Assessing the Impact of Tourism on New Zealand fur seals (*Arctocephalus forsteri*)

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Contents

Abstract

Marine mammal viewing and encounters are significant tourist activities in some areas of New Zealand — it was estimated in 1992 that at least 300,000+ tourists took part in marine related tourism in New Zealand annually (Robertson, 1992), and the industry has grown considerably since then. While eco-tourism can have positive outcomes (e.g. generating revenue and increasing environmental awareness), if it is not managed effectively, it can also have a negative impact on the target species and their environment. Effective management requires an understanding of how the target species react to tourist activities. We need to know:

- If the animals are modifying their behaviour and if so how can we measure the changes in behaviour?
- Are the changes in behaviour biologically significant?
- How can we prevent or mitigate any negative effects of eco-tourism on marine mammals?

New Zealand fur seals, *Arctocephalus forsteri*, are the only marine mammal found regularly ashore on accessible sections of the New Zealand coastline and are therefore the target of both land and sea-based tourism. The time that fur seals come ashore to breed (Nov-Feb) coincides with the peak tourist season making it important that we understand the implications of tourist/seal interactions on the behaviour as well as the reproductive success of the species.

Three study sites were chosen to reflect a spectrum of visitor density, type of tourism, and anticipated fur seal sensitivity. Two experimental sites, the Kaikoura coastline and Tonga Island in Abel Tasman National Park both attract a large number of tourists for viewing by boat, and kayak, and by land in Kaikoura. A control site, Whakamoa, on the Banks Peninsula, which receives no tourist traffic, was used to compare responses of seals to various approach types. Data were collected during the Austral summer seasons 1999/2000 and 2000/2001. Behaviour was observed using focal animal and instantaneous scan sampling (Altmann, 1974), while attributes of tourist approaches were tested experimentally via controlled approaches. Approaches were broken into land, kayak and boat approaches, and the following factors were manipulated: distance, noise, frequency of approach, and size of group approaching.

In the first field season (1999-2000), Focal Animal observations were carried out on 277 individual seals representing five different gender/age classes: adult male, adult female, sub-adult male, juvenile and pup. In the second field season (2000-2001), Focal Animal data were collected on 124 mother/pup pairs. Over both field seasons 162 hours of Instantaneous Scan data were collected. Controlled Approaches by land, kayak, and boat were carried out during both seasons and data were collected on 3525 seals. Frequency approach data were collected by land (n=13 seals), and by kayak (n=55 seals) in the first field season. Also in the first field season, the impact of group size was tested on 97 seals by land. Seals' responses to tourist approaches were recorded during both seasons, on land and at sea in both boats and kayaks (n=3699 seals approached). Data were collected on 327 seals approached by a commercial guided walk in the second field season. A total of 33 commercial swim-with-seal programmes were observed during the second season. A mark-recapture experiment was carried out at Ohau Point and Tonga Island breeding colonies both seasons (n=167 pups sampled) to assess pup productivity and condition at these sites.

The results from this study indicate that fur seals are changing their behaviour in response to tourist activities. Chapter 3 of this thesis details the results of the behavioural sampling. Focal Animal data collected on all gender/age groups suggests that there are significant differences in the behavioural repertoire of seals based on site and gender/age differences. Focal Animal data collected on mother/pup pairs suggests that time spent 'Nuzzling' was significantly less at Tonga Island ($p<0.019$) although no significant differences were observed in mother/pup association time between sites. Instantaneous scans showed significant changes in seals' behaviours in response to tourist disturbance. They also show significant differences in colony behaviour between sites ($p<0.0001$), as well as behavioural changes within the colonies over the two seasons ($p<0.042$).

The experimental data including controlled approaches are presented in Chapter 4. The results from the controlled approach aspect indicate that fur seals respond more strongly to land-based approaches than sea-based approaches ($p<0.001$). Response to different approaches also varied by site with more avoidance responses displayed at the control site ($p<0.005$). There was no significant correlation between group size and fur seal response or the frequency of approach and seal response. Results from the guided walk showed that seals' responses varied significantly based on the distance of approach, and the size of the group approaching. The responses of seals to the guided walk were also compared to responses of seals approached by tourists without a guide; the presence of a guide reduced the number of avoidance responses by as much as 15%. No significant difference was found in seals' responses to swims organised by different companies, however, particular human behaviours were observed to increase the likelihood of seals avoiding the swimmers.

The data presented here have shown that seal responses vary based on a large number of factors, and that seals may habituate over time in areas of high tourist activity. This study indicates that current management guidelines are not preventing negative impacts in tourist/seal interactions. In Chapter 5, strategies are recommended to lessen the overall impact of eco-tourism activities on fur seals including (See Chapter 4 for calculation) new minimum approach distances (land approaches — 30 m at non-breeding sites, prohibited at breeding sites; kayak approaches — 20 m at breeding sites; boat approaches — 30 m at all locations). Long-term monitoring is required to assess the possible impacts of tourism on the reproductive success of the species.

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Chapter 1: Introduction

1.1. New Zealand Fur Seals (*Arctocephalus forsteri*)

New Zealand fur seals are found along the New Zealand coast, primarily around the South Island and off-shore islands, as well as in South and Western Australia (Crawley and Wilson, 1976; Wilson, 1981; Cawthorn *et al.*, 1985; and Mattlin, 1987). Fur seals were hunted for their fur extensively from 1792 until populations began to collapse in 1815. By then fur seals had been exterminated from the Antipodes Islands and other locations (Mattlin, 1987). The New Zealand sealing industry was closed in 1894 with the odd restricted licenses being issued for Campbell Island for 1913-1916 and 1922-1924, and was briefly reopened in 1946 after complaints that seals were severely interfering with the local fishing industry (Mattlin, 1987). Fur seals have since been fully protected by the Marine Mammal Protection Act of 1978 (Cawthorn *et al.*, 1985; and Mattlin, 1987). As a result, fur seals have begun to recolonise their original range and their numbers are increasing. An in depth account of the abundance of fur seals around New Zealand by Wilson (1981) estimated the population at 39,000 with a range of 30,000-50,000. Numbers have most likely increased since then with new breeding populations becoming apparent since the time of the study, including sites around Kaikoura, the Banks Peninsula, and the Otago and Nelson coasts (Cawthorn *et al.*, 1985; Lalas and Harcourt, 1995; Taylor *et al.*, 1995; and Bradshaw *et al.*, 1999). Although the current total abundance of New Zealand fur seals is not known, estimates based on pup counts and rates of population increase suggest that New Zealand fur seal numbers are nearing 100,000 (Taylor, 1992; Taylor *et al.*, 1995; Wickens and York, 1997; Goldsworthy *et al.*, 1999; and Harcourt, 2001a).

Foraging behaviour of the various species of fur seals has been under investigation for a number of years (e.g. Croxall *et al.*, 1985; Costa, 1991; Harcourt *et al.*, 1995; and Mattlin *et al.*, 1998). Most studies have collected data on lactating females including one on Australian fur seals (*A. pusillus doriferus*) in southeastern Australia, in which diving occurred mostly during daylight hours (Arnould and Hindell, 2001).

A study on a male Australian fur seal showed no sign of a diurnal pattern with approximately 43% of dives occurring at night (Hindell and Pemberton, 1997). However, studies on dive behaviour in Galapagos fur seals (*A. galapagoensis*) and Antarctic fur seals (*A. gazella*) suggest most dives occur at night and either side of the hours of darkness (Croxall *et al.*, 1985; Trillmich, 1990; Dellinger and Trillmich, 1999; and Horning and Trillmich, 1999). A similar diurnal pattern with shallow dives occurring through the night and the deepest dives at dawn and dusk was observed in New Zealand fur seals (Harcourt *et al.*, 1995). It was suggested that these seals are following a vertical migration of prey, which brings deep-sea fish closer to the surface at night. Dietary analysis using otoliths in scats indicate that fur seals frequently feed on deep-sea species that would be beyond their diving abilities in the daytime (Tate, 1981; Carey, 1991; and Dix, 1993).

New Zealand fur seals are an opportunistic species and feed on a number of prey items. Several studies have looked at the prey species of fur seals around New Zealand, however, different methodologies show slightly different results. Street (1964) examined stomach contents and concluded that fur seals were eating barracouta (*Thyrsites atun*), octopus (*Octopus maorum*) and arrow squid (*Nototodarus sloanii*). Tate (1981) examined regurgitations and concluded they were eating arrow squid, octopus, hoki (*Macruronus novazelandiae*) and barracouta. Carey (1991) analysed fish otoliths in faeces and, while his study did not deal with cephalopods, it provided a thorough examination of the fish species consumed, seasonal variations in feeding pattern, and whether or not any of the prey species were commercially desirable for humans. Twelve fish species were identified with the most common prey species being lantern fish (Myctophidae), anchovy (*Engraulis australis*), ahuru (*Auchenoceros punctactus*), and hoki. The primary prey species for various sites depended on the distribution and abundance of available prey and the seals' ability to shift prey species as needed. The primary prey species for seals on the Kaikoura coast were lantern fish. Here the Kaikoura Canyon makes deep-sea species more accessible. Of all the fish species seen regularly in seal scat, hoki was the only species that is commercially important and, around Kaikoura, only made up 17.1% of total fish otoliths found in faecal samples in May and the rest of the year was of minor importance (2.1-3.7%) (Carey, 1991).

When not foraging, seals come ashore for body maintenance, to rest, give birth, and mate (Taylor *et al.*, 1995; and Barton *et al.*, 1998). In November males begin to come ashore and claim a territory. Fur seals are a polygynous species where one male holds a territory over several females (Stirling, 1970; and Carey, 1989). Females come ashore to give birth in late November, and pups are born from late November to early December (Stirling, 1970). Mothers remain with their pups for approximately the first week after birth, re-mate, and then begin to alternate between making foraging trips to sea and coming ashore to feed their pup. Due to the relatively small size of fur seal females, they must forage during lactation in order to maintain condition and nurse their young (Boness and Bowen, 1996). This is known as the 'foraging cycle' maternal strategy and is observed in all otariid species and possibly some of the smaller phocid species (Trillmich, 1990; Kovacs and Lavinge, 1992; and Boness and Bowen, 1996). Cows initially make short trips to sea but these gradually get longer, with cows spending up to 8-15 days away from the rookery near weaning (Miller, 1975; Oftedal *et al.*, 1987; Harcourt *et al.*, 1995; and Mattlin *et al.*, 1998), which occurs approximately 300 days post-partum (Stirling, 1971; and Harcourt, 2001a).

Fur seal mothers from colonies with a nearby food source have the ability to alternate between overnight foraging trips (less than a day in duration) and extended foraging trips (more than one day). This pattern was seen in Antarctic (*A. gazella*) and sub-Antarctic fur seals (*A. tropicalis*) at Maquarie Island (Goldsworthy, 1999). According to Arnould and Boyd (1995), the rate of nutritional transfer from mother to pup was highest immediately upon the mother coming ashore, as indicated by observations on suckling bout length (Trillmich, 1990; and Lea and Hindell, 1997). The function of short overnight trips may be to allow females to optimise the rate of nutritional transfer to the young by returning to feed at sea once the pup's digestive tract fills with milk and they are no longer able to assimilate food at a high rate

(Goldsworthy, 1999). A similar study on sub-Antarctic fur seals on Amsterdam Island found that pups grew faster and were heavier at weaning if their mothers performed short but regular feeding trips (Georges and Guinet, 2000).

The observed increase in time mothers spend at sea foraging and the subsequent decrease in time they spent ashore as lactation progresses, was suggested by Oftedal (1984) to be a result of the female meeting the greater demand for food by older pups. To support the pups during longer fasting periods at the end of lactation, an increase in milk fat percentage has been observed (Boness and Bowen, 1996).

If, however, extended foraging trips are brought on by environmental factors such as a decreased food supply, then the mother may not be able to gain enough energy on a foraging trip and as a result the pups often starve. Evidence of reduced growth rates and/or increased mortality in relation to mothers spending extended periods at sea has been seen in Galapagos fur seals, Antarctic fur seals (Trillmich, 1990), and New Zealand fur seals (Lea and Hindell, 1997). In a similar study, Ono *et al.* (1987) investigated maternal investment in California sea lions (*Zalophus californianus*) and found that females initiated foraging trips about 2 days earlier and spent more time at sea during years of an El Niño, in which food supply was lower. As a result, female attendance was lower and subsequent pup mortality was 10.9% higher in the El Niño year than the pre-El Niño year.

In general, otariid mothers have three options to increase nutritional transfer to pups during times of food shortages: 1) to increase diving effort while at sea and dive at all times of the day; 2) increase time spent at sea; or 3) a combination of both. California sea lions and Northern fur seals (*Callorhinus ursinus*) tend to adopt the first option, however they are not specialist feeders and they can dive deeper than many of the smaller otariid species. Sub-polar species including Antarctic fur seals, which are specialist feeders, appear to adopt the second strategy as they are not capable of diving to the great depths that their prey migrates to during the day (Trillmich, 1990;

and Boyd *et al.*, 1997). While mothers also have the strategy of increasing lactation length in periods of food shortage, this incurs an increase in reproductive cost for the next season (Trillmich, 1990).

Figure 1.1. New Zealand fur seal at Barney's Rock, Kaikoura

1.2. Wildlife Tourism

Tourism is a major world industry with 449 million international travellers world wide in 1991, and generating approximately US$ 62.5 billion in developing countries alone (WTO, 1992). A sub-set of tourism known as eco-tourism, has proved a successful source of income in developing countries bringing in US$ 12 million in 1988 (Lindberg, 1991). Scace (1993) defined eco-tourism as a subset of nature tourism in which conservationist and tourist interests work together to preserve environmental quality while mutually protecting tourism, but does not include adventure tourism based on thrill seeking or physical achievement. Eco-tourism is increasing at a rate of about 30% each year world-wide (Young, 1998). It is often assumed that eco-tourism "does not denigrate the resource" and that, if anything, "eco-tourism must benefit the resource" (Butler, 1993). The theory is that with more attention through tourism given to wildlife, we should see an increase in the beneficial effects by the initiation of conservation measures at multiple levels. In reality, all eco-tourism has some form of environmental impact and evidence has shown that animal watchers can represent a serious source of disturbance, even in protected areas (Edington and Edington, 1986). It is for this reason that eco-tourism is illegal or heavily legislated in many countries. For example, all swim-with-wild-dolphin, whale and seal programmes are illegal in the U.S.A, and many land-based viewing opportunities around the world are restricted to guided walks only (Constantine, 1999).

The livelihoods of many people are linked to the success of the eco-tourism industry, however the continued long-term sustainability of the species targeted by eco-tourism operations are subject to our ability to appropriately manage wildlife encounters. Effective management must reduce the negative impacts to a minimum and reinforce the positive impacts, such as the increase of knowledge and awareness of the public as well as providing an opportunity for promoting conservation (Glick, 1991; McSweeney, 1992; and Young, 1998).

Marine mammals attract a lot of tourist attention world wide because of their unique way of life and amazing swimming and diving abilities (Constantine, 1999). New Zealand offers many tourists their first opportunity to view marine mammals in their natural environment, and the opportunity for close encounters with marine mammals not available to tourists in other countries. With such a wide range of opportunities for tourists to interact with marine mammals, the industry is increasing in popularity and subsequently there is an increasing demand for tourist encounters with marine mammals (Jenner and Smith, 1992; and McKegg *et al.*, 1996).

Five species of dolphins, six species of whales and two species of pinnipeds are encountered on a regular basis in New Zealand; along with about four other cetacean species and two other pinniped species that may be encountered on rare occasions (Constantine, 1999). Of the species regularly encountered, the pinnipeds, especially the New Zealand fur seals, can be reliably found ashore at breeding and non-breeding sites during much of the year (Barton *et al.*, 1998). Because of their accessibility, the New Zealand fur seal has been the subject of many eco-tour operations in New Zealand.

1.3. New Zealand Fur Seals and Conservation

Fur seals are currently protected under the Marine Mammal Protection Regulations, New Zealand (1992, Regulation No. 322). This legislation aims to "make provision for the protection, conservation and management of marine mammals" and "to regulate human contact or behaviour with marine mammals, either by commercial operators or other persons, in order to prevent adverse effects on and interference with marine mammals." Under the present regulations, it is illegal to harass fur seals — harassment being defined as actions that disrupt significantly, or are likely to disrupt significantly, the normal behaviour patterns of an animal. To date no one in New Zealand has been prosecuted for "harassing a fur seal."

Of the fourteen Department of Conservation (DOC) conservancies, ten have permitted marine mammal viewing ventures. Seals can be viewed by land and from boat in the Wellington, and Nelson/Marlborough conservancies. Seals are viewed by boat on the West Coast of the South Island, and can currently be viewed from land in Canterbury, Otago and Southland regions, which includes Fiordland. Many of the boat-based operators primarily target cetaceans, however they also target seals (Constantine, 1999).

There is concern from the Department of Conservation that tourism may be adversely impacting individual seals and particularly seal breeding colonies. There is also some concern that tourists are risking their own safety with inappropriate behaviour around seals. It appears that the public is not well informed about the wildlife and how their behaviour may be affecting the seals. The current regulations governing people's behaviour around fur seals do not appear to be working (Barton *et al.*, 1998). Tourists have been observed throwing rocks at seals and whipping them with kelp in the past year at sites around Kaikoura (pers. obs.). While these may be isolated encounters, occasions where tourists attempt to get closer for a photo are common and it is not understood how these everyday encounters may be affecting the behaviour of the seals. It is thus important to understand how various activities may impact the target species and what factors appear to be most detrimental to the animals. This information would allow for more effective management of the species targeted. Prior to this study there has been no comprehensive investigation on the impact of land and sea-based tourism on the New Zealand fur seal.

1.4. Biological Concerns About the Impact of Tourism on Fur Seals

Tourist disturbance can potentially impact the target species on both short and long-term scales. Short-term changes are immediate and often easily observable behavioural responses, however, these short-term changes may actually lead to long-term changes that are more subtle but may impact negatively on the biology of the animal in question (Edington and Edington, 1986). Some common examples of long-term impacts include a decrease in population size, which may be brought about by displacement of animals, a decrease in breeding success, or a decrease in fitness due to over-exertion (Ward and Beanland, 1996).

New Zealand fur seals show a high degree of site fidelity (Stirling, 1971) meaning that they repeatedly return to a preferred site. Recent work by Ryan *et al.* (1997) and Bradshaw *et al.* (1999) investigated the impact of terrain on terrestrial habitat choice of fur seals. Despite some differences in results between the two studies, in general, both found that breeding sites were characterised by large rocks and crevices, which enabled pups to hide. Bradshaw *et al.* (1999) also suggested that other factors including gregarious behaviour, proximity to food sources, and degree of human disturbance may influence site selection in fur seals. Carey (1989) examined the importance of cooling substrates such as shade and rock pools, and concluded that such features were also an important factor in site choice for New Zealand fur seals. With increasing tourist numbers fewer seal colonies have low degrees of human disturbance and breeding colonies such as Ohau Point, and Lynch's Reef in Kaikoura, and Tonga Island in Abel Tasman National Park are now being exposed to higher degrees of human disturbance. Because fur seals show high degrees of faithfulness to sites which provide appropriate terrain for rearing pups, and are close to a reliable food source, they are less likely to be displaced by increasing tourist encounters and makes them more susceptible to detrimental long-term impacts. For this reason it is important to understand the possible impacts tourist interactions have on fur seal biology including: behaviour, reproductive success, and maternal investment.

1.4.1. Modification of Behaviour

Tourism may impact seals by forcing them to modify their behaviour. If seals are changing their behaviour in the presence of an outside disturbance it may lead to a change in the activity budget for an individual seal or even the colony. Seals spend a lot of time resting which is necessary for conserving energy and thermoregulation (Taylor *et al.*, 1995). Although the amount of time spent resting varies between gender/age classes as well as the season, adult seals may spend as much as 70-75% of their time resting (Crawley and Wilson, 1976; and Johnstone and Davis, 1987) If a disturbance significantly raises their activity levels this may cause a decrease in energy conservation and may result in a decrease in fitness for the individual or colony. Although few studies have investigated this impact in detail, increased energy expenditure due to tourist interactions has been a concern (Ward and Beanland, 1996; and Barton *et al.*, 1998).

Cows and younger seals will typically enter the sea in the presence of an outside disturbance (Barton *et al.*, 1998) and this may lead to changes in foraging patterns for the seals in question. For example, seals at sites exposed to regular disturbance may make more frequent trips to sea and, if the disturbances are of a high level and/or frequent enough, the seals may even leave the area permanently. Although site abandonment might not be as likely in fur seals, it has been observed in common seals (*Phoca vitulina*) in response to increased boat traffic (Allen *et al.*, 1984).

At the other extreme seals may become habituated, whereby through increased or regular exposure to a stimulus the animals become accustomed to it and responses decrease (Sternberg, 1995). Although habituation can be viewed as a benefit, which would possibly make tourist encounters more successful (Young, 1998), it is still a modification of behaviour brought on in an unnatural way and can have serious repercussions. Animals may habituate through excessive or predictable exposure to stimuli, but 'rewards' such as food enable this phenomenon to occur over a shorter period of time (Brown, 1960). Habituation through food provisioning has lead to behavioural problems including 'begging' (Connor and Smolker, 1985), decreased maternal investment (Mann and Kemps, 2001), and breakdown of territorial behaviour (Harris, 1973). Behavioural problems have also been associated with pinnipeds in captivity that were reared by humans. In these situations the animals tend not to socialise well with other pinnipeds and acquisition of skills such as swimming occurred much later than if raised by its mother (Atkin, C., pers. comm., 2001). Seals are wild animals and habituation may lead to a number of behavioural changes, which ultimately alters the integrity of the species (Edington and Edington, 1986). The attraction to New Zealand for tourists is to see animals in their natural environment, behaving in a natural way. This should not include habituation to people.

1.4.2. Impact on Reproductive Success

New Zealand fur seals may be especially vulnerable to the effects of eco-tourism, as the prime months for tourism in New Zealand, November to February, are also the key months in the fur seal reproductive cycle. These few months are vital for the survival of the fur seal population. The population must produce and rear enough young to compensate for adult mortality, or it will decline in numbers. The pressures placed on seal populations during this summer period by eco-tourism operations may be highly detrimental to the long-term survival of target populations since these pressures might decrease copulation rates, which would in turn impact future pup production.

1.4.3. Impacts on Maternal Investment

Little is known as to how human disturbances such as tourism may affect maternal strategies during lactation. The peak in the New Zealand fur seal's breeding season (December/January) is a crucial time when mother/pup pairs form a bond before the cow leaves for her first feeding trip. This bond is vital as it enables the pair to reunite upon the mother's return (Phillips and Stirling, 2000). Although the precise mechanism by which the pair reunites is not fully understood it was described in detail by Stirling (1970) as a combination of vocal and olfactory signals. The mother and pup call until they locate each other and the mother then sniffs the young to ensure that it is in fact hers. While the formation of this bond is especially critical for the survival of the offspring through to weaning, it has been shown in Northern fur seals (*Callorhinus ursinus*) that recognition is stable over time and that four-year-old females that returned to their natal site could still recognise vocalisations of their mothers. It is suggested that this long-term recognition could provide fitness benefits through cooperative associations between parents and mature offspring (Insley, 2000).

An outside disturbance may also impact the female's attendance time and thus the rate of milk transfer to the young. While some studies conclude that the pups control the rate of milk transfer while the mother is on land (Chilvers *et al.*, 1995), this is not possible if they are separated from their mother for an extended length of time due to a disturbance. Studies on African ungulates and cetaceans have also observed tourist vehicles separating mother/young pairs. While not as serious after the bonding process is complete, if the separation occurs prior to the formation of the bond the offspring may not be accepted by its mother and die (Edington and Edington, 1986). It is therefore important to understand the short and long-term implications these tourist interactions have on fur seal breeding biology.

Figure 1.2. New Zealand fur seal sitting by 'Seal Sign' at the Kaikoura Peninsula Carpark

1.5. Previous Tourism Impacts Studies

Eco-tourism has been the focus of many studies, however most of these investigate the social and economic impacts of eco-tourism, and only a few have looked at tourism impacts on animals or their ecosystems. Of the studies focusing on the impacts of tourism on specific animals, even fewer have focused on marine animals (Ward and Beanland, 1996). Much of the recent work investigating the impacts of tourism on marine species has focused on cetaceans and sea birds.

Many studies of seal behaviour have commented on the responses of seals to humans but very few studies (approximately 13) have specifically set out to investigate the impact of eco-tourism operations on pinnipeds. Of these 13 studies, nine have been carried out on phocid species in the Northern hemisphere, and four on otariids in the Southern hemisphere. While in principle seal responses may be very similar, there may be a great deal of variability in the responses between species. Kovacs and Innes (1990) investigated the impact of land-based tourism on harp seals (*Phoca greolandica*) in the Gulf of St. Lawrence, Canada, during two whelping seasons. They used behavioural sampling methods to observe mother/pup pairs with and without tourists present. It was found that female attendance was low and nursing behaviours decreased significantly in the presence of tourists. Lidgard (1996) again used behavioural observations of mother/pup pairs as well as collecting weight data on the pups in order to investigate the impact of land-based tourism on grey seals (*Halichoerus grypus*) over two breeding seasons at Donna Nook, Lincolnshire, UK. Adult females showed a preference for breeding in areas of low disturbance and would come ashore to pup earlier in the season when tourist disturbance was at a minimum. Animals present during the peak of tourist season also showed increased vigilance.

