Here, it appears that conservation of both the land and the wildlife was a key point when developing the management plan. To keep the public from wandering over the hillside and into the seal colony, a paved path with barriers was constructed, with educational signs, and several viewing points. This is something that the Ohau Point colony on the north end does not have but could benefit from. Both the north end of Ohau Point and the adjacent waterfall are key tourist attractions with little to no guidance for the public regarding where to walk, and how to behave when in close proximity to the seals. The south side of Ohau Point has a viewing point which is mostly effective in keeping the public out of the colony, though that observation point is not visible from the north end car park, and most visitors to the north end are unaware that there is an observation point. They, therefore, try to get a better view of the seals by walking into Ohau Point. When this project was initiated there were neither informational signs nor barriers at the waterfall. As a positive step forward, in the past year, educational signs have been posted to help reduce unwanted human-seal interaction; however, there is still no barrier to discourage people from harassing the animals.

Type of tourism is important

The type of tourism is important when trying to mitigate negative pressures on wildlife. Vessels and foot traffic affected the behaviour of seals on land. As seen from my study, seals spent more than 70% of their day resting. When one boat was present there was a notable increase in activity levels and a decrease in social behaviours, though the behaviour of seals returned to their previous behavioural states within 30-minutes (as seen in Chapter 4). Kayaks at Tonga Island elicited the greatest flight or fight reactions from resting seals, though motor boats were the most common type of vehicle for tourist approaches altogether. Kayaks are a quiet, small boat that can have a "predator like" appearance to a seal (Gunvalson 2011) which is potentially why seals reacted more to the kayak than a motor boat. Kayaks can get closer to seals before they are noticed by the animals, another potentially threatening aspect to seals. Motor boats, the most common form of vessel used when approaching marine mammals, tended to stay a shorter duration than kayaks, though engine noise can cause short-term behavioural changes (Tripovich et al. 2012). Engine noise was not factored into this research, though, from personal observations, it appeared that boats travelling along the coast line at a moderate pace did not receive a reaction from the seals until the engine stopped. Similar results have been observed in polar bears (*Ursus maritimus*) where the bears would not react to a moving snowmobile until they stopped and shut off the engine (Andersen & Aars 2008). It is thought that a passing vehicle was not perceived as a threat by the animal, and they have learned that potential danger (i.e., a hunter) is more likely to come from one that stops (Andersen & Aars 2008).

Specific alterations to current tourism regime

The third issue identified in my research was distance and sound during tour sessions are important components when considering effects on animal behaviour. All seals reacted more to vessels (i.e., were more alert or directly responded) when they were at a distance of 30 m, as compared to 50 m or 100 m. When sound was factored into the boat approaches (Chapter 3 and 4), seal reactions increased with greater vessel distances as well as the percentage of direct responses (fight or flight reaction). The distance of people in relation to wildlife has been shown to directly relate to the type of reaction from the focal animal (Burger & Gochfeld 1993). For instance, the site abandonment of nesting masked (*Sula dactylagra*), red-footed (*S. Sula*), and blue-footed (*S. nebouxii*) boobies (i.e., whether walking, flying, or remaining on their nest) was directly dependent upon the distance the people were from the birds (Burger & Gochfeld 1993).

Overall, tourist commentary was identified as the biggest factor in eliciting seal reactions, between every distance. In general, pinnipeds are less aware of a quiet boat than one running commentary during the tour (Bauszus & Tandy 2002, Orsini 2004). They also rested more when vessels were either not present or remained at a further distance. A seal's response to noise from the boat meant they altered their previous behaviour which could cause them to expend more energy while tour vessels are present. The primary purpose for going ashore is to rest, therefore modification to the resting state can lead to losses in fat stores (Boren 2002), decreased maternal events (Boren 2005), and increased foraging trips to maintain energy levels (Bejder et al 2006). Based on the high percentage of reactions, which could in turn lead to long-term behavioural shifts, as has been observed in cetacean during boat tours (Constantine et al. 2004), it is recommended that a running commentary not be used with external speakers during tour sessions. The mean viewing time was 7-minutes and any relevant information regarding the fur seals can be given prior to arrival at the colony, or upon departure. The presented results are supported by recommendations from Boren et al. (2002) and it is recommended to extend the permitted viewing distance for tourist vessels to 30 m to decrease the anthropogenic pressure on these seal colonies, and thus presumably decrease stress levels.

Proper management of important locations

Finally, “play” is an important part of development in most young mammals (Byers & Bekoff 1998) and becomes more complex with age (Bender 2012). Some of the physical benefits from play include muscle strength, endurance, agility, and social engagement, all of which are important later for survival (Bender 2012). Play is also practice for real world situations such as predator escape, holding territories (Crawley & Wilson 1976), fighting (Crawley & Wilson 1976), and acquisition of food (Diamond & Bond 2004). Without the ability to play, a young animal are less prepared in the world once they set out on their own. It is therefore important from a conservation prospective to protect areas utilized by the young of any species and allow them to grow and play in a normal environment without limited anthropogenic pressures.

The Ohau waterfall/stream provides New Zealand fur seal pups with a protected space and to be active and play in groups in which social learning can develop important life skills, such as predator avoidance. My study provided evidence that fur seal pups, when in the direct influence of human disturbance, will alter their behaviour and shift from active when people are not present to more inactive and vigilant when people are present. If no further management is implemented, then the potential for long-term negative effects on the fur seals increases as does their eventual habitation to humans since the pups have no previous experience with tourist in close proximity.

Conservation measures should be taken. The Marine Mammals Protection Regulations (1992) should be adhered to and proper measures taken to create a safe environment for the New Zealand fur seal pups. It is my recommendation based on this research that tourism be managed at the waterfall by erecting appropriate barriers and limiting the amount of people visiting per day to minimize negative impacts on the fur seal pups. To date, some measures have been taken to improve the tourism management at the waterfall, including, natural looking barrier (i.e. large boulders) to separate the viewing platform from the waterfall pool, volunteers during high tourist periods, and increased educational signage relaying specific information on the fur seal pups.

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ACKNOWLEDGEMENTS

First and foremost, this thesis is dedicated to my mom and my dad. They never let me give up.

Secondly, this project would not have been possible without the help, blood, sweat, tears, and support of many people. Specific thanks my supporters, editors, and information lenders: Dr. Jim Briskie, Dr. Tim Markowitz, Dr. Laura Boren, Dr. Dave Lundquist, Derek Cox, Laura Allum, Dr. Alejandro Acevedo-Gutierrez, the University of Canterbury, and the Department of Conservation.

I would also like to thank everyone who helped me with gear, boats, and housing: Jack van Berkel, Renny Bishop, and Dr. Bernd Wursig.

And lastly, all of the many volunteers that gave their free time, brain, and muscle power: Rachel Freeman, Emma Ball, Louise Taylor, Dougie Taylor, Dave Taylor, Alicia Ferrer Costa, Kerry Fraud, Sandra Nussbaum, Lacy Madsen, Skye McPherson, Camilla Lienart, Andrew Hopley, and Julian Yates.

Additionally, this project was based out of the town of Akaroa, Kaikoura, Westport, and the Abel Tasman National Park. The use of boats provided by Akaroa Dolphins, Black Cat Cruises, Abel Tasman Water Taxi, the University of Canterbury, and the New Zealand Department of Conservation was paramount in this project. I would love to give huge thanks to everyone at all of those companies, and everyone who supported me during this study. Everyone on this journey was a motivator, an inspirer and a mentor in their own way. Thank you very much for all your help to reach an end to this journey.