Two of the studies carried out on otariid species, were based on small, non-breeding, mainland populations of Hooker sea lions (*Phocarctos hookeri*), which do not regularly include females and pups (Heinrich, 1995; and Wright, 1998). Prior to this work there have been two studies on the impact of tourism on New Zealand fur seals (Barton *et al.*, 1998; and Shaughnessy *et al.*, 1999). The first study focused on land based tourism in Kaikoura, New Zealand, as well as incorporating a sociological aspect into the study. This study used behavioural observations, and controlled approaches on land, as well as conducting interviews with tourists. The results suggest that seals are habituating to tourists at Kaikoura, however, it also suggests that current regulations are not adequate to minimise the affect of tourist encounters on fur seals (Barton *et al.*, 1998). The second study investigated the impact of boats on New Zealand fur seals at Montague Island, New South Wales, Australia. Observations of seal reactions to boats were carried out from the boat as well as from land over the course of one year. There were four recognisable colonies in this study all of which showed signs of habituation although seals at one colony were more likely to flee during particular times of the year when densities were higher (Shaughnessy *et al.*, 1999).

There are a number of concerns about how tourism may be affecting the target species. Results from a number of studies point to three main areas:

1. **Variability of Response:** responses vary a great deal between species as well as between individuals, and an understanding of the variability in responses is required for more effective management (Kovacs and Innes, 1990; Gordon *et al.*, 1992; Kazmierow, 1996; Lidgard, 1996; Richardson and Würsig, 1997; Barton *et al.*, 1998; Young, 1998; Born *et al.*, 1999; Constantine and Baker, 1999; Shaughnessy *et al.*, 1999; and Suryan and Harvey, 1999).

2. **Habituation:** many studies have observed habituation occurring wherein a "resident" group of animals becomes more tolerant of human activity than is normal (Gordon *et al.*, 1992; Robertson, 1992; Heinrich, 1995; Olson *et al.*, 1997; Richardson and Würsig, 1997; Barton *et al.*, 1998; Wright, 1998; Young, 1998; Born *et al.*, 1999; Constantine and Baker,

1999; Fowler, 1999; Shaughnessy *et al.*, 1999; and Suryan and Harvey, 1999).

3. **Long-Term Effects:** in many instances long-term studies are required to fully document the role of eco-tourism impacts on natural populations. Many eco-tourism impact studies have looked at the short-term impacts over a couple of tourist seasons. If there is any impact on the species productivity, migratory or haul-out patterns, or foraging behaviours, there needs to be long-term monitoring. This was recommended by a number of studies, even when no major short-term changes were detected (Kovacs and Innes, 1990; Gordon *et al.*, 1992; Heinrich, 1995; Kazmierow, 1996; Lidgard, 1996; Davis *et al.*, 1997; Barton *et al.*, 1998; Wright, 1998; Young, 1998; Constantine and Baker, 1999; and Shaughnessy *et al.*, 1999).

1.6. Thesis Aims

Little work has been undertaken to specifically examine the impacts of eco-tourism on New Zealand fur seals, however previous work (Barton *et al.*, 1998; and Shaughnessy *et al.*, 1999) suggests that tourism is impacting on the fur seal behaviour. My study builds upon the earlier work of Barton *et al.* (1998) and Shaughnessy *et al.* (1999) by focusing specifically on the responses of New Zealand fur seals at popular tourist sites within New Zealand. This study includes known breeding sites with historical data available on pup production and condition, and also uses a control site with no tourist access. Sea-based tourism as well as land-based tourism was investigated using a novel combination of behavioural observations and experimental manipulations.

The objectives of this thesis are to address the following questions:

- What fur seal responses are directly attributable to tourist activities?
- What responses are significant in terms of the ecology and behaviour of fur seals and why?
- What level or type of fur seal/tourist encounters are acceptable (i.e. don't significantly change fur seal behaviour)?
- What management measures could be introduced to prevent or help mitigate the effects of significant tourist disturbance on fur seals?

Chapter 2 details the methods of the study, while Chapters 3 and 4 present the results of the behavioural sampling and the experimental sampling respectively. These chapters will also discuss the major trends observed and discuss the advantages and disadvantages of the various methods used. The answers to the above questions will be discussed along with suggestions for future work in Chapter 5. This information is not only pertinent for the management of eco-tourism focused on New Zealand fur seals, but will undoubtedly have relevance to the management of eco-tourism operations world-wide.

Chapter 2: Methods

This study incorporates behavioural observations as well as experimental manipulations to determine the behavioural changes in fur seal populations and in individuals associated with tourist activity. In addition, a mark-recapture program has been undertaken to provide baseline data for the long-term study of tourism on fur seal reproductive success. Three study populations were examined (Figure 2.1). Two sites attract large numbers of tourists: Kaikoura (42°25'25" S/173°43'13" E) received an estimated 325,432 visitors to view seals in 1998 (Simmons *et al.*, 1998) and Tonga Island (40°53'25" S/173°04'05" E) which in 2000 received approximately 72,000 water-based tourists (this estimate does not include day visitors in the park which may view the seals by water-taxi) (Tetteroo, R., pers. comm., 2001). Whakamoa, (43°52'50" S/172°51'19" E) the control site, located on the Banks Peninsula, receives no tourists. Data for this study was collected over two breeding seasons in the Austral summers 1999/2000 and 2000/2001.

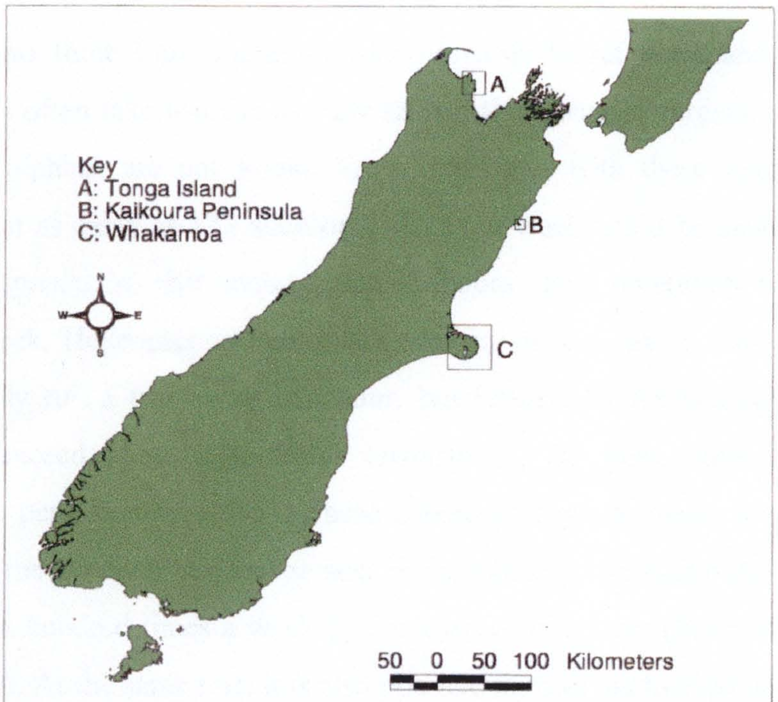


Figure 2.1: South Island, New Zealand

2.1. Study Sites

2.1.1. Kaikoura

The Kaikoura coastline is an important habitat for marine animals due to the Kaikoura Canyon and associated upwelling approximately 2 km off the coast (Garner, 1953; and Lewis and Barnes, 1999). This trench and related upwelling generates the rich food supply necessary to support the many species of whales, dolphins, and seals that frequent the region (Jaquet *et al.*, 2000). The richness and accessibility of marine life in Kaikoura also makes it a popular tourist destination. A recent case study in 1998 estimated the number of tourists visiting Kaikoura annually to be around 874,000, of these approximately 37.2% either viewed or swam with seals (Simmons *et al.*, 1998).

Currently there are five permitted tour operators that specifically target fur seal colonies along the Kaikoura coast (Morrissey, M., pers. comm., 1999). From interviews with these tour operators it was determined that between them they can potentially make a maximum of 114 trips per week to view and interact with seals. There are also three tour operators who primarily target cetaceans for viewing, however they often take tourists to view seals if their primary targets, sperm whales and dusky dolphins, are not found. From interviews with these operators it was calculated that as many as 133 additional visits per week could be made to the seals by these companies, so that seals around Kaikoura could potentially be visited 247 times in a week. Helicopter and aeroplane viewing do not have a limit on trips, and can potentially run a trip every half hour, but historically the weekly trip number would not exceed about 170 flights (Armstrong, D., pers. comm., 1999; and Macphail, J., pers. comm., 1999). These maximum trip allotments are infrequently reached but the potential exists for seal populations in the Kaikoura region to be visited over a hundred times a week by commercial operators (Morrissey, M., pers. comm., 1999). At the same time it is also possible for tourists to view seals from land without being part of an organised tour. Three main sites, Ohau Point, Kaikoura Peninsula and Barney's Rock are the most frequently visited by tourists around Kaikoura (Figure 2.2).

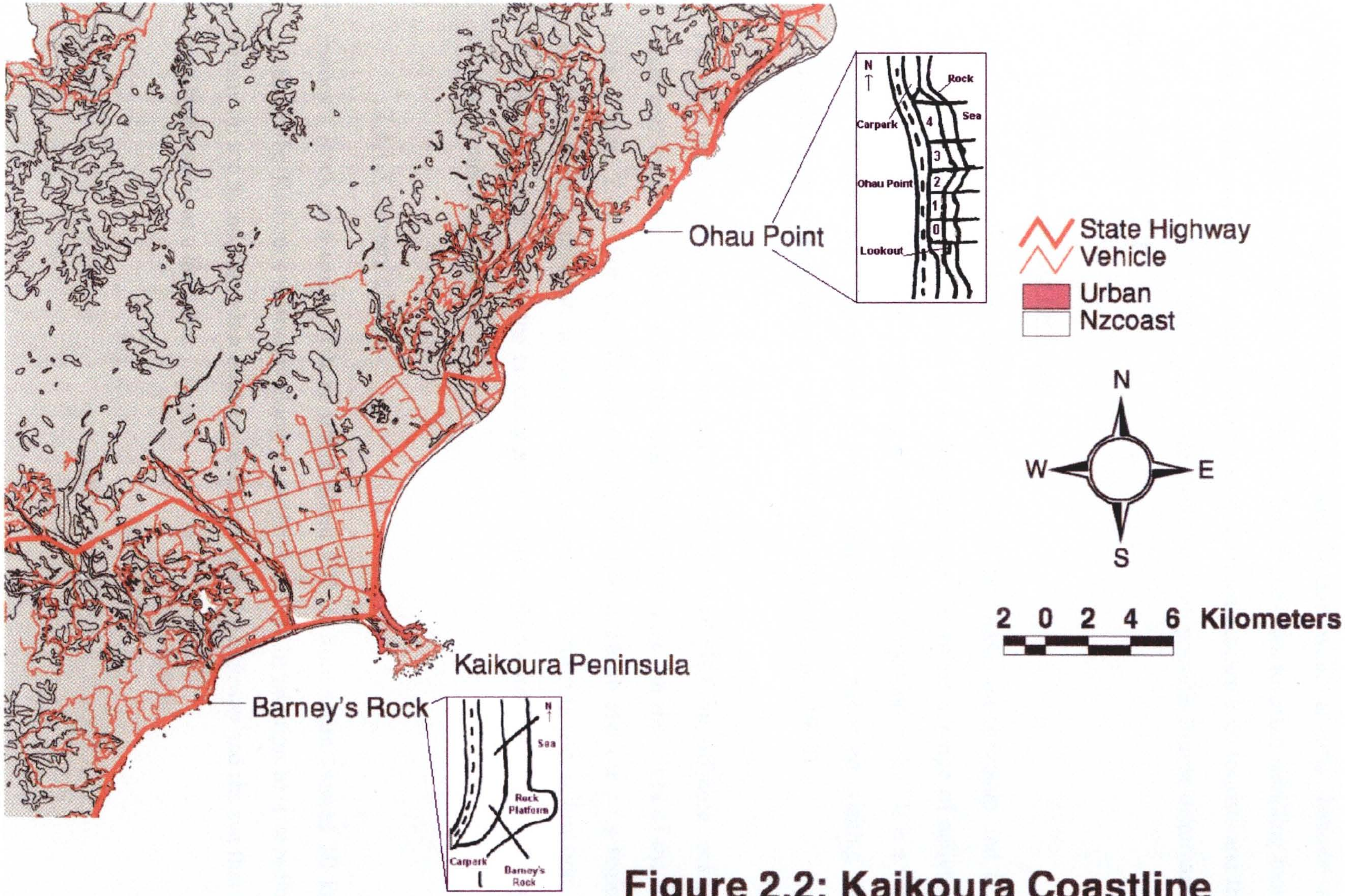


Figure 2.2: Kaikoura Coastline

2.1.1.1. Ohau Point

Ohau Point is found along State Highway 1, 26 km north of the Kaikoura township. The Ohau Point colony starts from Half Moon Bay and continues past the lookout point to a rest stop across from the Ohau Stream walk, a total distance of approximately 500 m. The site was divided into 5 sub-sites to make sampling more feasible. The two peripheral sites (0 and 4) are the most accessible to tourists and the three central sites (1, 2, and 3) are more sheltered from possible tourist disturbance (see insert Figure 2.2).

2.1.1.2. Kaikoura Peninsula

The Kaikoura Peninsula is located just south of the Kaikoura township and is a popular destination for tourists. It is close to town and offers a range of activities (peninsular walkway, diving, fossicking in rock pools and viewing seals). It is a very popular location and approximately 4000 tourists were recorded visiting the peninsula in one week during the summer of 1996 (Barton *et al.*, 1998).

Fur seals breed on Lynch's Reef and haul-out on the tidal platform, offshore rocks, a small reef located at Shark's Tooth, and, during high tides, on the edges of the car park (Figure 2.3). Fur seals hauled out on the tidal platform and car park region (usually bulls and sub-adult males) are easily accessible to tourists and, at low tide, it is possible to walk out to the breeding area. Three seal swims and one kayak tour operate around Lynch's Reef.

2.1.1.3. Barney's Rock

Barney's Rock is a small offshore island about 200 m from shore located 10 km south of the Kaikoura township along State Highway 1. In addition to a breeding colony on the island, there is a boulder beach between the highway and the sea that is used by fur seals as a haul-out.

Although tourist numbers have not been very high here in the past, 9 groups of tourists observed stopped to watch seals during 40 hours of observations (Barton *et al.*, 1998), knowledge of the accessibility of these seals is increasing and many bus drivers stop and guide people past the signs through the haul out colony (pers. obs.). The island is visited by private boats as well as the seal swim, whale, dolphin and bird watch boats.

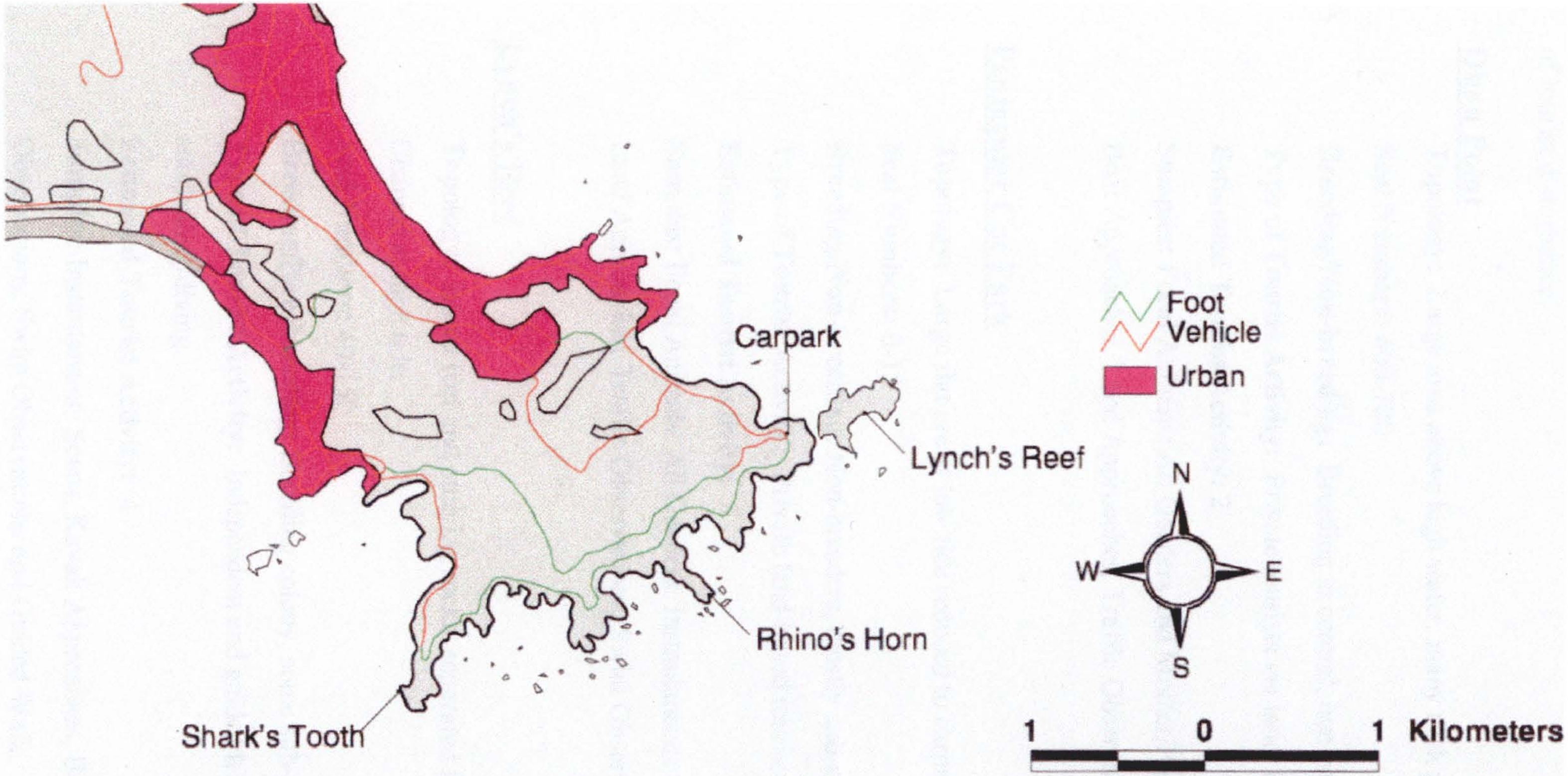


Figure 2.3: Kaikoura Peninsula

Table 2.1. Kaikoura Study Sites:

Numbers of seals are approximate. Breeding/Non-breeding denotes the type of colony. Tourist activity includes the possible type of approaches and whether they are guided or private/independent. Samples carried out at the sites are also included. Estimated tourist activity is ranked from 0-5: 0 representing no tourist disturbance, 5 representing high levels of tourist disturbance.

Ohau Point

Topology: Large area above high water, many rock pools, small tidal change.

Seal Numbers: 600-700

Breeding/Non-breeding: Breeding in central, non-breeders on edges.

Type of Tourist Activity: Private tourists via land, fishing boats.

Estimated Tourist Activity: 2

Samples: Focal Animals: All Genders and Mother/Pup Pairs. Instantaneous Scans, Boat Approaches, Land Approaches, Traffic Observations, and Noise Trials.

Peninsular Car Park

Topology: Large flat are at low tide reduced to carpark and grass at high tide.

Seal Numbers: 0-15

Breeding/Non-breeding: Non-breeders, mostly sub-adult males.

Type of Tourist Activity: Private land-based tourism.

Estimated Tourist Activity: 5

Samples: Focal Animals: All Genders. Instantaneous Scans, Kayak Approaches, Land Approaches, Traffic Observations, Swim Observations and Guided Walk.

Lynch's Reef

Topology: Island reef and outlying rocks, separated from land by Wolomooloo Channel at high tide.

Seal Numbers: 40-150

Breeding/Non-breeding: Breeding colony, some sub-adult males on edges.

Type of Tourist Activity: Independent and guided trips by land, boat, kayak and snorkelling/diving.

Estimated Tourist Activity: 4

Samples: Instantaneous Scans, Kayak Approaches, Boat Approaches, Traffic Observations, Swim Observations and Guided Walk.

Shark's Tooth

Topology: Exposed Southern side of Peninsula, large flat area at low tide.

Seal Numbers: 20-100

Breeding/Non-breeding: Non-breeders, mostly sub-adult males.

Type of Tourist Activity: Private land-based tourism, some guided swims, boats and kayaks.

Estimated Tourist Activity: 4

Samples: Land, Kayak and Boat Approaches, Frequency Approaches: Land and Kayak, Group Approaches, Noise Trials, Traffic Observations, Swim Observations.

Barney's Rock

Topology: Small area especially at high tide, crevices and cliffs, some rock pools.

Seal Numbers: 6-80

Breeding/Non-breeding: Non-breeders at haul-out, small breeding group on offshore island.

Type of Tourist Activity: Private land-based tourism at the haul-out, some guided swims and boat viewing at the island.

Estimated Tourist Activity: 2

Samples: Focal Animals: All Genders, Instantaneous Scans, Land, Kayak and Boat Approaches, Frequency Approaches: Land, Group Approaches, Noise Trials, Traffic Observations.

2.1.2. Tonga Island

Tonga Island is one of the five largest islands in Abel Tasman National Park, located northwest of Nelson. New Zealand fur seals have been breeding on Tonga Island since approximately 1988 (Taylor *et al.*, 1995). The island is a popular site for viewing seals by kayak and boat. The entire park attracts around 180,000 people annually, many of whom take part in the sea based tourist operations (Houston, S., pers. comm., 2000). There are eight kayak companies which offer both guided and independent rentals, four water taxis, one ferry, one charter boat and one seal swim, which regularly view and interact with the seals at Tonga Island. There is no limit to the number of trips to view the seals and an estimated 150-200 boats visited Tonga Island daily, during the peak of the tourist season (Dec-Jan) in 1998 (Barton *et al.*, 1998).

Tonga Island is triangular in shape with the East side being most exposed. There are two small embayments on this side sheltered by outlying rocks. Within these embayments are small breeding groups of 10-20 seals. Observations were carried out from land and water around high tide when weather and sea conditions permitted. These embayments were termed Tonga East. Land observations were made from bay #2 (See map Figure 2.4.).

The West side of Tonga Island is more sheltered and there are substantially more rocks above high tide, housing many more seals (40-130 seals visible). This side typically received the greatest amount of boat traffic. However, it was impossible to observe this site from land so all observations were carried out via kayak. This sub-site was termed Tonga West.

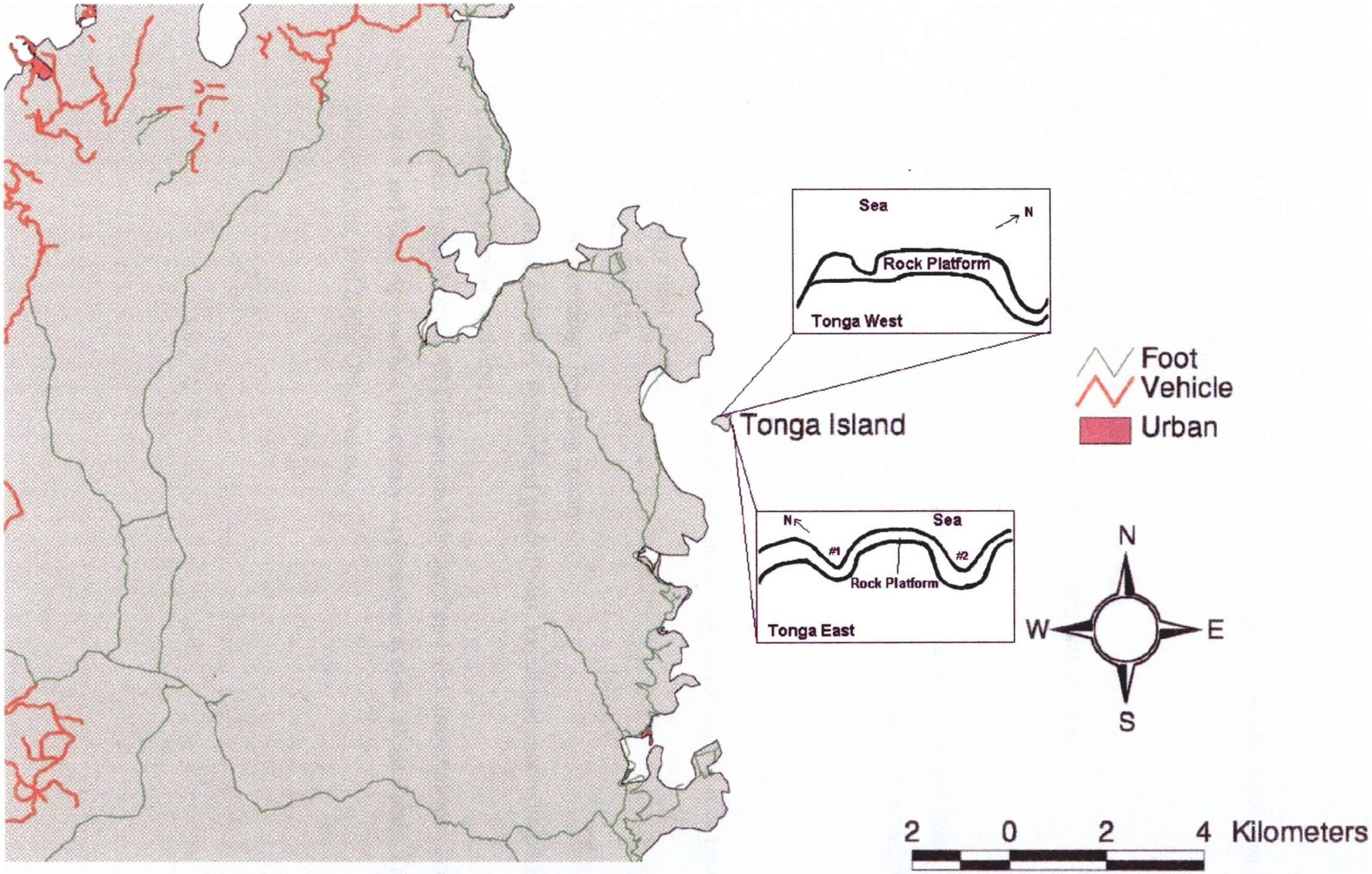


Figure 2.4. Tonga Island, Abel Tasman National Park

Table 2.2. Tonga Island Study Sites:

Numbers of seals are approximate. Breeding/Non-breeding denotes the type of colony. Tourist activity includes the possible type of approaches and whether they are guided or private/independent. Samples carried out at the sites are also included. Estimated tourist activity is ranked from 0-5: 0 representing no tourist disturbance, 5 representing high levels of tourist disturbance.

Tonga East

Topology: Steep rocky areas, small embayments, few rock pools. Small area above high water, large tidal change.

Seal Numbers: 20-40

Breeding/Non-breeding: Breeding in embayments.

Type of Tourist Activity: Private and guided boats, kayaks and snorkelling/diving.

Estimated Tourist Activity: 3

Samples: Focal Animal: All Genders, Instantaneous Scans, Kayak and Boat Approaches, Frequency Approaches: Kayak, Noise Trials, Traffic Observations, and Swim Observations.

Tonga West

Topology: More gradual slope, more area above high water, several rock pools, large cove, large tidal change.

Seal Numbers: 40-130

Breeding/Non-breeding: Breeding colony.

Type of Tourist Activity: Private and guided boat, kayak and snorkelling/diving.

Estimated Tourist Activity: 5

Samples: Focal Animal: All Genders and Mother/Pup Pairs. Instantaneous Scans, Kayak and Boat Approaches, Frequency Approaches: Kayak, Noise Trials, Traffic Observations, and Swim Observations.

2.1.3. Whakamoa

Whakamoa is located on the southern side of Bank's Peninsula. Access to breeding and haul-out sites is restricted, as the surrounding land is privately owned. The study area was divided into two sub sites (Whakamoa Bay and Island Bay). Observations were carried out from the cliffs above the sites (50 m high in Whakamoa, approximately 150 m high in Island Bay).

2.1.3.1. Whakamoa Bay

Fur seals breed in a small embayment (Bull Caves) sheltered by Whakamoa Reef and approximately 10-30 juvenile and sub adult seals haul-out on the reef.

2.1.3.2. Island Bay

Island Bay is south of Whakamoa Bay and is named for the island situated at its entrance. It is a much larger bay with steep cliffs on both sides making it only accessible by boat. Fur seals breed at two sites near the island: "Two Bulls" and "Ball Rock".

Kaikoura and Tonga Island were chosen as experimental sites because of the high frequency of tourist encounters the seals receive. Whakamoa was chosen as a control site due to its lack of tourist activity. The control site was chosen so that the responses of the seals at the other sites could be compared to a "normal" or relatively undisturbed colony.

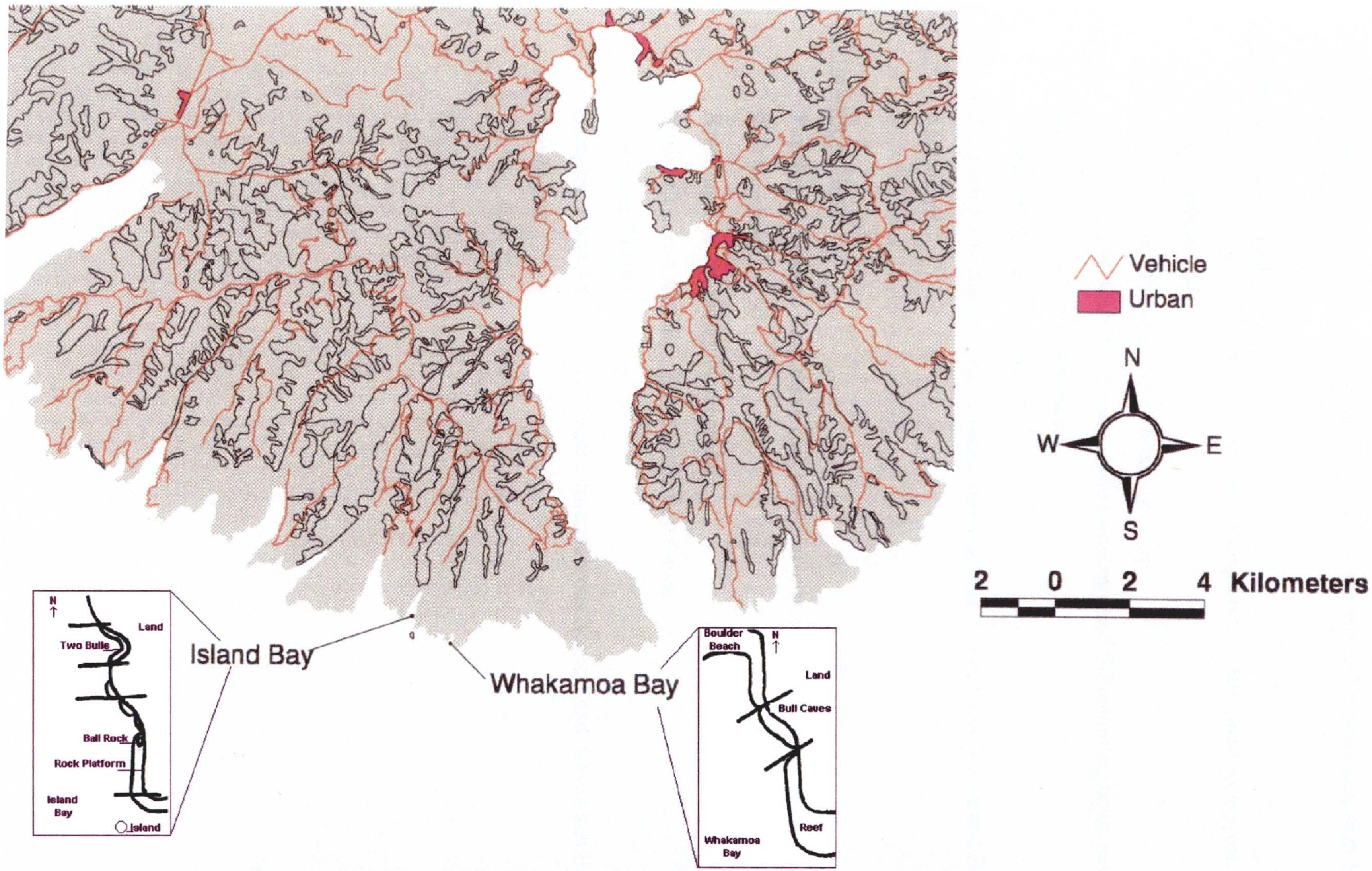


Figure 2.5: Whakamoa, Banks Peninsula

Table 2.3. Whakamoa Study Sites:

Numbers of seals are approximate. Breeding/Non-breeding denotes the type of colony. Tourist activity includes the possible type of approaches and whether they are guided or private/independent. Samples carried out at the sites are also included. Estimated tourist activity is ranked from 0-5: 0 representing no tourist disturbance, 5 representing high levels of tourist disturbance.

Whakamoa Bay, Bull Caves

Topology: Small embayment with rocks forming caves, a few small rock pools.

Seal Numbers: 5-10

Breeding/Non-breeding: Small breeding group.

Type of Tourist Activity: Some private aeroplanes and fishing/diving boats pass, but don't approach or target seals.

Estimated Tourist Activity: 0

Samples: Focal Animals: All Genders, Instantaneous Scans, Land, Kayak and Boat Approaches.

Whakamoa Reef

Topology: Exposed Reef, many rock pools, large area above high tide.

Seal Numbers: 10-30

Breeding/Non-breeding: Non-breeders.

Type of Tourist Activity: Same as for Bull Caves.

Estimated Tourist Activity: 0

Samples: Focal Animals: All Genders, Instantaneous Scans, Land, Kayak and Boat Approaches.

Island Bay, Two Bulls

Topology: Crescent shaped embayment, rock pools and space above high water.

Seal Numbers: 30-40

Breeding/Non-breeding: Breeding colony.

Type of Tourist Activity: Occasional aeroplane.

Estimated Tourist Activity: 0

Samples: Focal Animals: All Genders and Mother/Pup Pairs. Instantaneous Scans, Land, Kayak and Boat Approaches, Noise Trials.

Island Bay, Ball Rock

Topology: Long stretch of rocky beach, many rock pools and crevices, large area above high water.

Seal Numbers: 50-100

Breeding/Non-breeding: Breeding colony with some non-breeders on most exposed edge.

Type of Tourist Activity: Occasional aeroplane and fishing/diving boat pass, it is rare that they enter the bay.

Estimated Tourist Activity: 0

Samples: Focal Animals: All Genders and Mother/Pup Pairs. Instantaneous Scans, Land, Kayak and Boat Approaches, Noise Trials.

2.2. Behavioural Sampling

2.2.1. Focal Animal Sampling: All Gender/Age Classes

Focal animal observations were chosen to follow specific animals for a period of time noting how long the focal animal spent in each behavioural state (Altmann, 1974). Thirty minute time periods were initially chosen for focal analyses based on a previous study by Barton *et al.* (1998), but it was soon decided that this was too small of a snapshot in the seal's day and the time frame was extended to 1 hour to get a more accurate picture of how the seal spends it's time. If a seal was out of view for more than five minutes the sample was ended. I chose this conservative approach for two reasons. First, while the adult seals would reliably come back to their territory, pups, juveniles and sub-adults were easy to lose track of due to their highly gregarious behaviour. Second, the absence of tags on some individuals made identification difficult if the seal came back into view. The sex and age of each focal animal were recorded and the start and finish of the focal time noted. Weather and sea conditions were also recorded including tide times and height, cloud cover and estimated air temperature. Behavioural data were converted to proportions of time spent carrying out a specific behaviour in one hour. Pre-defined behavioural states, which were monitored, are described in Table 2.4 and are based on the categories used previously in the literature (Stirling, 1970; Mattlin, 1978; Kovacs and Innes, 1990; and Barton *et al.*, 1998). The number of interactions between, the focal seal and other animals, and the number of behavioural changes were also counted. The number of behavioural changes was calculated by counting the number of times the seal moved between behavioural states during the hour.

Individuals were chosen at random for the observations, however gender of the seal chosen was set in order to maintain approximately equal gender/age ratios across the data set. The numbers vary slightly between sites depending on gender ratio at the site in question.

This method is popularly used (MacGibbon, 1991; Olson *et al.*, 1997; Barton *et al.*, 1998; and Wright, 1998) for getting a baseline behavioural repertoire for the gender/age classes of seals at the specific sites as it samples all occurrences of biologically important behaviours (Altmann, 1974). With this information the time spent in certain behaviours at the different sites can be compared, and further analyses to examine if the impacts of tourism differ between sexes and age classes can be undertaken.

Focal animal data were initially calculated as percentages (Bart *et al.,* 1998). The data were plotted to test for a normal distribution. An Arcsine transformation for percentage or proportion data was used to normalise the data (Dytham, 1999). Data were analysed to look for differences in behavioural repertoire between each gender/age class by a one-way ANOVA (STATISTICA) (Dytham, 1999). Number of interactions and number of changes of behaviour were also tested for normality and then analysed via a one-way ANOVA.

Table 2.4. Ethogram of Seal Behaviour:

These behaviours were used for Focal Animal Sampling: All Gender/Age Classes, Instantaneous Scan Sampling, and for the behaviour of the seals prior to Controlled Approaches. The table includes Rank System for Recording Interactions.

Behaviour	Definition
Resting	Lying down with eyes closed, also included "Supine" lying down with eyes open
Comfort	Grooming, scratching, shifting position/weight, active thermoregulation including waving flippers and lying in a shallow pool
Mother/Pup Interaction	Cow lying on side, pup in oral contact with nipples, also includes body contact i.e. sniffing, caressing etc.
Swimming	Seal mostly submerged in water; diving & loafing included
Active	Sitting up aware, alert or moving, including territorial vertical display of neck
Interaction	Interaction with other animal. The sex/age of seals involved were recorded along with the appropriate code: **0=jaw gape** **1=lunge/chase** **2=wrestle/contact** **3=bite** **4=bite resulting in a wound** **v=vocalise** **s=sniff** as many codes as necessary were used to describe the interaction

2.2.2. Focal Animal Sampling: Mother/Pup Pairs

In order to investigate the mother/pup bond more closely, focal animal samples were carried out on mother/pup pairs during the second field season only. Focal pair data were collected at Tonga Island from a kayak and at Ohau Point, Kaikoura and Island Bay, Whakamoa by land. Pairs were observed if individuals were within 1 m of each other at the beginning of the sample, this was to ensure that the mother was not at sea feeding or that the pup was not orphaned. The pair was observed for an hour and the time spent in various behavioural categories recorded (See Table 2.5). If both individuals moved out of sight sampling was not terminated until the hour was completed. This was different to the previous focal sampling because adult females and their pups have small territories and are easier to track (Stirling, 1971) and if they go for a swim they will always come back to the same territory. While the animals were out of sight the observer watched the area where the pair was last seen, in case either individual returned. Due to the strong site fidelity of fur seals (Stirling, 1971) it was common for either one or both individuals to return to the starting point.

Times spent in each behaviour were converted to percentages by dividing the time spent in a behaviour by the total time at least one of the pair was in view. If one of the pair was in view then the observer could reliably evaluate behaviour, however, if both seals were out of view no meaningful data could be collected. Association time was calculated by adding the amount of time spent 'Suckling', 'Nuzzling' and 'Other behaviour less than 1 m apart'. Separation was calculated by combining the 'Mum away' and 'Pup away' categories. Data were again tested for normality and an Arcsine transformation used to normalise the data, which were then analysed through a one-way ANOVA (STATISTICA) to test for significant differences in behavioural categories between sites (Dytham, 1999).

Table 2.5. Ethogram of Seal Behaviour Used for Focal Mother/Pup Pairs

Behaviour	Definition
Suckling	Cow lying on side, pup in oral contact with nipples
Nuzzling	Behaviour other than suckling with mother and pup still in physical contact, i.e. lying on each other, sniffing and caressing
Other <1 m	Other behaviours such as resting and grooming where the two are still within a meter of each other but not in physical contact, may include following one another and swimming together
Mum Away	The mother moves greater than a meter away and the pup does not follow, cow may be in sight or out of sight, however the cow has initialised separation
Pup Away	The pup moves greater than a meter away and the mother does not follow, pup may remain in sight or move out of sight, however the pup has initialised separation
Out of Sight	This is the period of time both individuals are out of sight

2.2.3. Instantaneous Scan Sampling

Instantaneous scan sampling (Altmann, 1974) was used to examine behaviour across the whole colony. Instantaneous scan sampling is a unique way of determining all occurrences of particular behaviours for a large group of animals by scanning the area and recording the behavioural state of each animal and has been used to investigate impacts of tourism on other species (Kovacs and Innes, 1990; Lidgard, 1996; and Suryan and Harvey, 1999). The main benefit of this method is that the data obtained approaches a simultaneous sample of all individuals at a given time. Again the data can be converted into percentages to show the amount of time the group spends in each behaviour (Altmann, 1974).

Scans were usually performed from land and all animals in view of the observer were counted within a defined set of landmarks. Scans at Lynch's Reef were carried out from the cliff top using a Geoma 80-A 80 mm x28, 65 mm x22 spotting scope. Scans on the west side of Tonga Island were carried out from a kayak. At all sites, seals in the water were counted if they were within the farthest outlying exposed rock. Scans were taken every 10 minutes for an hour, with the last scan at the end of sixty minutes, giving a total of 7 scans (i.e. 9am, 9:10, 9:20, 9:30, 9:40, 9:50, 10am).

The ten-minute sampling schedule was chosen to be the shortest time frame necessary to complete a scan. While scans at small sites would only take a minute, the largest sites, Tonga West, Lynch's Reef and Ohau Point 2 and 3 would require 10 minutes to count all of the seals. In order to make comparisons between sites, the sample schedule needed to be consistent, therefore 10 minutes was chosen. For each scan, every seal in a defined area was classified into one of five behavioural states: Resting, Comfort, Swimming, Active and Mother/Pup (Table 2.4). These states were chosen because of their biological importance to the seals, thus they are likely to spend a reasonable amount of time in these behaviours, they are also broad behaviours that will be easy to follow or determine when looking through a spotting scope.

Each scan hour was tested via a Chi-squared test of homogeneity to see if behaviour changed significantly over the hour period (Dytham, 1999). If there was a significant change during the observation period, the tourist traffic recorded for that hour was referred to see if any tourist disturbance coincided with the change in behaviour. Chi-squared analyses were run using a smaller confidence interval of 99.5% to maintain the overall significance level as a result of several comparisons being made (Bart *et al.*, 1998). Prior to running the ANOVA, an Arcsine transformation was performed to normalise the scan data. All scans were compared using a one-way ANOVA to look for differences in behaviour between sites (Dytham, 1999).

2.2.3.1. Calculation of Activity Level in a Colony Under Undisturbed Conditions

Out of 162 total scan hours, 85 hours contained behavioural data on seals where no tourist disturbance was present. Activity other than swimming, grooming and thermoregulating was averaged for these 85 hours to determine the average proportion of the colony that may be active at any given time under normal conditions. Swimming, grooming and thermoregulating were excluded from this analysis because they are not common behaviours indicative of a disturbance, wheras the behaviour used, 'Active' can be indicative of a disturbance (Barton *et al.*, 1998). For example, a seal will not start grooming in response to a disturbance, instead they are more likely to move away from the stimulus, or become active. By comparing this value to experimental seal response data (See Chapter 4: Sections 4.2.3. Calculating a Minimum Approach Distance, and 4.2.4. Guided Walk) it can be determined what level of disturbance may be detrimental to the colony. Along with statistical analysis of controlled approaches this value can be used to gauge the level of the effect of tourist approaches by seeing how far activity levels are being raised above an 'undisturbed' state and what factors of the approaches may lessen this change.

2.3. Controlled Approaches and Experimental Manipulations

In order to investigate how various disturbance factors affected the seals at each of the study sites, a series of controlled approach experiments were carried out. This method has been used to some extent in other tourism impacts studies (Barton *et al.*, 1998; Wright, 1998; and Shaughnessy *et al.*, 1999) however the details of the method differ slightly between studies depending on what the researchers were trying to examine. In this thesis controlled approaches were used to test the role of approach route (i.e., land, kayak or motor boat), the frequency of approaches, the number of people approaching, the impact of different noises, and the distance and angle of approach. The sex and age of each animal approached was recorded as well as date, time, weather and sea conditions.

Seal behaviour prior to the approach was evaluated using the parameters outlined in Table 2.4. Controlled approaches were carried out and the following approach data were recorded: distance between the approacher and seal when the seal became aware of the approach (seal followed the approacher with their eyes), and the distance at which the seal responded to the approacher. Seal responses were ranked according to Table 2.6.

All approaches were analysed using Chi-squared tests of independence to see if seal responses were dependent upon site or the particular approach parameter being tested (Bart *et al.*, 1998).

Table 2.6. Response Ranks Used for Seal Behaviour in Response to Disturbance

Response Rank	**Definition of Response Rank**
Interaction	Non-aggressive movement towards stimulus
Neutral	No apparent response
Change Behaviour	Change in behaviour including looking up, becoming alert
Avoidance/ Aggression	Vocalise, threat, enter water, flee

2.3.1. Single Approaches: Land and Kayak

A single person would approach a seal by foot or in a kayak in a cautious manner until the seal responded or the approacher could no longer advance in a safe manner (usually around 1-2 m). Target seals were chosen that were predominantly at the periphery of the colony and therefore easily accessible. These seals were chosen to avoid causing a large disturbance to the colony, which would most likely result in all seals moving into the sea prematurely or even affect later observations such as Focal Animal samples and Instantaneous Scans. Seals at the periphery of the colony are also those most likely to be disrupted by tourists. The target seal(s) had to have been undisturbed by tourists for at least 10 minutes prior to an experimental approach. In Barton *et al.* (1998), 30 minutes was used however this made replication difficult in areas of frequent disturbance such as the Kaikoura Peninsula Carpark, and 10 minutes is a closer approximation of the average time in between tourist approaches to seals. From preliminary sampling the recovery time (the time it took for the seals to return to their prior behaviour after responding to the approacher) of a seal depended on the level of disturbance, which was indicated by the way in which the seal responded. If the seal only looked up their recovery would be immediate, if they sat up recovery occurred as soon as the disturbance was out of sight, if the seal moved away or entered the water their recovery might take up to an hour or more, however these seals were no longer available for further approaches. For these reasons, 10 minutes was chosen to be enough time to allow a seal to recover from a previous approach and to also be a realistic approximation of the frequency of a tourist approach. Following the approach the researchers moved out of sight of the seal and waited 10 minutes, after which the recorder noted if the seal had returned to its prior behaviour or not. This time frame also allowed for more approaches to be carried out in a session.

2.3.2. Frequency Approaches

A range of 6-9 seals were selected as subjects. One seal would be approached every five minutes beginning with Seal #1 finishing with Seal #6. Five minutes after Seal #6's first approach he/she would be re-approached and so on back to Seal #1. The end result was six seals all approached twice in different time frames (i.e. Seal #6, twice in 5 minutes, Seal #1, twice in 60 minutes).

Table 2.7. Example Scenario of Frequency Approaches:

Seal Number	1	2	3	4	5	6
1st Approach	9am	9:05am	9:10am	9:15am	9:20am	9:30am
2nd Approach	10am	9:55am	9:50am	9:45am	9:40am	9:35am

2.3.3. Group Approaches

Group approaches were carried out at Kaikoura with five volunteers. One target seal or a small group of seals (up to about 15) were used for each session. The number of approachers was chosen randomly, the options being 1 male, 1 female, then groups of 2, 3, 4, or 5 people of mixed gender. The same male and female were used for the single person categories to eliminate possible bias of size or other characteristics. The same protocol was followed as for the single approaches and the same details recorded.

2.3.4. Motor Boat Approaches

Boat approaches were carried out with the assistance of the Department of Conservation field offices at Kaikoura, Motueka and Akaroa. Boat approaches were made by passing at a speed of ~5 knots at a variety of distances ranging from 5-100 m depending upon conditions. The speed was chosen to keep wake and noise to a minimum, a slow speed also allowed the observer to more easily follow all of the seals' responses. The boats in general remained side on to the seals (90%) but did occasionally move head on towards a group (10%), a side on profile was preferred as it was safer at the close distances of some of the approaches, and was a more realistic simulation of tour boat approaches, most of which approach side on except when turning to avoid getting too close to the rocks.

2.3.5. Impact of Anthropogenic (Man-Made) Noise

To investigate the affect of various anthropogenic (man-made) noises on seal behaviour, a playback experiment was carried out at Tonga Island, Kaikoura and Whakamoa by playing a series of noises to the seals.

The noises chosen were a combination of novel sounds such as: rock music, car horn, phone ringing, easy listening music, and some that seals may have been previously exposed to, including: peoples' voices, car and truck traffic, walking on gravel, aeroplanes (2), and dogs barking. The noises were played back using a Sony TC-D5M tape-recorder and 14 inch speakers. Due to the different accessibility of the seals the distance between the seals and the speakers could not be kept constant but ranged between 20-60 m. The observer would note the prior behaviour of the seals, the sound they were exposed to, and a description of any response to the sound. The responses were ranked according to Table 2.6.

2.4. Observations of Commercial and Private Tourist/Seal Interactions

2.4.1. Tourist Approaches

All tourist approaches (i.e. boat, person, or kayaks in the vicinity of seal/s) were recorded opportunistically whenever they occurred. The type of approach, distance between the approacher and the closest seal and response of the seal(s) were recorded. Animal responses were ranked according to Table 2.6. Land, kayak and boat traffic were analysed in a similar manner to the controlled approach data. Chi-squared tests of independence (Bart *et* al., 1998) were used to detect any difference in response patterns between sites or to variability in approach parameters, for example, the current Department of Conservation minimum approach distances.

2.4.2. Guided Seal Walk

A guided seal walk at Lynch's Reef, Kaikoura was run during the summer of 2000-2001 on a trial basis under a temporary permit from DOC. Observations were made on this walk in a similar manner to tourist approaches (See Section 2.4.1. Tourist Approaches), where the number of tourists, distance to seal(s) and the response of the seal(s) were recorded (See Table 2.6. for ranks). The data were used to compare percentage of seals responding to approaches of different distances and to approaches of different group size. Data were also compared to private traffic to assess if the presence of a guide decreases the likelihood of seals changing their behaviour and/or avoiding the tourist. The data were compared using Chi-squared tests of independence.

2.4.3. Commercial Swim-With-Seal Programmes

Seal swims are becoming more popular as a summer tourist attraction, with one commercial seal swim at Tonga Island and three at Kaikoura. Seal swims were observed at both Tonga Island and Kaikoura in order to assess whether organised swim programmes are impacting the seals in any way. The proportion of seals interacting, showing no apparent response, or avoiding the swimmers were recorded and used to compare the approach types and various strategies used by the four seal swim companies (Constantine and Baker, 1999). The date, time, weather and sea conditions were recorded for each swim observed, along with the company, approach type: (land or boat), number or passengers and the presence or absence of a guide. For every minute of the swim the following were recorded:

- The number of seals on the rocks targeted by the swim and any response (See Table 2.6 for ranks).
- The number of seals swimming within 20 m of the swimmers.
- The number of seals showing interactive behaviours (defined as: swimming within 2 m or less of the tourists, swimming underneath tourists, or leaping around the tourists).
- The number of seals showing no apparent response (defined as: neutral but also included slow movement away).
- The number of seals showing avoidance behaviours (defined as: seals exiting the water, fast porpoise away, a sudden splash and dive to resurface greater than 20 m, or a threat).

Data from the seal swims were converted to percentages for the three response categories and were Arcsine transformed for normality. A one-way ANOVA (STATISTICA) was used to compare responses based on the various tour operators, the approach type and the tour group's size (Dytham, 1999). Data were also compared to observations made on private seal swims in order to assess whether or not organised seal swims are effective in reducing the possibility of detrimental seal-human interactions.

2.5. Pup Production and Condition

At Tonga Island and Ohau Point pups were caught with a noose or by hand. The pups were sexed, bagged and weighed. Dorsal-ventral length and girth were measured to calculate pup condition. A patch of fur was cut on the top of the head with a pair of scissors (marked) and then the pup was released (Shaughnessy *et al.*, 1995). A day after the pups had been caught, the numbers of marked and unmarked pups seen during a walk-through of the colony were counted and these data were used to calculate a Peterson Estimate (PE) for the site (Seber, 1982). The PE is an estimation of number of pups produced that season based on the following equation:

$$PE= \{(n_l + 1)(n_{l+i} + 1)/ (m_{l+i} +1)\}- 1$$

Where; n_l= the number of pups marked initially, n_{l+i}= the total number of pups recounted, and m_{l+i}= the number of marked pups recounted (Seber, 1982).

A condition index was calculated by regressing $\log_e$ pup mass in kilograms against $\log_e$ length in centimetres for each year class. The regression equation was then applied to $\log_e$ length (L) to give an estimate of predicted mass (M_p):

$$\log_e M_p = a + b * \log_e L$$

Where; a is the slope of the regression line and b is the y-intercept. The condition index was the final result obtained from dividing the observed mass (M_o) by the predicted mass (M_p) (Bradshaw, 1999):

$$CI = M_o / M_p$$

Standard linear regressions (STATISTICA) were used to test for a relationship between the observed weight and expected weight of the pups (Dytham, 1999). Average pup conditions between years and sites were then compared using a one-way ANOVA (STATISTICA) (Dytham, 1999). Peterson estimates were also compared between years and sites in the same manner.

Figure 2.6. Measuring a Pup During Mark-Recapture Experiments at Ohau Point, Kaikoura, 2001

Figure 2.7. Pup with 'Mark' at Ohau Point, Kaikoura, 2001

Chapter 3: Behavioural Sampling

3.1. Introduction

Focal Animal sampling and Instantaneous Scan sampling were carried out at Kaikoura, Tonga Island, and Whakamoa during the Austral summers 1999/2000 and 2000/2001. These methods were applied initially to give baseline behaviour of the seals at different sites. They were also used in order to understand how individual seals might respond to an outside disturbance. Various trends emerge, showing differences in behavioural repertoire of seals between sites as well as significant changes in group behaviour as a response to tourists.

3.2. Results

3.2.1. Site Differences

This study was conducted at three main sites, Kaikoura, Tonga Island, and Whakamoa. Depending upon accessibility and factors such as the number of seals present at each site, not all sample types were carried out at each site. A breakdown of the sites and sampling carried out at each site is shown in the Methods: Tables 2.1-2.3. A comparison of pooled data from this study, based on the different sampling methods, showed significant behavioural differences between sites (Table 3.1). The major differences are based on the:

- Colony Type
- Accessibility of the Site to Kayaks and Boats
- Accessibility of the Site to People on Foot
- Space Available to the Seals on Land
- Prior Exposure to Sea-based Tourism and
- Prior Exposure to Land-based Tourism

Table 3.1. Site Differences

This table shows the key differences between sites, which may influence the way in which seals respond to particular stimuli.

Site (map reference)	Colony Type	Accessibility by Sea	Accessibility by Land	Space Available (density)	Prior Exposure to Sea-based Tourism	Prior Exposure to Land-based Tourism
Tonga East (Fig. 2.4)	Breeding	Easy	Difficult	Little	High	Very Low
Tonga West (Fig. 2.4)	Breeding	Easy	Difficult	Little	Very High	Very Low
Ohau Point 0 (Fig. 2.2)	Breeding	Kayaks: Difficult; Boats: Easy	Moderate	Little	Moderate	Moderate
Ohau Point 1 (Fig. 2.2)	Breeding	Kayaks: Difficult; Boats: Easy	Difficult	Little	Moderate	Low
Ohau Point 2 (Fig. 2.2)	Breeding	Kayaks: Difficult; Boats: Easy	Difficult	Little	Moderate	Low
Ohau Point 3 (Fig. 2.2)	Breeding	Kayaks: Difficult; Boats: Easy	Difficult	Little	Moderate	Low
Ohau Point 4 (Fig. 2.2)	Breeding	Kayaks: Difficult; Boats: Easy	Easy	Little	Moderate	Moderate
Peninsula Carpark (Fig. 2.3)	Non-breeding	Moderate	Easy	Large area low tide; Little at high tide	Moderate	High at low tide
Lynch's Reef (Fig. 2.3)	Breeding	Moderate	Moderate	Little	Moderate	Moderate
Shark's Tooth (Fig. 2.3)	Non-breeding	Moderate	Easy	Large area low tide; Little at high tide	Moderate	High at low tide
Barney's Rock (Fig. 2.2)	Breeding	Kayaks: Difficult; Boats: Easy	Difficult	Large area low tide; Little at high tide	Moderate	None
Barney's Rock haul-out (Fig. 2.2)	Non-breeding	Moderate	Easy	Little	Low	Moderate
Whakamoa Reef (Fig. 2.5)	Non-breeding	Kayaks: Difficult; Boats: Moderate	Difficult	Large	None	None
Bull Caves (Fig. 2.5)	Breeding	Kayaks: Difficult; Boats: Moderate	Difficult	Little	None	None
Two Bulls (Fig. 2.5)	Breeding	Kayaks: Difficult; Boats: Moderate	Difficult	Little	None	None
Ball Rock (Fig. 2.5)	Breeding	Kayaks: Difficult; Boats: Moderate	Difficult	Large	None	None

3.2.2. Focal Animal Sampling: All Gender/Age Classes

A total of 277 focal animal samples were collected: 54 adult males, 65 adult females, 43 pups, 70 sub-adult males and 46 juveniles. These samples were carried out at various sub-sites within Kaikoura, Tonga Island and Whakamoa during the first season (See Tables: 2.1-2.3).

Significant differences were found in the behavioural repertoire between sites of all gender classes except pups (Table 3.2). Bulls changed behaviour the least at Whakamoa ($p<0.0123$). Cows rested the least at Tonga Island, spent the least amount of time interacting with other seals at Tonga Island and swam the least at Whakamoa ($p<0.0002$). Sub-adult males spent the most time in interactions, were involved in the most interactions and changed behaviour the most at Ohau Point ($p<0.003$). Juveniles rested the least and swam the most at Whakamoa ($p<0.000001$). No significant differences were found in mother/pup interactions.

During season one (1999/2000), the focal animal samples covered all gender classes so the individual sample size for each class was relatively small. For example, out of 277 focal animal hours, 65 of those are of cows and 42 are of pups. These data made it difficult to obtain any meaningful understanding of differences in biologically important behaviours such as mother/pup interactions. For this reason, in season two, Focal Animal samples focused on the interactions between mother/pup pairs at the three major sites.

Table 3.2. Behavioural Repertoire of Focal Animals: All Gender/Age Classes The mean percent of time spent in each behaviour by seals of different age/gender classes at different sites. Also shown are the mean number of interactions and the number of behavioural changes for each gender/age class at each site. The p-value from the ANOVA is also given. Values that differed significantly between sites are shown in bold.

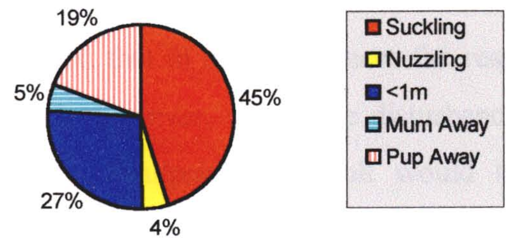
Gender	Site	n	Resting	Comfort	Swimming	Mother/Pup	Active	Interactions	# of Interactions per hour	# of Behavioural Changes per hour	p-value
Bulls	*Whakamoa*	25	69.3+/-6.8%	9.8+/-4.7%	1.5+/-1.3%	N/A	11.4+/-3.0%	8.2+/-3.2%	1.1+/-0.3	**9.2+/-1.5**	**0.012**
	Ohau Point	24	75.3+/-5.7%	5.6+/-1.9%	3.5+/-3.0%	N/A	9.7+/-3.1%	3.5+/-1.2%	3.5+/-1.1	28.5+/-5.2	
	Tonga Island	5	53.9+/-19.5%	9.0+/-4.9%	16.6+/-15.4%	N/A	15.1+/-13.6%	4.5+/-2.9%	3.0+/-0.8	39.4+/-13.2	
Gender Mean			70.5 +/- 4.4%	7.9+/-2.4%	3.8+/-2.1%		11.0+/-2.2%	5.7+/-1.6%	2.3+/-0.5	20.5+/-3.0	
Cows	*Whakamoa*	24	75.2+/-6.0%	4.5+/-1.5%	**0.0%**	8.3+/-4.4%	4.9+/-2.5%	5.1+/-2.8%	0.9+/-0.3	**10.0+/-2.0**	**0.000**
	Ohau Point	25	59.7+/-7.2%	6.1+/-2.0%	6.5+/-3.2%	15.9+/-6.3%	7.0+/-2.7%	2.5+/-0.8%	2.0+/-0.5	18.0+/-2.6	
	Tonga Island	16	**49.6+/-9.7%**	6.4+/-2.3%	24.4+/-9.7%	13.7+/-8.0%	2.0+/-0.7%	**0.2+/-0.1%**	0.2+/-0.1	16.3+/-3.0	
Gender Mean			62.9+/-4.4%	5.6+/-1.1%	8.5+/-2.9%	12.6+/-3.5%	5+/-1.4%	2.9+/-1.1%	1.1 +/- 0.3	14.6 +/- 1.5	
Pups	*Whakamoe*	11	23.4+/-10.2%	5.6+/-1.3%	20.6+/-9.9%	31.6+/-11.1%	14.1+/-4.2%	2.7+/-1.9%	0.7+/-0.3	15.5+/-2.6	0.443
	Ohau Point	22	22.4+/-6.4%	9.3+/-3.0%	11.7+/-3.6%	30.9+/-7.6%	11.6+/-3.0%	3.2+/-1.1%	3.6+/-1.0	27.0+/-3.6	
	Tonga Island	9	29.2+/-13.7%	10.8+/-6.1%	9.2+/-8.5%	36.0+/-14.7%	9.2+/-3.8%	0.6+/-0.6%	0.1+/-0.1	21.2+/-4.4	
Gender Mean			24.1+/-5.1%	8.7+/-2.0%	13.5+/-3.6%	32.2+/-5.7%	11.7+/-2.1%	2.5+/-0.8%	2.1+/-0.6	22.7+/-2.3	
Sub Adult	*Island Bay*	7	49.9+/-15.3%	18.7+/-12.1%	16.5+/-14.1%	N/A	11.9+/-6.1%	3.4+/-3.3%	0.7+/-0.3	7.1+/-3.6	**0.003**
Males	*Whakamoe Reef*	15	66.4+/-8.2%	8.2+/-3.4%	16.1+/-8.0%	N/A	8.1+/-2.4%	0.8+/-0.4%	0.6+/-0.6	13.5+/-2.5	
	Ohau Point	23	57.4+/-7.8%	13.6+/-3.2%	3.9+/-1.7%	N/A	11.4+/-4.2%	**6.5+/-2.2%**	**6.4+/-2.0**	**37.5+/-5.1**	
	Barney's Rock	20	74.1+/-6.5%	21.1+/-6.2%	0.0%	N/A	3.6+/-1.1%	0.0%	0.1+/-0.05	16.5+/-4.0	
	Carpark	5	60.7+/-19.5%	28.0+/-14.8%	1.2+/-1.2%	N/A	5.4+/-3.4%	2.0+/-2.0%	0.8+/-0.6	17.2+/-7.7	
Gender Mean			63.6+/-4.2%	16.1+/-2.7%	6.5+/-0.2%		8.1+/-1.6%	2.8+/-0.8%	2.4+/-0.7	21.9+/-2.6	
Juveniles	*Whakamoa*	14	**26.0+/-8.6%**	10.7+/-3.8%	**51.3+/-9.3%**	N/A	8.0+/-3.3%	3.2+/-1.1%	1.6+/-0.4	12.5+/-1.9	**0.000**
	Ohau Point	24	65.3+/-7.5%	17.1+/-5.1%	5.6+/-4.2%	N/A	3.7+/-1.3%	1.1+/-0.4%	1.4+/-0.5	19.9+/-3.0	
	Barney's Rock	8	60.3+/-13.5	11.3+/-5.1%	19.0+/-12.8%	N/A	6.3+/-1.5%	0.4+/-0.4%	0.1+/-0.13	12.6+/-3.3	
Gender Mean			52.5+/-5.8%	14.1+/-3.0%	21.8+/-5.1%		5.4+/-1.2%	1.6+/-0.4%	1.2+/-0.3	16.3+/-1.8	
Total Mean			56.9+/-2.3%	10.6+/-1.1%	10.0+/-1.4%	20.3+/-3.2%	20.3+/-3.2%	8.0+/-0.8%	1.8+/-0.2	19.1+/-1.1	

3.2.3. Focal Animal Sampling: Mother/Pup Pairs

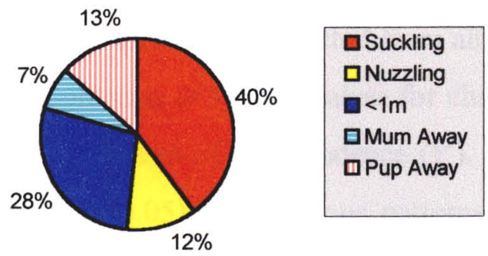
A total of 124 mother/pup pairs were observed during the second season: 40 at Kaikoura, 42 at Tonga Island and 42 at Whakamoa. The only difference observed in the way mother/pup pairs spent their time between sites was in the time spent in the 'nuzzling' behaviour, which was significantly less at Tonga Island ($p<0.019$, $df=234$). No significant difference was found in the amount of time mother/pup pairs spent together at each site ($p<0.4029$, $df=240$). Percent of time in each behaviour is illustrated in Figures 3.1a-c. Focal Mother/Pup Pairs.

Out of 40 focal hours at Ohau Point and 42 focal hours at Whakamoa, few actually coincided with tourist activity due to the low amount of human or tourist disturbance at these sites. At Ohau Point, only 3 focal hours coincided with tourist traffic and in one instance this resulted in the mother/pup pair to break up temporarily. Nineteen pairs out of 40 separated during the course of the hour, the mothers initiated 9 of these and 10 by the pup and on most occasions were related to an interference from another seal. At Whakamoa, a similar pattern was seen with only 3 hours of sampling coinciding with outside traffic, in two of these cases the pair had separated prior to the traffic. The remaining one did not alter behaviour. Eighteen out of 42 pairs separated, with the mother initiating 8 of these and the pup the remaining 10.

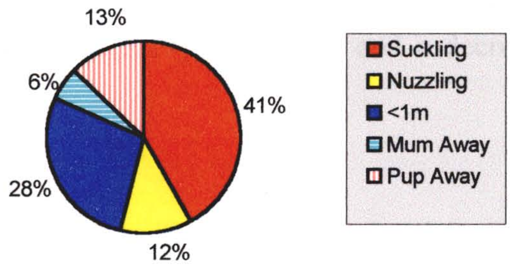
However, of 42 mother/pup pairs observed at Tonga Island, there were 27 instances where either the mother or the pup left or terminated the interaction. The pup terminated 17 of these, and of these 17, 12 coincided with the presence of tourists. Likewise, of the 10 instances where the mother initiated the separation, eight coincided with the presence of tourists. Out of 30 pairs observed in the presence of tourists, 9 changed their behaviour upon the direct approach of a vessel and on 10 occasions behaviour changed that may have been related to the level of traffic rather than an individual approach, while 4 behavioural changes were most likely due to interactions with other seals. On 7 occasions, traffic did not result in separating the pairs or stopping the interaction.



a. Tonga Island, n=42



b. Ohau Point, n=40



c. Whakamoa, n=42

Figure 3.1. Behavioural Repertoire of Mother/Pup Pairs at a) Tonga Island, b) Ohau Point and c) Whakamoa

Focal Animal Mother/Pup Pairs collected over the 2001 summer season. Solid slices represent 'Association Time' while textured slices represent 'Separation Time.' Note that significantly less ($p<0.019$) amount of time Tonga Island pairs spent 'Nuzzling.'

3.2.4. Instantaneous Scan Sampling

Focal animal sampling was reliant on an outside disturbance directly affecting the focal individual/pair. I noticed that in many instances the response of the colony to tourist disturbance was high, however, unless the disturbance specifically impacted upon the chosen focal individual/pair this result would have been undetected. Therefore, to compliment the focal analyses, Instantaneous Scan sampling was used in order to assess the behaviour of the colony as a whole in response to an outside disturbance.

A total of 162 one-hour scan samples were collected from all sites. One hundred and eighteen scans involved enough seals (>30) to analyse for changes in behaviour over the hour period via Chi-squared tests of independence (χ^2). For seventeen of these scans, significant differences ($p<0.05$) in behaviour patterns were observed (Table 3.3).

Most of the significant behavioural changes appeared to be triggered by a human disturbance (12/17), which resulted in an increase in the number of fur seals involved in active (12/17) or swimming (5/17) behaviours and a decrease in the number of seals resting (10/17).

There were 63 scan hours where traffic was observed and the number of seals present was high enough to statistically analyse. Of these, 12 hours showed behavioural changes (See Table 3.3) while 51 remained unaltered. More tolerance to traffic was observed at Tonga Island where 38 of 41 instances of traffic did not result in a behavioural change compared to 6 of 9 at Ohau Point, 6 of 11 at Lynch's Reef and 1 of 2 at Whakamoa.

Table 3.3. Significant Individual Instantaneous Scans

The observed number of behavioural changes in the colony, which were significantly different from the expected values. The column χ^2 Behavioural Changes' shows the time during the sampling hour at which the change occurred and the actual number of seals involved in a behaviour versus the predicted. P-values in bold are those scans where the changes observed could be attributed to tourist traffic.

Behavioural Trigger	Site	Dates	χ^2 Behavioural Changes Time in min. (Actual vs. Predicted)	p value
Power Boat	Tonga West	2-Feb-00	Resting 50(7 v. 16) Active 50(14 v. 5)	**0.001**
Level of Traffic	Tonga West	20-Feb-00	Resting 0(37 v. 26), 50(17 v. 29) Comfort 10(4 v. 14), 50(22 v. 13)	**0.001**
Level of Traffic	Tonga West	29-Jan-01	Resting 40(4 v. 11) Swimming 40(9 v. 5)	**0.005**
Observer 60-80 m from seals in breeding area	Ohau Point	10-Feb-00	Resting 0(52 v. 67) Active 0(21 v. 9)	**0.001**
Unknown	Ohau Point	19-Jan-00	Swimming 0(15 v. 6), 20(0 v. 7) Active 20(20 v. 13)	0.001
Tourists at lookout	Ohau Point	23-Jan-00	Resting 10(63 v. 76) Swimming 10(28 v. 8)	**0.001**
Unknown	Ohau Point	6-Feb-00	Active 50(16 v. 8) Swimming 50(2 v. 8)	0.005
Weather cooling, Power boat present	Ohau Point	17-Jan-01	Active 40(7 v. 12) Swimming 40(3 v. 5) Comfort 40(16 v. 11)	**0.025**
Unknown	Lynch's Reef	15-Dec-99	Resting 0(25 v. 32), 60(41 v. 35) Active 0(16 v. 9), 60(3 v. 9)	0.005
Tourists 20-40 m from breeding area	Lynch's Reef	15-Jan-00	Active 20(13 v. 5)	**0.001**
Tourist in breeding colony	Lynch's Reef	13-Jan-00	Active 30(18 v. 11)	**0.005**
Tourist in breeding colony	Lynch's Reef	15-Jan-00	Active 0(60 v. 24) Resting 0(42 v. 73)	**0.0001**
Unknown	Lynch's Reef	20-Nov-00	Active 0(14 v. 7), 60(0 v. 7)	0.001
Seal Swim	Lynch's Reef	17-Jan-01	Active 40(22 v. 8) Resting 40(40 v. 53)	**0.001**
Snorkellor on land at 20 min. Boat passes close at 60 min.	Lynch's Reef	22-Jan-01	Active 20(12 v. 7), Swimming 60(12 v. 5)	**0.05**
Power Boat	Two Bulls	15-Jan-00	Active 10(22 v. 14) Resting 10(7 v. 15)	**0.025**
Increasing temperature	Ball Rock	12-Mar-00	Resting 20(26 v. 20), 30(15 v. 28) Swimming 20(2 v. 17), 30(24 v. 15)	0.001

3.2.4.1. Within Site Differences

Instantaneous scans were compared between sites. Initially they were broken down into the various sub-sites to look for any differences within the three locations, before pooling site data (See Section: 3.2.4.2: Between Season Differences: General Trends). Table 3.4a shows the percent of time seals engaged in each behaviour for sub-sites during the first field season and Table 3.4b shows the same details for the second field season. Values in bold are those that are significantly different than the others for Season One (Rao's R [test statistic calculated from ANOVA] [48, 248]=3.503, $p<0.00001$) and Season Two (Rao's R [40, 252]=4.876, $p<0.00001$). During the first season, resting was low at Tonga West while swimming was significantly higher. Activity was low at Ohau 2 and Barney's Rock and Swimming was low at Lynch's Reef. Mother/pup interactions appeared low at all Ohau sub-sites and Lynch's Reef. For the second season, resting was low at Tonga Island, Ohau 0 and 1. Activity was low at Barney's Rock, and was the highest at Ohau 0. Swimming was highest at Tonga Island and Ohau 0, 1, and 3 while it was low at Barney's Rock, Two Bulls and Whakamoa Reef.

Table 3.4a. Behavioural Repertoire of Seals at Colony Level, All Sub-Sites, Season One (1999/2000)

Mean time seals spent in each behavioural category at various sites during the first season (1999/2000). n= the number of sampling hours. Values in bold differed significantly from the other sites with $p<0.0001$ using a one-way ANOVA. Note: two scans carried out at the Kaikoura Peninsula carpark are not included.

Sites	n	Resting	Active	Comfort	Swimming	Mother/Pup
Tonga East	5	52.3%	15.5%	13.1%	13.3%	6.9%
Tonga West	13	**43.5%**	13.6%	9.4%	**25.1%**	8.5%
Ohau 0	5	51.4%	24.9%	15.5%	7.9%	**0.4%**
Ohau 1	4	61.1%	18.6%	11.5%	6.2%	**2.6%**
Ohau 2	6	71.5%	**9.5%**	13.0%	6.0%	N/A
Ohau 3	4	73.5%	10.9%	8.6%	6.2%	**0.8%**
Ohau 4	5	48.3%	28.4%	13.9%	6.8%	**2.6%**
Lynch's Reef	10	72.9%	13.3%	10.7%	**2.9%**	**0.2%**
Barney's Rock	9	65.4%	**10.4%**	15.6%	8.7%	N/A
Whakamoa Reef	4	48.7%	15.7%	15.5%	20.1%	N/A
Bull Caves	5	57.2%	19.2%	10.1%	7.7%	1.1%
Two Bulls	5	61.2%	22.5%	8.3%	4.1%	4.9%
Ball Rock	5	47.8%	21.1%	7.4%	13.2%	10.4%
Means	6	58.1%	17.2%	11.7%	9.9%	3.8%

Table 3.4b. Behavioural Repertoire of Seals at Colony Level, All Sub-Sites, Season Two (2000/2001)

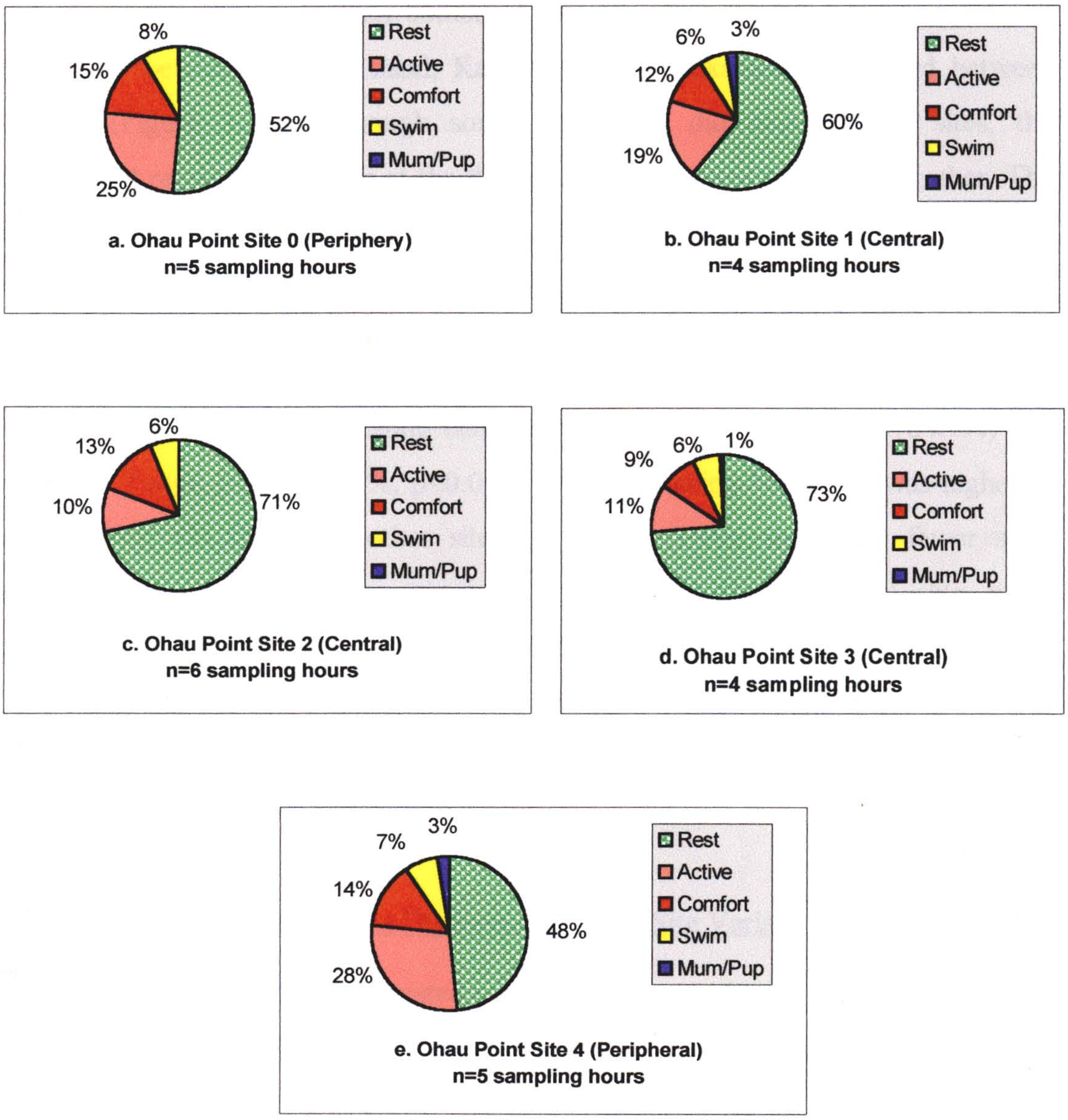
Mean time seals spent in each behavioural category at various sites during the second season (2000/2001). n= the number of sampling hours. Values in bold were significantly different from the other sites with $p<0.0001$ using a one-way ANOVA. Note: One scan from the Kaikoura Peninsula carpark and one from Bull Caves, Whakamoa are not included.

Sites	n	Resting	Active	Comfort	Swimming	Mother/Pup
Tonga Island	32	**54.6%**	16.9%	7.9%	12.4%	8.2%
Ohau 0	3	**37.7%**	**33.0%**	9.1%	20.3%	**0.0%**
Ohau 1	4	**45.5%**	26.6%	9.8%	17.8%	**0.3%**
Ohau 2	4	62.4%	19.3%	7.6%	10.7%	N/A
Ohau 3	5	54.6%	24.8%	7.8%	12.5%	**0.3%**
Ohau 4	4	58.8%	18.8%	10.7%	10.2%	**1.6%**
Lynch's Reef	10	70.2%	13.1%	8.9%	7.6%	**0.9%**
Barney's Rock	4	77.8%	**5.9%**	11.9%	4.4%	N/A
Whakamoa Reef	3	71.8%	13.2%	12.7%	**2.4%**	N/A
2 Bulls	5	66.1%	18.3%	5.9%	**1.1%**	8.7%
Ball Rock	4	69.8%	17.0%	5.4%	**5.6%**	2.3%
Means	7	60.8%	18.8%	8.9%	9.5%	2.8%

3.2.4.1a. Ohau Point Within Site Variation

Most colonies were small enough to view at one time, however, Ohau Point was broken into 5 sub-sites for both seasons, and for Tonga Island, the East and West of the island were treated as separate sub-sites for the 1999/2000 season. One-way ANOVAS were again used to look for any differences in seals' behaviour between sites. There was a slight difference between the two sites at Tonga Island (Rao's R $[4,13]=4.295$, $p<0.019$) with lower resting and higher swimming on the West side, which has fewer rock pools for thermoregulation.

The differences apparent at Ohau Point are illustrated in Figures 3.2a-e. Resting was lowest at sites 0 and 4, while activity was subsequently higher. Sites 0 and 4 are on the edges of the colony, whereas at the internal sites, (1, 2 and 3) resting was high and activity was low (Rao's R $[16, 49]=2.610$, $p<0.005$). For the second season, differences observed at Ohau Point were not as great as the first season, however, from the initial analysis of sub-sites, resting was low at sites 0 and 1 and activity was high at site 1 (Table 3.4b).



a. Ohau Point Site 0 (Periphery)
n=5 sampling hours

b. Ohau Point Site 1 (Central)
n=4 sampling hours

c. Ohau Point Site 2 (Central)
n=6 sampling hours

d. Ohau Point Site 3 (Central)
n=4 sampling hours

e. Ohau Point Site 4 (Peripheral)
n=5 sampling hours

Figure 3.2. Behavioural Repertoire of Seals at the Five Ohau Point Sub-sites a) #0, b) #1, c) #2, d) #3, e) #4

Data collected using Instantaneous Scan Sampling in the 1999/2000 summer field season. Note the significantly lower resting rates and higher activity rates for seals at the peripheral sub-sites 0 and 4.

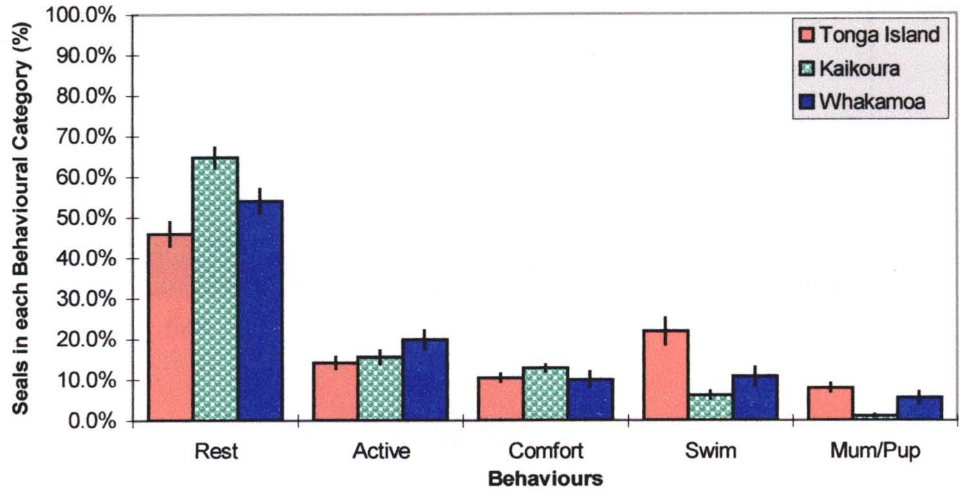
3.2.4.2. Between Season Differences: General Trends

Data from sub-sites were then combined into the three major sites to investigate differences between Tonga Island, Kaikoura, and Whakamoa within and between seasons (Figure 3.3a). Although some differences did occur within sites, the behavioural repertoire of seals at the three main sites tended to clump together. The samples were also carried out across four months at various times of the day to account for the natural variability in the populations.

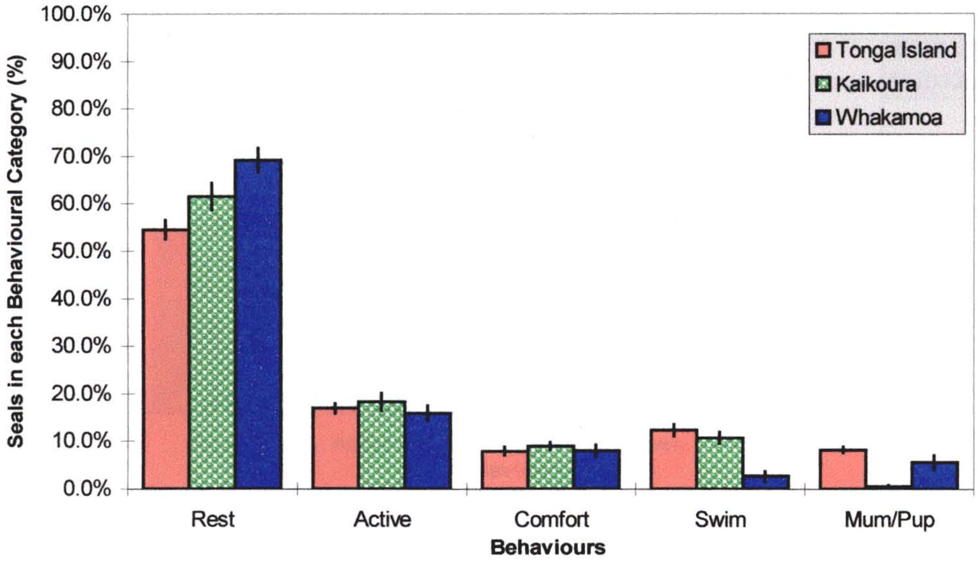
For the 1999/2000 season, resting behaviour was highest at Kaikoura (64.7%) and lowest at Tonga Island (45.9%, $p<0.001$) while swimming behaviour was higher at Tonga West (21.8%) than other sites ($p<0.001$). There were also fewer seals involved in mother/pup interactions at Kaikoura (1.2%, $p<0.000$). No other differences in behaviour were observed. For the following season similar trends were observed (Figure 3.3b). Resting was still lowest at Tonga Island (54.6%) but was highest at Whakamoa (69.2%, $p<0.0001$). Results were similar for swimming and mother/pup interactions.

3.2.4.3. Between Season Differences: Within Site Variation

Although the broad patterns appeared to remain the same over the two seasons some changes were observed within sites over the seasons. These changes are illustrated in Figures 3.4a-b. At Tonga Island, two behavioural categories showed significant changes. Resting increased and swimming decreased in the second field season (Rao's R [5, 44]=3.92, $p<0.005$). The only differences observed at Kaikoura were within the breeding colony at Ohau Point (Figure 3.4b) with comfort and mother/pup interactions decreasing and swimming increasing (Rao's R [5, 38]=8.09, $p<0.0001$).



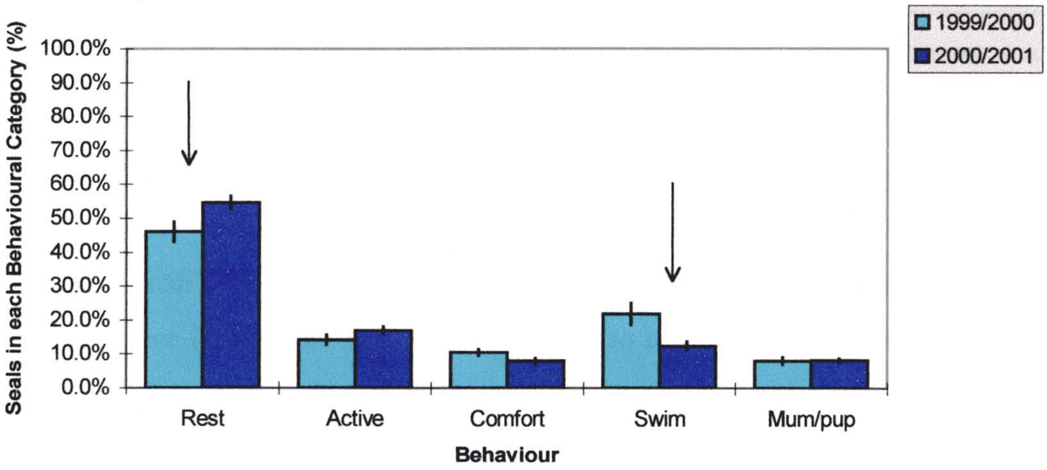
a. Season One
Tonga Island n= 18, Kaikoura n= 43, Whakamoa n= 19



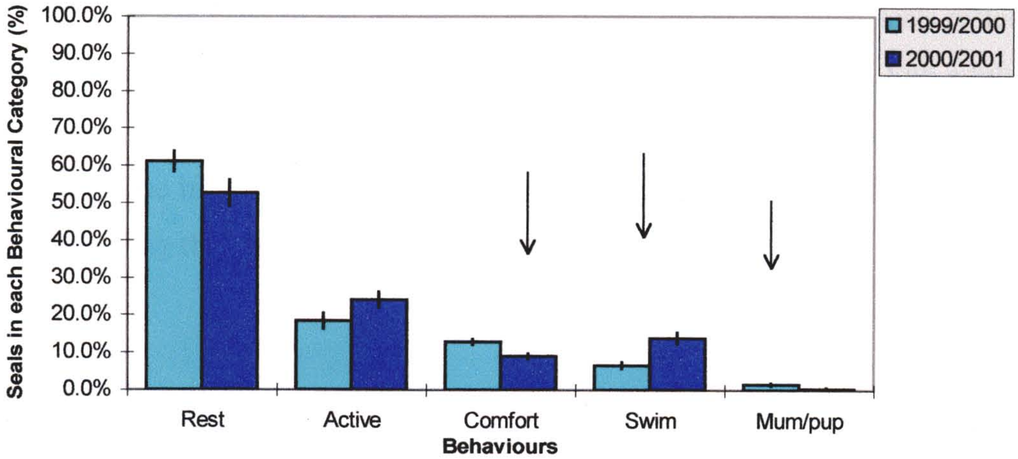
b. Season Two
Tonga Island n= 32, Kaikoura n= 34, Whakamoa n= 12

Figure 3.3. Behavioural Repertoire of Seals During Instantaneous Scans at the Three Major Sites
a) Season One (1999/2000) and b) Season Two (2000/2001)

Note the low proportion of seals resting at Tonga Island for both seasons, while Kaikoura shows high resting in the first season and Whakamoa shows high resting in the second season. Also note the high proportion of seals swimming at Tonga Island for both seasons and the low proportion of Mother/Pup interactions at Kaikoura for both seasons



a. Tonga Island
1999/2000 n= 18. 2000/2001 n= 34



b. Ohau Point
1999/2000 n= 24. 2000/2001 n= 20

Figure 3.4. Seasonal Differences in Seal Behaviour at a) Tonga Island, b) Ohau Point and c) Whakamoa

Data collected using Instantaneous Scan Sampling, significant differences between seasons are shown with the arrows.

3.3. Discussion of Behavioural Data

The results from the behavioural data have provided baseline information on seal behaviour at Kaikoura, Tonga Island and Whakamoa. The results show significant differences in seal behaviour that varies by gender/age class (See Table 3.2), site (See Tables 3.1, 3.4, and Figures 3.2-3.3) and by season (See Figure 3.4). The Instantaneous Scan data provided some interesting information on seal responses to tourist disturbance (See Table 3.3). Seal responses to tourists are likely to depend on a number of factors, such as gender/age class, site, and season, which are illustrated in the behavioural data.

3.3.1. Gender/Age Differences

The initial Focal Animal data showed significant differences in seal behaviour related to the gender and age class of the individual seal. It was found that adult seals rested more than pups (62.9-70.5% vs. 24.1%) of all age classes (See Table 3.2). Sub-adults and juveniles rested less at breeding sites than at non-breeding sites; most likely a consequence of the high level of interactions with other young seals, territorial bulls and cows defending their pups at breeding sites.

3.3.2. Site Differences

Many aspects of the behavioural data showed significant differences in seal behaviour between sites, most of which relates to the level of tourist traffic present at the sites, and the accessibility of these sites to tourists. Focal Animal: All Gender/Age Class sampling showed significant differences in adult gender classes between sites (See Table 3.2). Bulls change behaviour the least at Whakamoa, which may be a result of the low level of disturbance at this site. For example, at Whakamoa, bulls only have to defend their territory from other seals rather than tourists and other disturbances and can spend more time conserving energy. The majority of behavioural changes seen at the control site are likely to be natural behavioural changes and the increased levels seen at the other sites may result from interactions due to outside disturbances (approximately 9 behavioural changes per hour at Whakamoa compared to 29 and 39 per hour at the other sites). A similar pattern was observed for cows, where the time spent resting decreased with increasing tourist activity.

Upon combining the data from the Instantaneous Scans into the three major sites, similar trends to those seen in the focal animal data were apparent. For example, resting was low at Tonga Island in comparison to other sites while swimming was highest (See Table 3.2 and Figure 3.3). When looking at individual sub-sites, activity was also low at Barney's Rock (10.4% in season one, 5.9% in season two, See Table 3.4a-b). These differences are again most likely related to the amount of tourist disturbance the site receives. The haul-out at Barney's Rock is a low density, non-breeding colony which does not receive as much traffic as other sites around the coastline (48 tourists were observed stopping at Barney's Rock in one eight hour day versus Ohau Point and Kaikoura Peninsula carpark which commonly have 50 tourists stop at one point in time). Tonga Island receives the most tourist traffic (150-200 boats/day in the peak of the season) and seals there are often interacting with each other as well as responding to tourists, possibly explaining why resting was observed to be very low at this site (See Table 3.4 and Figure 3.3).

An increase in the time spent in the water at Tonga Island was also observed (23-25% at Tonga West in season one, See Table 3.4a and Figure 3.3a), presumably because the sea is not only a source of food and a way to cool down in extremely hot temperatures, but it is also a means of escape. Seals are incredibly agile in the water and are more able to evade a potentially threatening situation from humans at sea rather than on land. This can be seen not only from their swimming ability but also by the many times a seal has entered the water as a result of a disturbance (Barton *et al.*, 1998; Young, 1998; Born *et al.*, 1999; and Suryan and Harvey, 1999). In this study, 24% of all avoidance responses at all sites resulted in seals entering the sea, and out of 252 tourist traffic observations recorded over the 1999/2000 summer period, 110 seals entered the water as a result of a tourist disturbance.

The time spent resting differed between sites and may be explained by physical factors associated with the site, such as, the ease of tourist access to the site. The expectation being that resting behaviour should be high in areas where the level of outside disturbance is low. This expectation was upheld for the control site, which has no tourist disturbance, as well as a few sites around the Kaikoura coast where access is limited. For example, the lookout at Ohau Point focuses tourist attention on a small portion of the colony (near sites 0 and 4), while the swell along the coast keeps boat, kayak and diver traffic to a minimum, leaving the main breeding area (1-3) relatively undisturbed. In contrast, most of the colony at Tonga Island is visually exposed to boat and kayak traffic and may be why less resting and more swimming behaviour was observed here, 23% compared to less than 15% at the two other sites (See Figure 3.3a).

This breakdown of Ohau Point into smaller sub-sites served as an interesting example of how seals behave relative to their accessibility to tourists. The Ohau Point colony is accessible in two places (See Map Figure 2.2). The first point of access is the lookout, situated over a non-breeding portion of the colony, with Ohau 0 being the closest breeding area to the lookout. Ohau 4 on the North end is the closest breeding portion of the colony to the Ohau Stream carpark, which is the second point of access. Some non-breeders are easily visible to people from this carpark and so many people walk into the colony from this side. At these accessible sites the seals spent less time resting, (52% at Ohau 0 and 48% at Ohau 4) compared to sites sheltered from tourist activity in the middle (60%, 71% and 73%) (See Figures 3.2a-e). Consequently, activity levels were significantly higher (25% at Ohau 0 and 28% at Ohau 4) compared to sites 1,2, and 3 (19%, 10% and 11%). A study investigating vigilance or scanning behaviour in harbour seals (*Phoca vitulina*) in the Bay of Fundy, Canada, found that seals on the periphery of the colony spent significantly more time scanning than seals in the middle of the colony (Terhune and Brillant, 1996).

At Ohau Point in the second season a similar trend was observed with a decrease in resting behaviours extending into Ohau 1, but in year two the effect on Ohau 4 was less noticeable (See Table 3.4b). Observations in the second season, show that pups are closer to the lookout than in previous years and breeding may be expanding from the centre of the colony to the periphery. If this is the case, the tourist activity at the lookout may begin to have a greater impact on this end of the colony by significantly raising their activity levels which may in turn impact on the breeding success of these individuals. The lookout does receive more tourist traffic than the North end carpark and therefore seals at Ohau 0 are more likely to be adversely affected than the seals at Ohau 4, however, the lack of traffic in the middle of the colony allows the central sub-sites to spend more time resting and conserving energy. Analysis of pup production by sub-site might be a useful long-term measure of the impacts of tourist disturbance at Ohau Point.

Another interesting difference observed between sites through Instantaneous Scans was a lower proportion of seals at Kaikoura involved in mother/pup interactions than Tonga Island and Whakamoa (See Fig. 3.3a-b). Approximately six pups are born each year at Lynch's Reef (Barton *et al.*, 1998) and during scans over the last two seasons, were often difficult to see with the spotting scope resulting in low estimates of mother/pup interactions for this sub-site, however, it also appeared low for Ohau Point. This does not fit with the results of the pup condition data collected for Ohau Point, which suggests that pups at Ohau Point are at or above their expected condition (See Chapter 4: Section 4.2.7. Pup Production and Condition).

The sub-sites at Ohau Point contained anywhere from 40-120 seals depending upon the time in the breeding season. This was comparable to other breeding sites observed (i.e. Tonga West and Lynch's Reef both ranged between 40-150 animals). Although each sub-site contained similar numbers of seals the terrain at Ohau Point is very broken, providing many places for pups to hide (Bradshaw, 1999). This may result in a small portion of mother/pup pairs being visible at the time of a particular scan and a subsequent underestimate of time spent in mother/pup interactions at

Ohau Point. The only way to satisfactorily address this problem would be to carry out scans at all five sub-sites simultaneously and combine the data to get a more accurate picture of mother/pup interactions within the colony with the use of video footage. Preliminary field work determined that video-recording also has its disadvantages, depending on the capability and expense of the equipment, so it was not utilised in this thesis. To employ this methodology, approximately five video cameras with colour view finders and high resolution digital enhancement would be required, and the reliability of determining the behaviour of the seals off the screen would need to be tested.

To more closely investigate specific behaviours such as 'mother/pup interactions', focal animal observations were only carried out on mother/pup pairs in the second season and were designed to look at specific behaviours such as suckling and nuzzling. It was hypothesised that sites with more tourist encounters would show lower levels of suckling or nuzzling behaviours. In fact, the only significant difference observed between mother/pup pair association time at different sites was in the time spent nuzzling, which was lowest at Tonga Island (See Figure 3.1a). This does fit with what was expected, although there were no noticeable differences in time spent suckling, or in total association time.

At Ohau Point and Whakamoa there were few or no outside disturbances during mother/pup observations, thus it is unsurprising that no relationship between tourism and mother/pup association was observed. However, at Tonga Island, mother/pup pairs were frequently approached by kayaks or boats (30 out of 42 pairs observed). Boat and kayak traffic around Tonga Island tends to be very predictable becoming heavy from 10am-12pm (72% of boat and kayak traffic recorded in the second season occurred between these hours), dropping off for about an hour and then picking up again from 1-3pm. After 3pm, traffic drops off dramatically as most kayakers have stopped for the day, and after 3pm only a few water taxis and private boats visit the island. While the kayak/boat traffic data is somewhat limited based on sea conditions and the observers position at the time, it does follow the general pattern observed in the park. It was noticed that in the mornings not many mother/pup pairs were visible, however after the traffic dropped off in the afternoons more pairs became visible. It could be possible that, with high levels of tourist encounters at this site, the seals may be able to adjust their daily routine to fit the peaks and lulls of traffic, with mother/pup interactions increasing in number with the decrease in traffic, or with the pairs moving out of sight during times of peak traffic to perform these important behaviours. To address this issue directly it would be necessary to carry out a full day scan focusing on mother/pup pairs and boat traffic around the island.

All three major aspects of the behavioural data show significant differences in seal behaviour between sites, which apparently to relate to the level of tourist traffic present at the colonies suggesting that habituation is occurring. Seals at the control site rest more, while sites with increased tourist activity tend to be more active. The habituation or acclimation of the populations to humans may take several years (Fowler, 1999) and will depend on the ecology of the animal, for example, how far the animal disperses and where it feeds. In a study on dolphin swim operations in the Bay of Islands, Constantine and Baker (1999) suggested that areas with a plentiful food source may support more "resident animals" as they do not need to go as far to find food. Given the abundant food source for marine mammals, the suitable habitat for rearing young, and the high degree of site fidelity observed in fur seals, (Stirling, 1971) the animals at Tonga Island and Kaikoura are unlikely to disperse and subsequent habituation to tourism is inevitable.

3.3.3. Seasonal Differences

Given that habituation occurs over a period of time, it will be likely to influence seal behaviour over time as was observed at Tonga Island and Kaikoura. At Tonga Island more resting was observed in the 2000/2001 field season (See Figure 3.4a). If the weather in the second season had been cooler this change would make sense as seals typically rest more in cooler weather (Stirling, 1970), however, the second season was in fact hotter, windier and drier and from December 2000 to March 2001, it only rained once in the park, which suggests this change may in fact be a habituation response. With increasing tourist traffic the seals are becoming more accustomed to the tourists and continuing with more normal behavioural patterns.

There was also a decrease in the number of seals swimming at Tonga Island. Early in the season (Nov-Dec), the majority of the seals swimming were bulls moving between territories to challenge for the territory (Carey, 1989). There were few seals in the water at any one time in comparison to later in the season. After pupping and re-mating, the males will begin to leave and, as the pups become older, the cows begin to move into the sea for thermoregulation (Barton *et al.*, 1998). In 1999/2000 many cows were observed "loafing" (also called "jug handle", a form of thermoregulation where the seal rests in the water clasping the fore flipper between the hind flippers) off of the island in the mornings before the boat traffic began to arrive. On 8 of 13 occasions, the number of cows "loafing", on the West side of the island exceeded 20 with maximum numbers at any one time ranging from 26-47 (approximately 34% of all seals visible in the scan). The following season this behaviour decreased dramatically. Groups of cows would still be found "loafing" but not in the numbers seen in the previous season. Only twice out of 32 scans did numbers of cows swimming reach 20, the maximum numbers on those two occasions were 20 and 21 (25.5% of all seals visible). This shift in behaviour is interesting although not well understood. There are two possible explanations, one being that with habituation and an increase in seals resting, there may be fewer instances of seals moving into the water for protection. The other reason relates to the increase in boat and kayak traffic, which may increase the chance of a swimming seal getting bumped into or frightened by a boat while in the water. Swimming is another behaviour that warrants more investigation along with mother/pup interactions and should be compared to numbers of vessels around a focal group throughout the day. It may be that cows are waiting on land for traffic to die down to a minimum when the sea will be less congested and safer for swimming.

At Kaikoura, differences between seasons were only observed at Ohau Point (See Figure 3.4b), where there was a decrease in comfort and mother/pup interactions and an increase in swimming. The increase in swimming may be a result of the hot dry summer experienced in 2000/2001 in comparison to the rainy summer in 1999/2000. The decreases in the comfort and mother/pup interactions are not as dramatic although they are significant ($p<0.0001$) and may be due to the slight increase in activity ($p<0.06$). The decrease in mother/pup interactions may also relate to the time at which the scans were carried out. As the pups get older and the cows are spending more time at sea feeding (McNab and Crawley, 1975; Miller, 1975; and Georges and Guinet, 2000), the chance of carrying out a scan on a day or particular time when several mothers are away is quite high and there is bound to be a certain degree of variability in this behaviour. Scans were carried out at a variety of times over a four month period for two seasons in order to eliminate any possible bias from the natural variability inherent in animal behaviour. Although the decrease in mother/pup interactions could be related to a decrease in food resources or an increase in tourist activities, this is not supported by the pup condition data (See Chapter 4: Section 4.2.7. Pup Production and Condition) and would require more long-term work to see if that actually is the case.

3.3.4. Response to Tourist Disturbance

To detect the impact of tourist disturbance on seal behaviour, Instantaneous Scans were the most successful observational method for this purpose. Out of 118 scan hours, which contained enough seals to be statistically testable, behaviour changed significantly during 17 of these individual scan hours. In twelve of these the behavioural changes observed were directly attributable to an external force such as tourist activity (See Table 3.3).

One particular example occurred at the Lynch's Reef breeding colony on the 15th of January 2000 when a man was observed entering the colony at the beginning of the scan. At the time he entered, activity in the colony was high ($p<0.001$) with 60 seals active versus the 24 expected based on baseline observations (See Table 3.3). A partial recovery was observed 40 minutes into the scan when the man exited the colony, however many other people had followed him across the channel during the course of the scan and complete recovery did not occur until the end of the hour and tourists were no longer near the breeding colony.

Only two of thirty-three scans collected at the control site showed significant changes in behaviour. One scan, on the 13th of March 2000 was carried out at midday with air temperatures ranging between 25-30°C. The observed change in behaviour appeared to be a thermoregulatory response as halfway through the scan the number of seals resting decreased while the number of seals swimming increased. The majority of activity observed included seals moving into or out of the sea. The second scan that showed a significant change in behaviour occurred on the 15th of January 2000 when ten minutes into the scan the Akaroa DOC boat was observed in the bay viewing the seals. During this period resting was lower than expected by chance ($p<0.025$).

While not all of the 162 scans carried out contained adequate numbers of seals to be analysed statistically, a number of interesting anecdotal observations are worth reporting. For example, two scans were carried out at the Kaikoura Peninsula carpark in the 1999/2000 season. In both scans, half of the seals remained resting while the other half sat up alert, vocalising at the tourists, and eventually leaving the area. All of the animals in these scans were sub-adult males, suggesting that individual differences were responsible for these reactions rather than gender/age differences. Again, relating to the site fidelity of seals (Stirling, 1971) and the rich food source available from the Kaikoura Canyon (Jaquet *et al.*, 2000), many of the seals around Kaikoura may have become habituated over time. On the other hand, due to the movement of juveniles, sub-adult males and adult males looking for a place to haul-out (Crawley and Wilson, 1976), some seals may not yet be habituated, leading to a strong difference in responses.

Other studies of the tourism impacts upon marine mammals have made similar observations. Gordon *et al.* (1992) while investigating the impact of whale watching vessels on sperm whale (*Physeter macrocephalus*) behaviour found that the sperm whales fell into two distinct categories, the "residents" that were regularly sighted along the continental shelf, and the "non-residents", which included the majority of unidentified whales. The resident whales received a lot of attention from the whale watch vessels and appeared more tolerant of the vessels, while the "non-residents" showed significantly shorter surface times and shorter blow intervals in the presence of boats. Gordon *et al.* (1992) concluded that the differences between these two groups were likely the result of habituation.

3.3.5. Conclusions

While the behavioural sampling provided some useful baseline data, they did not provide enough conclusive data to answer the questions this thesis originally set out to investigate, such as how seals respond to disturbances and what factors affect these responses. Focal animal observations were carried out to obtain a baseline behavioural repertoire for the specific gender/age classes of seals at the specific sites to compare the time spent in certain behaviours at the different sites, and to examine if the affects of tourism differed between sexes and age classes. Focal animal sampling of all gender/age classes was not an useful method for looking at seal behaviour in response to tourists, mainly due to sample size. Although a total of 218 focal animals were observed for the 1999/2000 field, season this was split between three sites, and in the case of the sub-adult males, 5 sub-sites. There were also five gender/age categories that these focal hours were split between. As a result there were too few replicates of each gender/age class at each site to adequately detect differences in behavioural repertoire between sites, which hindered the ability to look more closely at specific behaviours that are critical to the species survival, such as 'mother/pup interactions.' For this reason focal animal sampling for the second season focused specifically on mother/pup pairs.

The results from the mother/pup pairs again did not provide much conclusive data, although this may be due to the way in which the data were collected. The category where both individuals were 'out of sight' was significantly higher at Tonga Island (21% vs. 5 and 7%, $p<0.024$) because the pairs were observed from kayaks. This method was chosen because there is only one place on land where the seals can be observed. Unfortunately, this site is on the East side where only about ten seals are visible at any one time and generally included only one or two mother/pup pairs. Furthermore, landing at Tonga Island causes a huge disturbance to the colony. The main disadvantage of observations from a kayak is that the observer is at sea level and if a mother/pup pair moves behind a boulder they will be blocked from view. In this situation the observer is unable to tell if the pair are together or determine their behaviours. The focal animal data were recalculated out of the total time spent in view and re-analysed without (See Section: 3.2.3. Focal Animal Sampling: Mother/Pup Pairs), and the only significant difference seen was in the amount of time spent nuzzling.

At the other two sites the pairs were observed from steeply sloping beach sites, which gave the observers the advantage of an aerial view. Therefore, even if the pair moved behind a boulder it was still possible to keep them in view. To more accurately compare the behaviours between the sites it would be necessary to observe the pairs from land at all sites, however, due to the nature of Tonga Island this may be difficult without a purpose built hide, which still doesn't eliminate the problems that landing on the island causes.

Focal animal sampling was not effective at observing a given seal's response to a particular disturbance. Frequently, the focal seal was not the target of tourist activity and thus no response was observed. For this reason, Instantaneous Scans (Altmann, 1974) were used to examine the impacts of particular perturbations upon the colony as a whole. Although Instantaneous Scans were more successful in allowing measurement of group dynamics in the presence of a disturbance, the analysis was reliant on a disturbance occurring at the time of the scan, and therefore the results obtained were predominantly anecdotal. To further investigate the responses of seals to tourist activities, it was necessary to undertake some experimental manipulations of approach variables, and will be presented in Chapter 4.

Chapter 4: Experimental Manipulations

4.1 Introduction

Behavioural sampling was unable to adequately show how seals would respond in the presence of a disturbance, because it relied on the presence of a disturbance at that particular time and place. A method was needed to test variables of a disturbance such as approach type, group size, frequency of approach and anthropogenic noise. To this end, Controlled Approaches were carried out on land and by motor boat and kayak. These approaches were used to assess the response of seals to the different approach types and also the distance at which seals were most likely to respond. Approaches were also used to test the impact of repeated exposure to a stimulus (frequency approaches), as well as, the size of the group approaching.

Much of the information gained on tourism impacts is based on observations of behaviours or responses that might be indicative of a disturbance (Gordon *et al.*, 1992; Carlton, 1993; Olson *et al.*, 1997; and Constantine and Baker, 1999). Other studies have investigated breeding success (Giese, 1996), hormonal responses (Fowler, 1999), foraging trip duration (Wilson *et al.*, 1989), and maternal strategies (Kovacs and Innes, 1990; and Lidgard, 1996) Few studies have used controlled approaches to test the impact of tourism on a target species (Barton *et al.*, 1998; Wright, 1998). Another study carried out on New Zealand fur seals used the tour boats as a viewing platform and recorded the behaviour of the seals every 15 seconds for a 2.5 minute period, approximating a typical approach by the tour boats (Shaughnessy *et al.*, 1999).

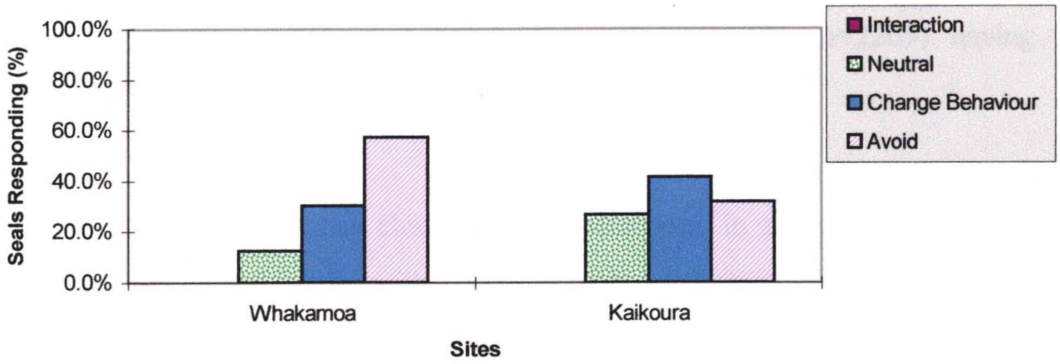
Commercial and private tourist traffic were also sampled to make a real-life comparison to the controlled approaches. A guided seal walk was observed to assess whether a guide might lessen any possible impact to the seals and to compare to the group size controlled approaches. Seal swims were observed to investigate how certain human behaviours may impact the seals targeted by the swim. Various anthropogenic noises were also played to the seals for a preliminary investigation of the impact of noise on seals.

4.2. Results

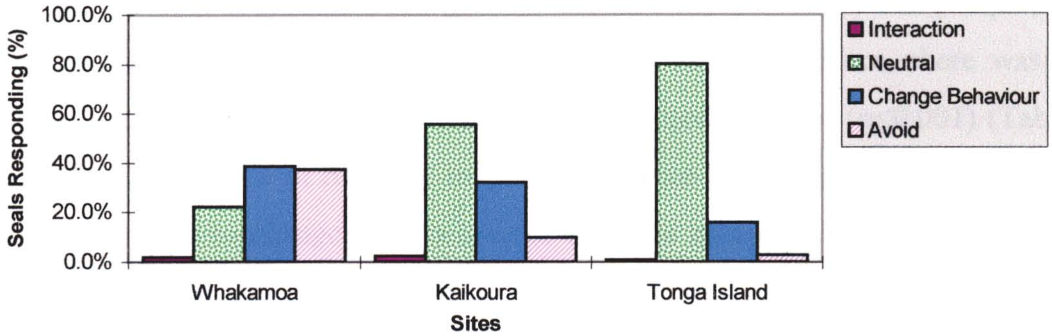
4.2.1. Controlled Approaches

4.2.1.1. Single Approaches

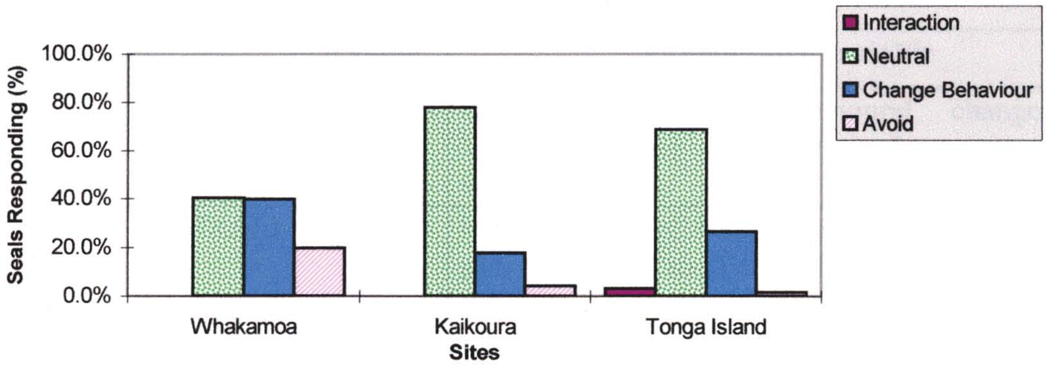
A total of 3538 single controlled approaches (by land, kayak, and boat) were carried out at all three sites during the Austral summers 1999/2000 and 2000/2001. Responses recorded were interaction, neutral and avoidance (See Table 2.6). Responses to different approaches varied by site (Figure 4.1a-c). No interaction responses occurred during land approaches at any sites, whereas all sites exhibit an interaction response to kayaks (0.9-2.3%). Fur seals at Tonga Island were the only seals to exhibit an interaction to boats in the first season (3.3%), however this behaviour was not observed in the second season.



a. Controlled Approaches by Land
Whakamoa n=56, Kaikoura n=256



b. Controlled Approaches by Kayak
Whakamoa n=429, Kaikoura n=131, Tonga Island n=1709



c. Controlled Approaches by Motor Boat
Whakamoa n=323, Kaikoura n=341, Tonga Island n=271

Figure 4.1. Response of Seals at Whakamoa, Kaikoura and Tonga Island to Controlled Approaches by a) Land, b) Kayak, c) Motor Boat
Controlled Approaches were carried out at all sites for both the 99-00 and 00-01 summer breeding seasons. Note the high amount of responses for Whakamoa to all approach types.

Seals altered their behaviour most during land approaches (75.7%, n=321), with boat approaches (36.9%, n=935) and kayak approaches (31.0%, n=2269) having a significantly lower impact (p<0.001).

The proportion of seals that changed their behaviour in response to controlled approaches, also varied by site with 70.3% of seals exhibiting behavioural changes at Whakamoa (n=808), 44.1%, (n=737) at Kaikoura and 19.8%, (n=1980) at Tonga Island.

Significant differences were observed between sites for all approach types (p<0.001 for kayak and boat approaches, and p<0.005 for land approaches). When comparing the three approach types using a Chi-squared test of independence, there was a significant difference in response patterns between approach types (p<0.001) (Table 4.1). Although the type of response may differ between gender/age classes, all seals have the potential to change their behaviour or avoid an approach. Also, minimum approach distances that require the tourist to be able to differentiate between haul-out and breeding colonies are not very practical and are difficult to enforce. For these reasons the responses for genders have been pooled.

Table 4.1. χ^2 Comparison of Approach Type

Approach Type	χ^2	p value	Explanatory variable
Land	17.809	<0.005	High number of behavioural changes at Whakamoa and Tonga Island compared to Kaikoura
Kayak	678.913	< 0.001	High number of behavioural changes at control site compared to Tonga Island, Kaikoura is in between
Boat	136.181	< 0.001	High number of behavioural changes at control site compared to Tonga Island, Kaikoura is in between
All approaches	325.971	< 0.001	Seals changed their behaviour most in response to land approaches compared to kayaks, boats were in between

4.2.1.2. Frequency of Approach

Frequency approaches by kayak were carried out at Shark's Tooth on the Kaikoura Peninsula (n=11 seals approached), and at Tonga East (n=13) and West (n=31) in the first field season (1999/2000). Frequency approaches by land were carried out at Barney's Rock (n=6 seals approached) and Shark's Tooth (n=7). This was a preliminary aspect carried out in the first season, and as of yet no other study has manipulated the frequency of approach to a target animal.

These approaches were used to test if the frequency of approaches would increase the seals chance of responding and the results are illustrated in Tables 4.2a-b. 'Frequencies' were defined as the number of minutes between approaches and varied from 5-60 minutes. There were three possible scenarios that were observed. One possibility was that the seal entered the water or left the area after the first approach, and as this seal was no longer available to approach again, it was classed as 'Left Area.' A second possibility was that the seal responded in either the same way to the second approach as it did to the first, or showed a neutral response, this was classed as 'No Difference.' The final scenario was that the seal responded to a greater degree to the second approach, for example, if a seal's response to the first approach was to 'look' and it's response to the second approach was to 'vocalise' it was included in this group. These seals' responses make up those in the 'minute categories' in the following two tables. For the time between the two approaches, the approacher would move out of sight to allow the target to recover, therefore no seal was alert for the entire period between two approaches.

The frequency between kayak approaches had little effect on the fur seal responses at Shark's Tooth. Only 9.1% of the animals exhibited a greater response to the second approach and these occurred at the highest frequency level with only 5 minutes in between approaches. In contrast 60.1% of the animals approached at Tonga Island responded to a higher degree to a second approach (Table 4.2a). However, during land approaches 42.8% of the seals at Shark's Tooth moved into the water immediately after the first approach. At Barney's Rock none of the animals left the site after the first approach (Table 4.2b).

Table 4.2a. Percentage of Animals that Responded More During the Second Approach by Kayak

	Response of Seals to Frequency of Kayak Approaches (Minutes between 1st and 2nd approaches)								
Site	5	15	25	35	45	55	60	Left Area	No Difference
Tonga Island n=31	12.6%	4.9%	19.6%	3.9%	4.9%	1.6%	1.6%	11.0%	40.15%
Shark's Tooth n=11	9.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	90.90%

Table 4.2b. Percentage of Animals that Responded More During the Second Approach by Land

	Response of Seals to Frequency of Land Approaches (Minutes between 1st and 2nd approaches)								
Site	5	15	25	35	45	55	60	Left Area	No Difference
Barney's Rock n=6	16.7%	0.0%	0.0%	16.7%	16.7 %	0.0%	0.0%	0.0%	49.9%
Shark's Tooth n=7	14.3%	14.3%	14.3%	0.0%	14.3 %	0.0%	0.0%	42.8%	0%

'Left Area' indicates the percentage of animals that entered the water or moved out of the area between the 1st and 2nd approaches. 'No Difference' indicates the proportion of animals that responded to the same or lesser degree on the second approach.

4.2.1.3. Group Size

The effect of group size on fur seal responses was tested at Shark's Tooth and Barney's Rock, Kaikoura during the first field season (1999/2000). A total of 97 seals were approached: 41 at Barney's Rock and 56 at Shark's Tooth. No significant difference in fur seal response due to group sizes of one to five tourists was detected

(χ^2 observed = 3.0076, $p>0.1$). However, there was a significant difference in fur seal responses between sites (χ^2 observed = 8.268, $p<0.005$), with more seals exhibiting an avoidance response at Barney's Rock to all group sizes (Figure 4.2).

4.2.2. Tourist Approaches: Comparison of Approach Type

Land, motor boat and kayak tourist "traffic" data (See Section 2.4.1. Tourist Approaches) from both seasons were grouped according to approach type and plotted in a similar manner to Controlled Approach data. Because of low amounts of land traffic at Tonga Island, kayak traffic at Kaikoura and all traffic types at Whakamoa, all sites have been pooled to show the general trend (Figure 4.3). Again there was a significant difference in seals' responses to various approach types (χ^2=306.7915, $p<0.001$). Land approaches caused more seals to change behaviour, which is a result consistent with that seen in controlled approaches. However, kayak traffic caused more seals to change behaviour than boat traffic, which is the exact opposite to the findings of the controlled approaches.

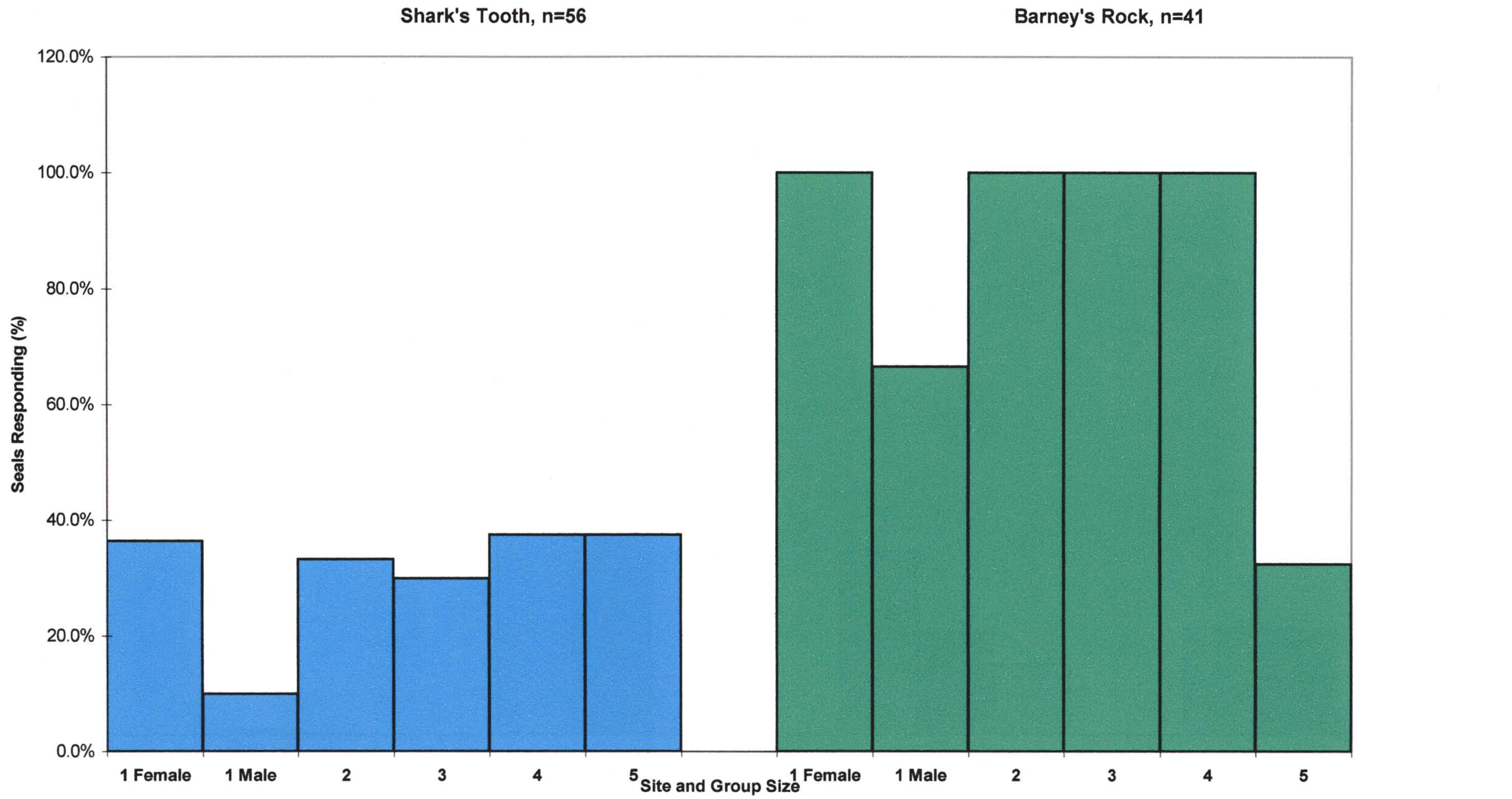


Figure 4.2: Response of Seals to Approaches on Land by Groups of Different Sizes.
No difference was found between group size ($p>0.1$) but note the difference in responses between sites ($p<0.005$)

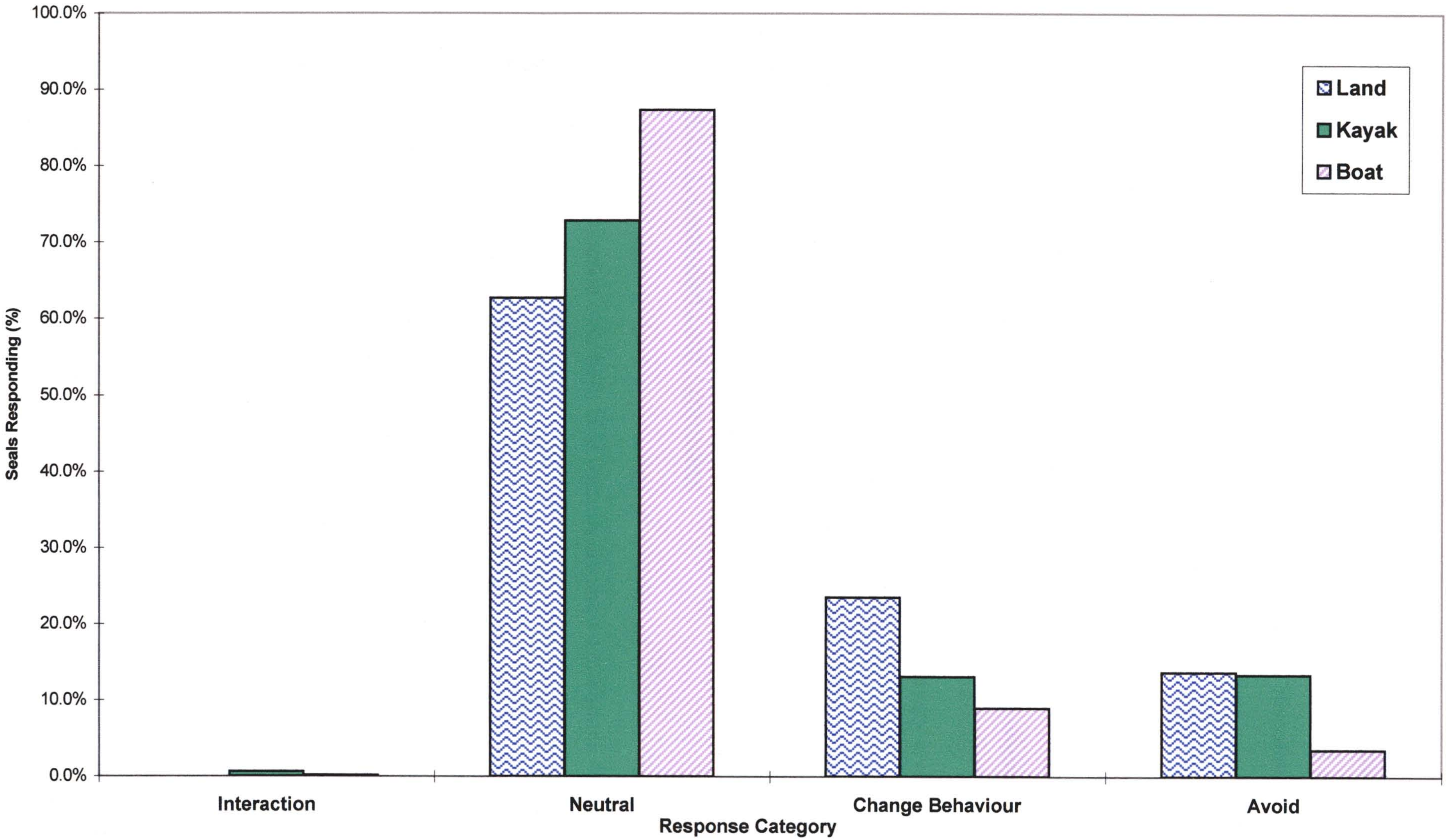


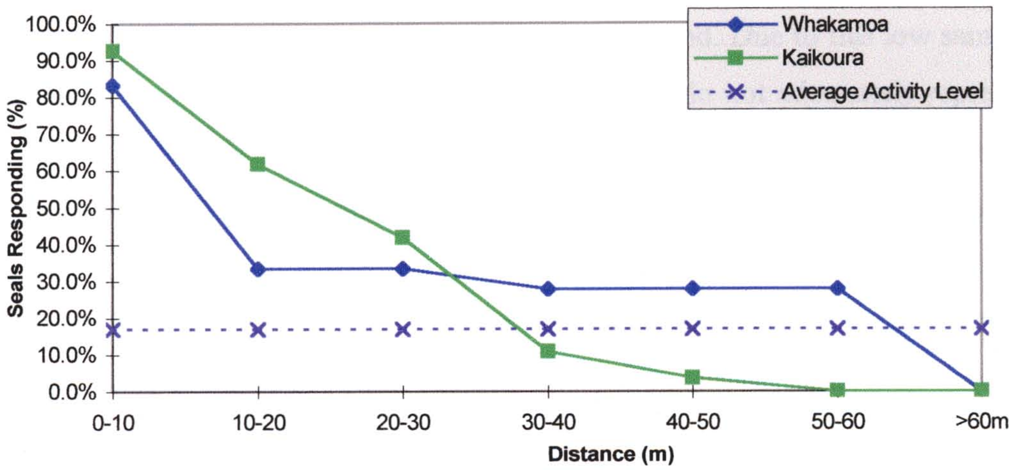
Figure 4.3: Response of Seals to Various Tourist Approaches at All Three Sites From 1999-2001, Land n=1467, Kayak n=874, Boat n=1939

4.2.3. Calculating a Minimum Approach Distance

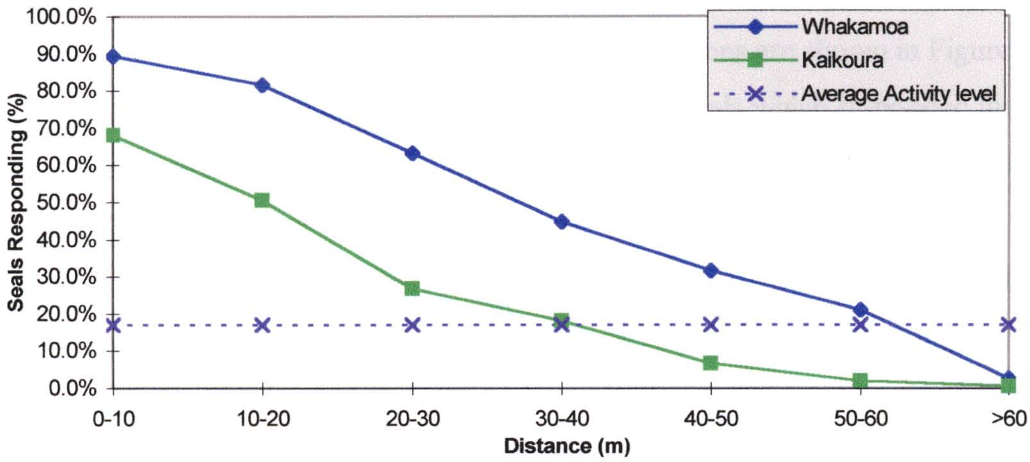
Analysis of 85 hours of Instantaneous Scan sampling data on seal populations at all three sites, without outside disturbances, indicated that fur seals spent about 16.6% +/- 1% of their time engaged in active behaviour. Data on response distance to controlled and tourist traffic approaches by kayak, boat and land were analysed to calculate minimum approach distances using the baseline of 17% active behaviour as an indicator of presence/absence of disturbance. The basic assumption is that if the level of activity increases above this baseline level it suggests that an external factor may be influencing the fur seals' behaviour. Using 17% as the Average Population Activity Level (APAL) is conservative as this includes two sites where habituation may have occurred and seal activity is less likely to change dramatically in the face of a disturbance. This is supported by the fact that the average activity level, calculated from all 162 scans regardless of tourist presence, is 16.8% +/- 0.7% which is similar to the 16.6% calculated for the absence of tourists, suggesting that habituation has occurred at Kaikoura and Tonga Island.

4.2.3.1. Controlled Land Approaches

The responses of seals to land approaches at a series of distances carried out at Kaikoura and Whakamoa over both field seasons are shown in Figures 4.4a-b. Figure 4.4a shows the response of seals to controlled approaches on land in the first field season (1999/2000). The responses of seals at Whakamoa and Kaikoura sites are plotted separately and are compared to the 'Average Population Activity Level' calculated from the Instantaneous Scans (17%). A high proportion of seals (27.8%, n=18) responded to land approaches as far away as 50-60 m at Whakamoa, while the proportion of seals responding at Kaikoura did not increase above the APAL of 17% until the approaches were within 30 m (10.9% to 41.8%, n=55). In the following season, seals at Whakamoa again showed a marked response at around 50-60 m (n=39) and the proportion of seals responding at Kaikoura again increases above 17% (APAL) when the approacher was between 30-40 m (n=210) (Figure 4.4b). Landing on Tonga Island created a great disturbance and to avoid this, land approaches were only carried out in the cove on the northern corner of the island and



a. Season One (1999/2000) Whakamoa n=18, Kaikoura n=38



b. Season Two (2000/2001) Whakamoa n=38, Kaikoura n=210

Figure 4.4. Cumulative Response of Seals at Whakamoa and Kaikoura, to Various Distances of Controlled Approaches by Land in the a) 1999/2000 and b) 2000/2001 Summer Breeding Seasons.

The responses of seals at Whakamoa and Kaikoura Sites are compared to the 17% Average Population Activity Level. Note that in both seasons at Whakamoa, seal responses were above the 17% threshold by 50-60m. Seals at Kaikoura increase activity at 30m for the first season and at 30-40m for the second season.

only if there were seals present upon landing. There was a low sample size, only 2 seals from the first season and 11 seals from the second. Due to this low sample size, the results are not plotted on figures 4.4a-b as they do not adequately represent the population and only offer an idea of how seals might respond. However, all seals that were approached did respond and enter the sea as soon as they were aware of the approach, (a range of 10-30 m). Observations during the mark recapture confirm these findings; all pups ran into crevices and cows entered the sea. If bulls were still at the colony in February (either season) they stayed and defended their territory and only moved into the water if the observers came within 10 m.

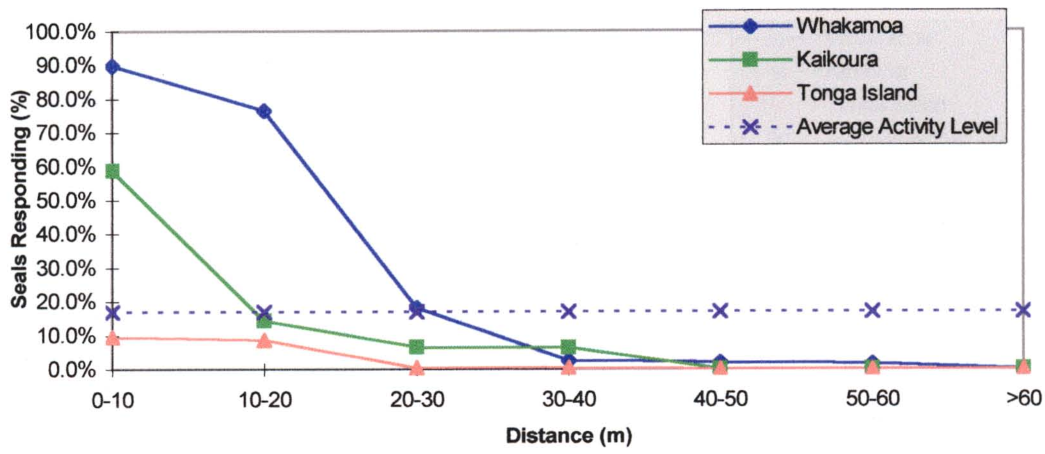
4.2.3.2. Controlled Kayak Approaches

Seal responses to kayak approaches at a series of distances, carried out at Whakamoa, Kaikoura and Tonga Island over both seasons are shown in Figures 4.5a-b. In the first season (Figure 4.5a), the proportion of seals which responded increased above the threshold 17% (APAL) when the approacher was between 20 and 30 m at Whakamoa (18.2%, n=197) and at 10 m at Kaikoura (14.3%-58.7%, n=63), however, it never increased above 17% at Tonga Island (n=691). In the following field season (Figure 4.5b), the proportion of seals responding at Whakamoa increased from 14.7% to 37.9% when the approacher was 30 m away (n=232). Seal responses at Kaikoura increased from 5.9% to 25% at 20 m (n=68). A very different trend was seen in seals at Tonga Island with responses increasing to 26.7% around 10 m (n=1018).

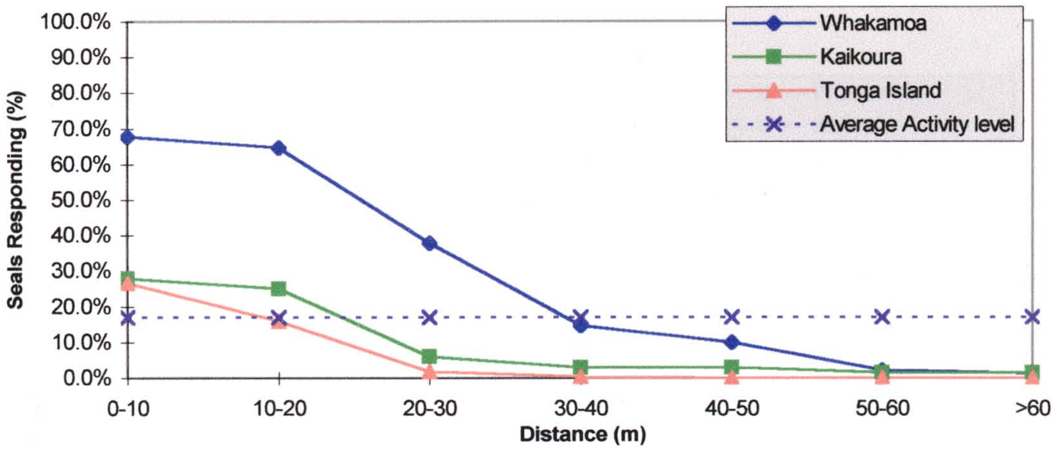
4.2.3.3. Controlled Boat Approaches

Seal responses to motor boat approaches at a series of distances, carried out at all three sites over both seasons are shown in Figures 4.6a-b. Boat approaches in the first season (Figure 4.6a) show 17% (APAL) or more of the seals at Whakamoa becoming active in response to boat approaches when the boat was less than 30 m away (0%-60.9%, n=154). Seals were not approached at closer distances due to rough sea conditions in 1999/2000, so the data line ends at 20-30 m. At Kaikoura, seal responses increased above the 17% threshold when the boat was 20 m away

(16.8%-21.3%, n=199) and at Tonga Island this occurred at 30 m (16.5%-24.5%, n=154). In the second season, (Figure 4.6b) seals at Whakamoa became increasingly active around 40-50 m (17.7%, n=158), while the response of seals at Kaikoura dropped back to around 10 m (15.6%-23.1%, n=187) and at Tonga Island activity never increased above 17% (n=72).



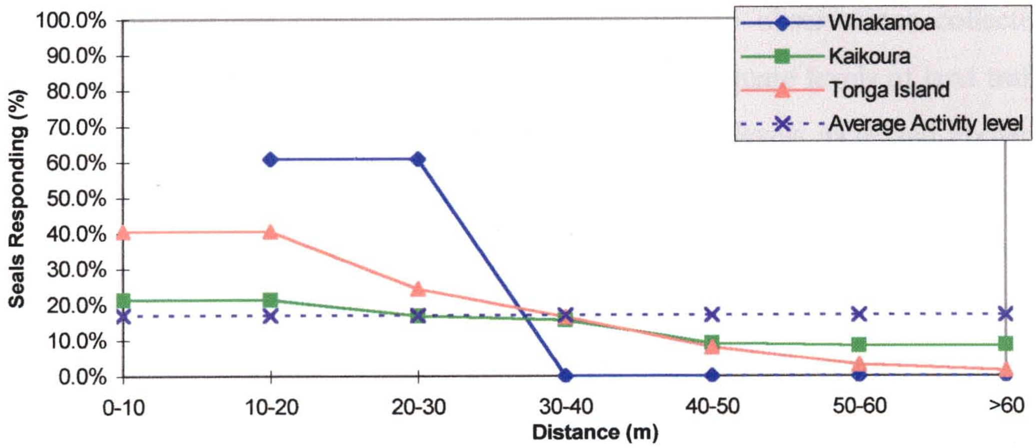
a. Season One (1999/2000) Whakamoa n=197, Kaikoura n=63, Tonga Island n=691



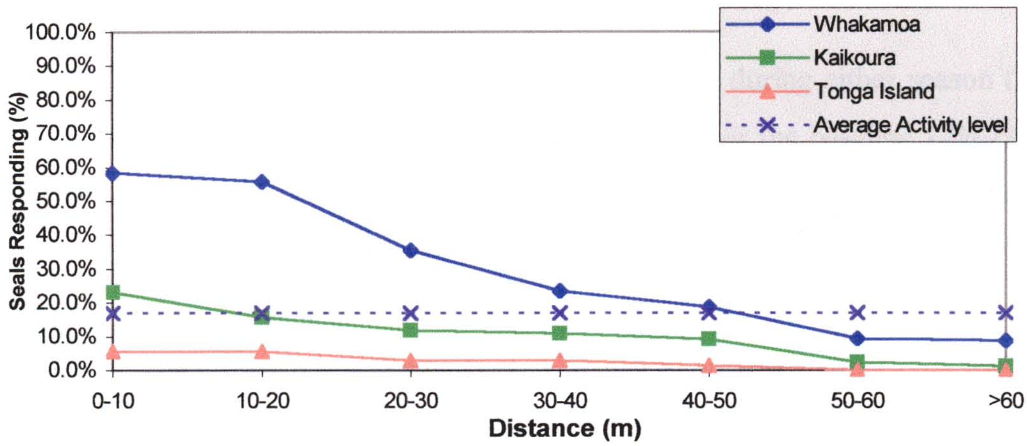
b. Season Two (2000/2001) Whakamoa n=232, Kaikoura n=68, Tonga Island n=1018

Figure 4.5. Cumulative Response of Seals at Whakamoa, Kaikoura, and Tonga Island to Various Distances of Controlled Approaches by Kayak in the a) 1999-2000 and b) 2000-2001 Summer Breeding Seasons.

The responses of seals at Whakamoa, Kaikoura and Tonga Island are compared to the 17% Average Population Activity Level. Note that Seals at Whakamoa increase over this threshold at 20-30m in the first season and around 30m in the second. Seals at Kaikoura increased their activity in response to approaches at 10m in the first season and 20m in the second season. Seal responses at Tonga Island never increase over the threshold 17% in the first season but do increase over this at 10m in the second season.



a. Season One (1999/2000) Whakamoa n=174, Kaikoura n=199, Tonga Island n=154



b Season Two (2000/2001) Whakamoa n=158, Kaikoura n=187, Tonga Island n=72

Figure 4.6. Cumulative Response of Seals at Whakamoa, Kaikoura, and Tonga Island to Various Distances of Controlled Approaches by Motor Boat in the a) 1999/2000 and b) 2000/2001 Summer Breeding Seasons.

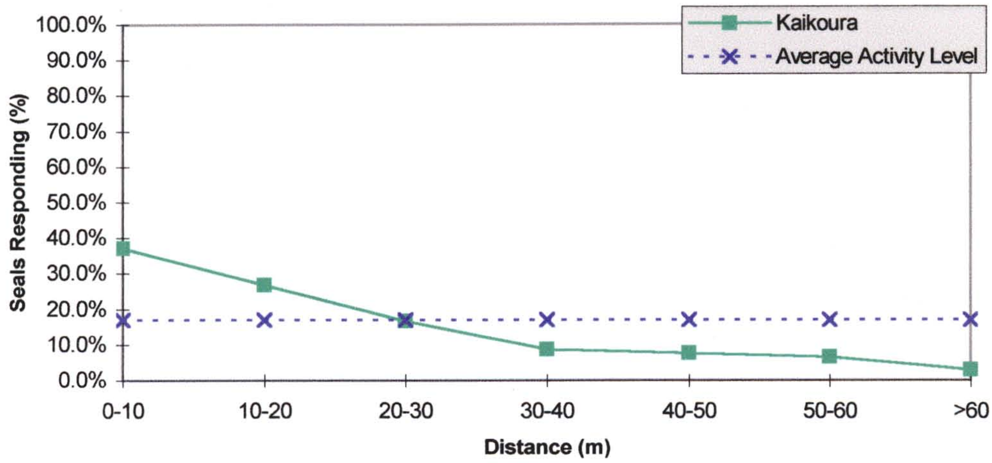
The responses of seals at Whakamoa, Kaikoura and Tonga Island are compared to the 17% Average Population Activity Level. Note that seal responses at Whakamoa increased above this threshold at 30m in the first season and at 40-50m in the second season. Seal responses at Kaikoura increased above 17% at 20m in the first season and 10m in the second season. Seal responses at Tonga Island increased above 17% to approaches 30m away in the first season but they never increased over 17% in the second season.

4.2.3.4. Tourist Approaches

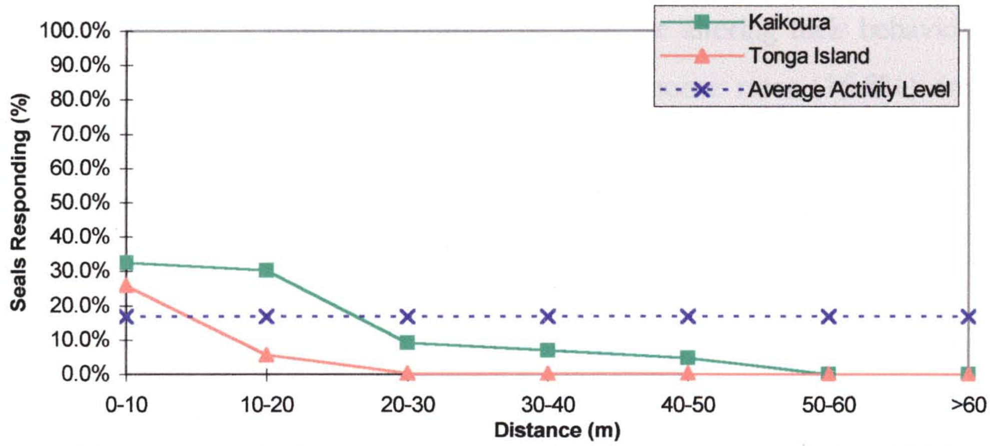
When comparing the controlled land approach data to observations collected on 'tourist foot traffic' Kaikoura was the only site with adequate levels of land traffic to analyse statistically (Figure 4.7a). At Kaikoura activity levels increased above 17% (APAL) when tourists were 20 m away (16.7%-26.8%, n=1171). Only once was outside traffic observed on land at Whakamoa, however, due to the observers' position at the time, distances between the stimulus and the seals were unclear. On this occasion all seals (n=10) barring a single territorial bull entered the water and remained there for more than an hour. Landing on Tonga Island by tourists is extremely rare (<1% of tourists were observed to land on the island) and unless the traffic lands at the cove, there will always be seals within 20-30 m, typically resulting in a disturbance. During the second field season, 10 seals were observed being approached by tourists on land at Tonga Island and all of the seals responded by vocalising and entering the water.

As for kayak traffic, none was observed at Whakamoa during either season (Figure 4.7b). The percentage of seals responding increased over the baseline 17% (APAL) when kayaks approached within 20 m for Kaikoura (9.3%-30.2%, n=43) and 10 m for Tonga Island (5.7%-25.9%, n=804).

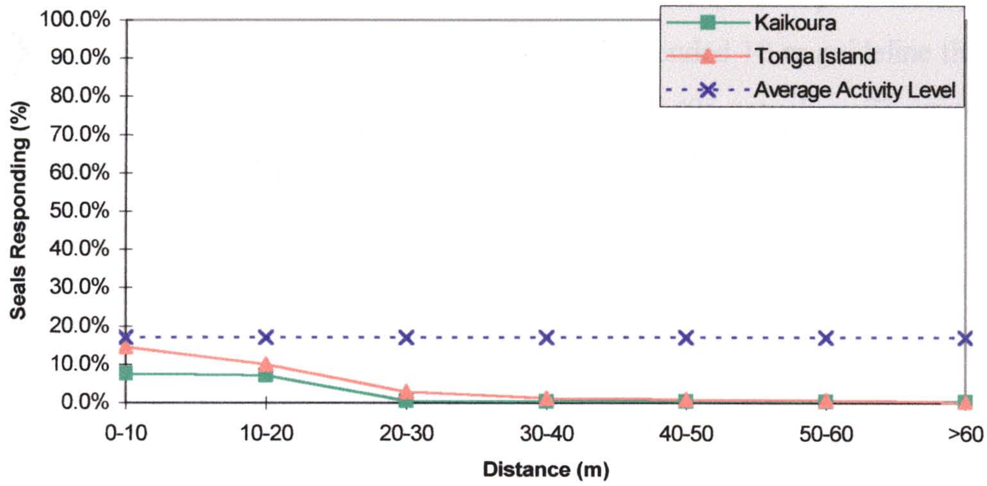
No tourist boats approached the seals at Whakamoa, however, other boat traffic was observed there on two occasions, but are not included in Figure 4.7c with the tour boat traffic from Tonga Island and Kaikoura. At Whakamoa, on neither occasion did the boat approach within 40 m, but in both instances 40-50% of the seals (n=40) altered their behaviour significantly above the 17% APAL. Activity levels at Kaikoura and Tonga Island never increased above 17% even when tour boats approached within 10 m (Kaikoura n=623, Tonga Island n=1305), a result that is consistent with the low level of disturbance seen by controlled approaches with motor boats (See Section 4.2.3.3. Controlled Boat Approaches).



a. Tourist Approaches on Land, Kaikoura n=1171



b. Tourist Approaches by Kayak, Kaikoura n=43, Tonga Island n=804



c. Tourist Approaches by Motor Boat, Kaikoura n=623, Tonga Island n=1305

Figure 4.7. Cumulative Response of Seals at Kaikoura and Tonga Island to Tourist Approaches by a) Land, b) Kayak and c) Motor Boat

Responses are compared against the 17% Average Population Activity Level. Note that tourist traffic shows seals responding at closer distances than Controlled Approaches.

4.2.3.5. Seal Response to Tourist Traffic Compared to Current Minimum Approach Distances

Tourist "traffic" data were grouped by approach type and the distance between "traffic" and fur seal(s) in relation to the current DOC guidelines (Morrissey, M., pers. comm., 1999; and Houston, S., pers. comm., 2000) (Table 4.3). The data shown have been collected over two seasons (n=3967 seals). The DOC guidelines used for the comparison are: 10 m for land, 10 m for kayaks and 15 m for motor boats. In general, response rates were observed to decrease from land, to kayak, and then boat. Response rates were high for land approaches (33.6%) even if tourists were following the recommended guidelines, suggesting that regardless of the approach distance, a substantial number of seals are altering their behaviour to land approaches by tourists. For kayak approaches response rates (16.8%) are close to 17% (APAL) for those following the DOC guidelines. However, the response rate of seals to motor boats following the DOC guidelines is quite low (7.1%).

Statistically there is a significant difference in the way the seals respond between the two distance categories for all three approach types. Land approaches closer than the DOC recommended guidelines (10 m) resulted in a significantly higher number of 'avoidance' responses than expected (60 actual vs. 39 expected, χ^2=19.996, p<0.001). For kayak approaches that were within the recommended 10 m guideline there was a significantly higher number of 'behavioural changes' (95 actual vs. 73 expected) and a higher number of 'avoidance' responses (77 actual vs. 68 expected, χ^2=27.717, p<0.001). A similar trend was seen when motor boat approaches came within the recommended 15 m minimum approach distance with 'behavioural changes' being higher (107 actual vs. 69 expected) and 'avoidance' behaviour being higher (47 actual vs. 27 expected, χ^2=67.48, p<0.001).

Table 4.3: Seal Responses to Tourist Approaches in Comparison to Current Minimum Approach Distances

The number of seals responding in each situation is shown along with the percent of responses. Note that for tourist approaches by land following DOC guidelines more than 17% of seals responded, in comparison to tourist boat approaches, where the response of seals did not exceed 17% for those following the guidelines.

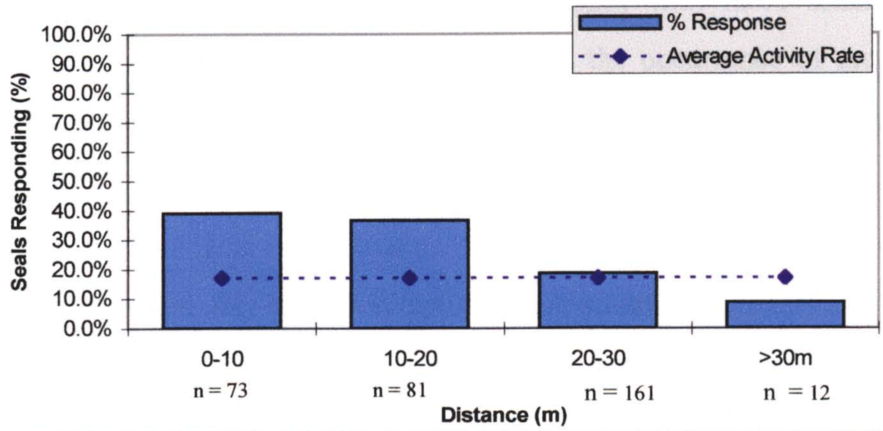
	Neutral	Change Behaviour	Avoidance	% Response	> 17% APAL
Land: 10 m					
>= DOC Regulations	610	198	111	33.6%	YES
< DOC Regulations	147	64	60	45.8%	YES
Kayak: 10 m					
>= DOC Regulations	267	22	32	16.8%	EQUAL
< DOC Regulations	358	95	77	32.5%	YES
Boat: 15 m					
>= DOC Regulations	1061	61	20	7.1%	NO
< DOC Regulations	639	107	47	19.4%	YES

4.2.4. Guided Seal Walk

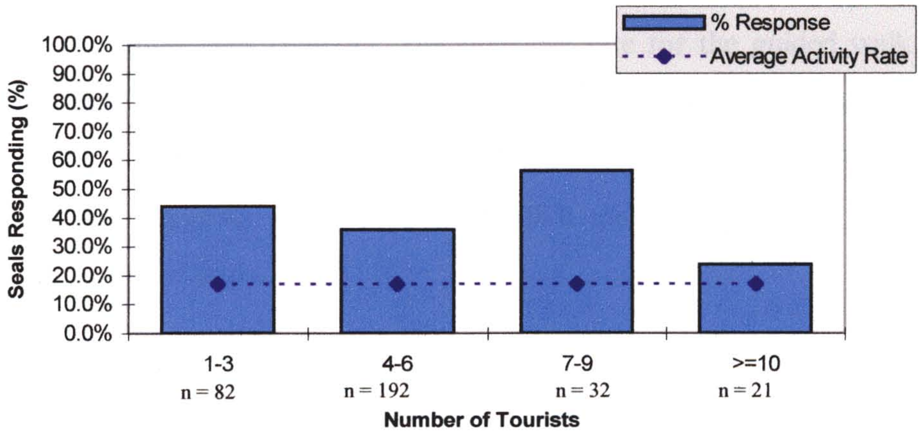
Tourists were observed approaching seals (n=327) on a guided tour around Lynch's Reef during the second field season. This is a new operation being run on a trial basis permit through DOC. The guided walk was observed to compare the distances at which seals responded to tourist approaches to other methods used in this study, as well as to test the impact of group size on seals, and to evaluate the effectiveness of a guide in reducing the numbers of seals responding.

Results from the guided seal walk were analysed via Chi-squared tests of independence to investigate the impacts of the distance of approach and group size on the fur seals. The impact of distance (Figure 4.8a) shows that the seals' activity levels exceeded 17% at less than 30 m (n=327). Statistically, there was a trend in the response repertoire of the seals in relation to distance with a greater number of seals avoiding approaches that were less than 10 m (χ^2=14, $0.025<p<0.05$).

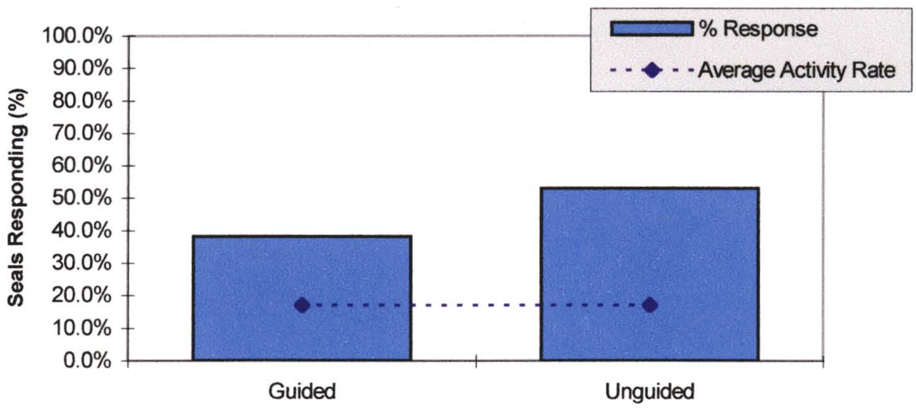
Group size was broken into four categories: 1-3 tourists, 4-6 tourists, 7-9 tourists and 10 or more tourists. The category '10 or more' was chosen because DOC uses 10 passengers as an upper limit of group size for other tour operators viewing seals, but currently imposes no maximum limit on guided walks. The other categories were used to tease out any possible impact of smaller groups and to obtain a more even spread of sample sizes, since these groups were more common they contained a much higher sample size. The response rate of seals to all group sizes was greater than 17%, however the greatest response was seen for group sizes of 7-9 people (Figure 4.8b). It was expected that this trend would continue into the category for 10 or more tourists, however, there were only two trips in this size category resulting in a smaller number of seals approached, thus no definite conclusion can be made. It was quite common for the guide to take a family group so the number of seals approached for categories '1-3' and '4-6' were much higher (n=82 and 192 respectively) with only 32 and 21 seals being approached by groups of '7-9' and '10 or more', respectively. Statistically, there was a significant difference in seal responses



a. Cumulative Response of Seals to Various Distances of Approaches by the Guided Walk, total n=327



b. Effect of Guided Walk Group Size, total n=327



c. Effect of Having Guide Present, Guided n=315, Unguided n=117

Figure 4.8. Impact of a Guided Walk to View Fur Seals, Investigating:
a) Distance of Approach, b) Number of Tourists, and c) Effective of Having Guide Present

All factors are compared to the 17% Average Population Activity Level. Note the increase in seals' responses as approachers reach 20-30 m. Although seals still appear to be responding to all group sizes and to guided and unguided tourists, smaller group sizes and the presence of a guide appear to decrease the likelihood of this response.

dependent on group size (χ^2=16.226, 0.01<p<0.025) with more seals changing behaviour and avoiding groups of 7-9 tourists. As the occurrence of groups sized '10 or more' was rare observations of seal behaviour in response to larger groups are purely anecdotal.

Having a guide present may help to mitigate tourist/wildlife encounters and provide a safer encounter for both the seals and the tourists (Figure 4.8c). This hypothesis was tested by comparing all guided approaches that followed DOC guidelines (approaches either greater than or equal to 10 m, and that did not enter the breeding colony, n=315) to all private tourists around the Kaikoura Peninsula who also followed the DOC guidelines (n=117). The response rate for the guided walk was 38.1% in the presence of a guide, while it was 53% during unguided tourist approaches The difference (15%) was statistically significant (χ^2=8.769, 0.025<p<0.05) and suggests that the presence of a guide reduces the impact of tourist encounters on fur seals.

4.2.5. Commercial Swim-With-Seal Programmes

Seal swim companies may impact seals in a number of ways. If they approach by boat or on land, their method of approach may alter a seal's behaviour. These situations are included in land and boat traffic analysis. Once the swimmers are in the water they may impact the seals in the water around them, as well as, the seals on the rocks. Figure 4.9 addresses the impact of four seal swim operations on seals in the water. The majority of seals show no apparent response (64.4% +/- 5.6%), followed by those exhibiting an interactive response (23.7% +/- 4.5%) and a few seals showed an avoidance response (5.8% +/- 2.3%). Although it looks as though 'Company C' elicits very different responses from the seals, its impact shows a high standard error, resulting from great variability between three swim opportunities, and based on the present data there is no significant difference between companies effects on seal behaviour (Rao's R [9,65]= 1.545, p=0.1514).

Table 4.4 shows the percentage of seals on land and in the water responding to the swimmers from the four commercial seal swims and also some private (unguided) swimmers that were observed. Seals on land were never observed 'interacting' with the swimmers. In general, the swim companies elicited high numbers of neutral responses and low numbers of avoidance responses regardless of whether seals were on land or in the water. Private swims showed the opposite trend with 72.4% of seals avoiding the swimmers in the water (n=29) and 78.6% of seals avoiding on land (n=42), illustrating that private swimmers are causing more seals to alter behaviour than commercial seal swims.

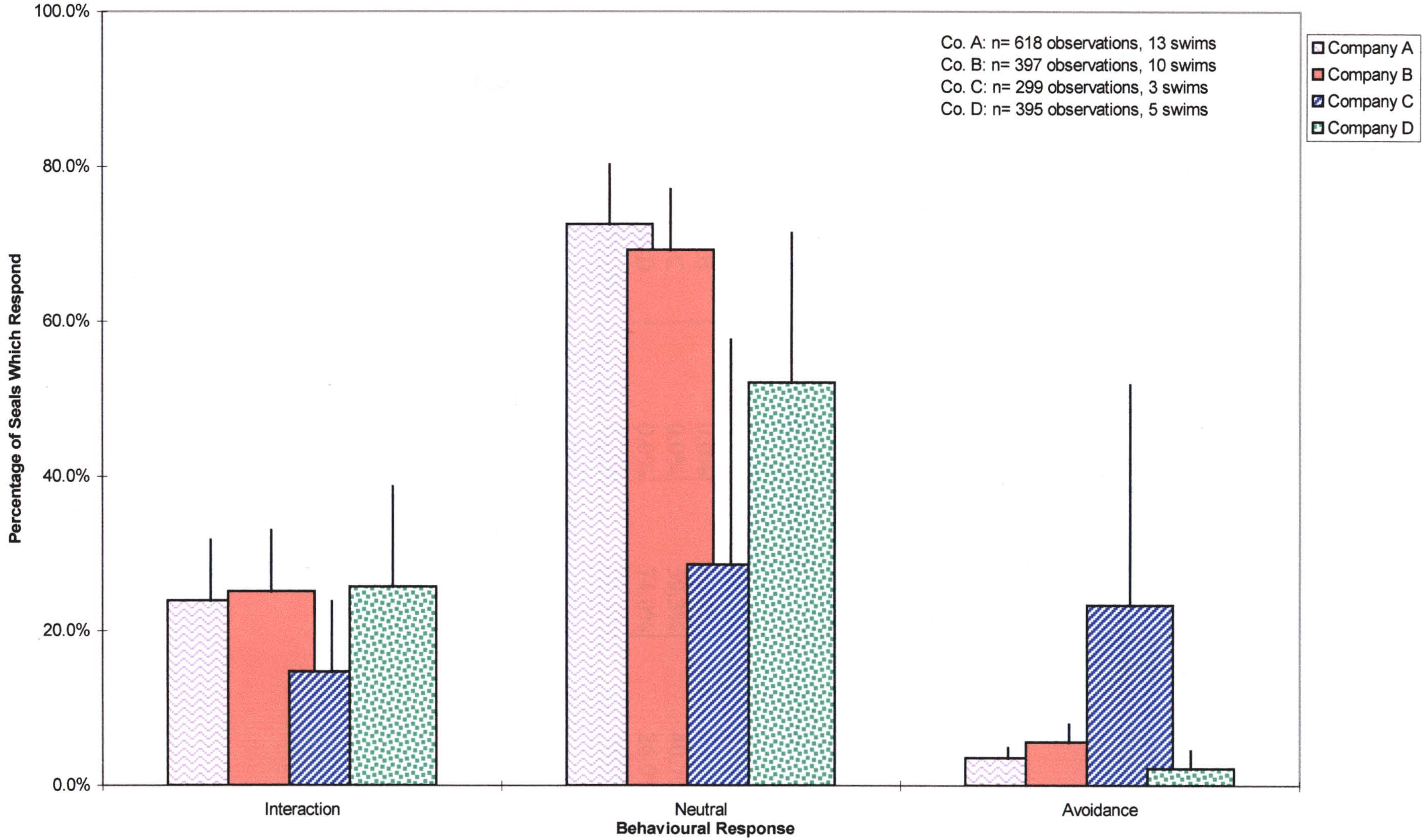


Figure 4.9. Responses of Seals to Various Swim-with-Seal Companies at Kaikoura and Tonga Island During the 2000/2001 Summer Season

Table 4.4. Response of Seals on Land and in Water to Swimmers

This table shows the four commercial seal swims in comparison to private swimmers. Note the high proportion of 'avoidance' responses caused by private swimmers shown in bold, and the lack of interactions between seals and private swims.

Response in Water	**Interaction**	**Neutral**	**Avoidance**
Company A	23.9%	72.5%	3.6%
Company B	25.2%	69.2%	5.6%
Company C	14.7%	28.6%	23.3%
Company D	25.7%	52.1%	2.2%
Private Swims	0.0%	27.6%	**72.4%**
Response on Land	**Interaction**	**Neutral**	**Avoidance**
Company A	0.0%	82.7%	17.3%
Company B	0.0%	65.4%	34.6%
Company C	0.0%	59.3%	40.7%
Company D	0.0%	74.0%	26.0%
Private Swims	0.0%	21.4%	**78.6%**

4.2.6. Impact of Anthropogenic (Man-Made) Noise

Hearing is an important sense for pinnipeds, as it plays a major part in reuniting the mother and pup after a separation (Stirling, 1970; and Phillips and Stirling, 2000). It has even been suggested that long-term vocal recognition of kin may be important for increased fitness through cooperation between a mother and her mature offspring (Insley, 2000). Despite its importance, little is known about the impacts of man-made noise on pinnipeds. Much of the literature is based on observations and few experiments have been carried out to assess specific details such as the distance seals become aware or disturbed by a noise (Richardson *et al.*, 1995). In order to assess the affect of man-made noises on New Zealand fur seals, playback experiments were carried out at all three sites during the 1999/2000 field season.

Most fur seals (771/1135) showed no response (neutral) to the range of sounds played to them during the noise experiments. The only significant responses were to three sounds: rock music (64 responses out of 128 trials), people talking (54/119) and dogs barking (67/127) ($\chi^2 = 105.764$, $p<0.001$). The three sounds that produced the fewest behavioural changes were kicking gravel (20/119), vehicle traffic (28/130) and aeroplanes (27/126).

Fur seals at Island Bay responded to playback sounds significantly more than animals at the other sites when all the sound data were pooled by site ($\chi^2 = 355.122$, $p< 0.001$). One hundred and thirty eight animals (out of a total of 170 tested) exhibited a change response, 20/170 avoidance, and only 12/170 a neutral response (See Table 2.6). At all other sites the majority of fur seals showed a neutral response (759/1135) to the taped sounds. The distance between the seals and the speakers could not be held constant between sites, because of different accessibility at the sites, and as a result the noise volumes differed. Therefore these results are predominantly anecdotal, however, they provide evidence that seals could be altering their behaviour to particular man made sounds.

4.2.7. Pup Production and Condition

Animals that are stressed or are unable to allocate time to biologically important behaviours such as resting, thermoregulating, breeding, and rearing young may be less resilient to an outside disturbance (Kuss *et al.*, 1990; and Barton *et al.*, 1998). This could possibly result in decreased pup production, or if the female is unable to attend her young, may also result in low pup condition. To assess whether or not tourism may be impacting the breeding success of seal colonies at popular tourist destinations, mark-recapture experiments were carried out at Tonga Island and Ohau Point for both the 1999/2000 and 2000/2001 field seasons and were compared to historical data collected by K. Barton, and C. Bradshaw.

Pup numbers at Tonga Island decreased significantly from the 1998 breeding season, whereas pup production continued to increase at Ohau Point (Figure 4.10). In 2000, for the first time since 1996, seals at Ohau Point produced more pups than Tonga Island, but was not statistically significant ($p>0.05$). The following season (2001), pup numbers at Tonga Island continued to decrease and pup numbers at Ohau Point continued to increase resulting in a significant difference in pup production between sites (86 pups produced at Tonga Island vs. 127 pups produced at Ohau Point, $F[1,10]= 24.56$, $p<0.0005$). The number of pups produced at Tonga Island differed significantly over the years with more pups being born in 1998 than in 1993-96 and 2000-01 (approximately 175 pups, $F[7,29]=21.187$, $p<0.00001$). Also, the 86 pups produced in 2001 was significantly lower than years 1994, 1995, 1997, and 1998 ($p<0.00001$). Historical data (1996-1998) was not available in its entirety from Ohau Point for analysis, hence the only comparison at Ohau Point, made over the years is for 2000-01 in which the number of pups produced did not differ ($F[1,10]= 0.0089$, $p<0.926$).

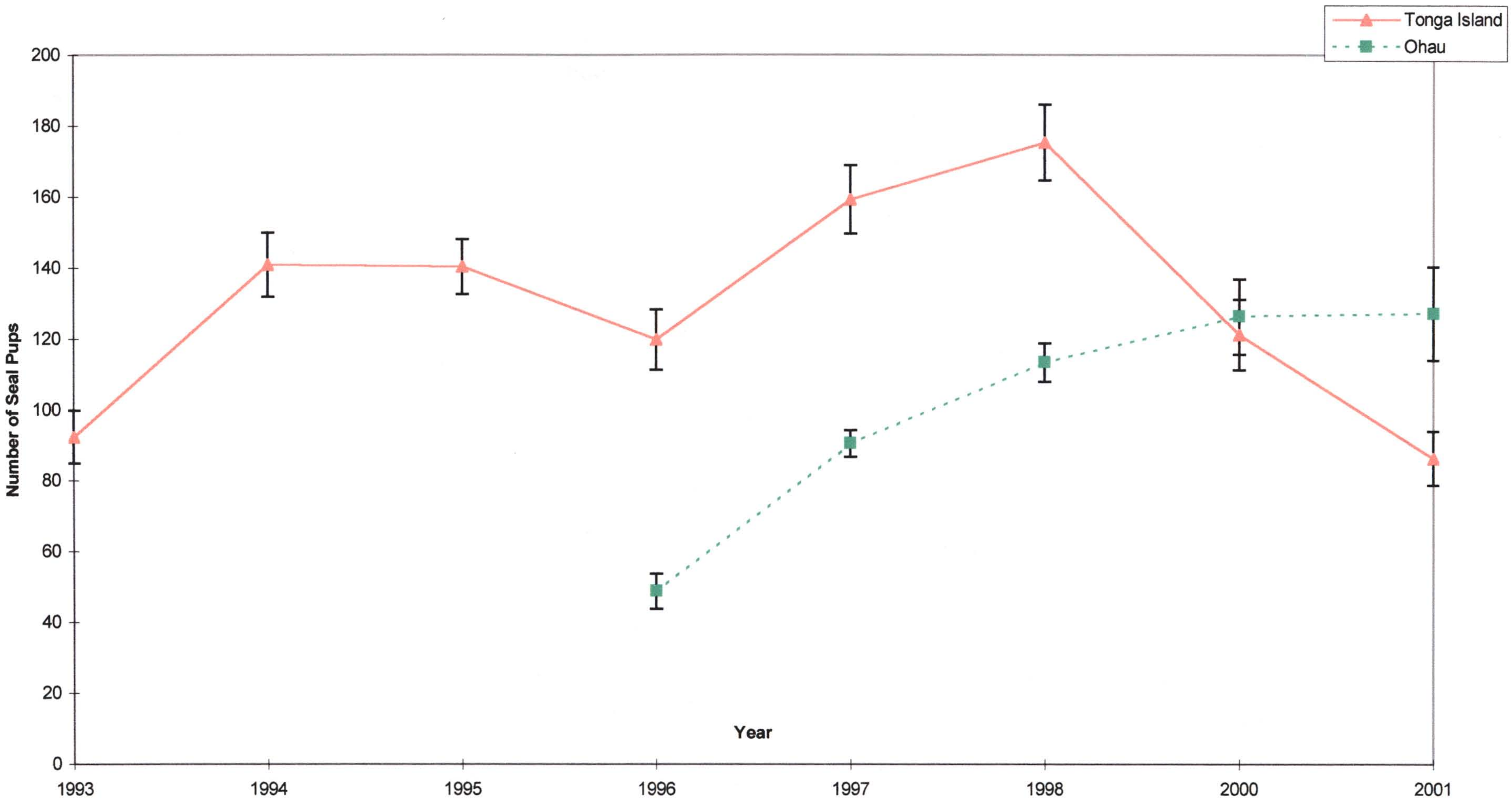


Figure 4.10. Peterson Estimate of Number of Seal Pups Born at Tonga Island from 1993-2001 and at Ohau Point from 1996-2001

A Condition Index (CI) provides a comparison of the pups' observed weight to its predicted weight, given its length (Bradshaw, 1999) and this was calculated for all years (1993-2001) at Tonga Island (Figure 4.11) and for 2000 and 2001 for Ohau Point (Figure 4.12). A CI greater than or equal to 1 means the pup is at or above its theoretical expected weight for its length, and in good condition. In all years, more than 55% of the pups at Tonga Island were at or above their predicted weight and those that were under were distributed closely around the expected value. Only in two years (2000 and 2001) were there individuals sampled with a CI below 0.6, however, the rest of the individuals sampled in those years were in a tight cluster with CI's between 1.35-0.8. The results from the regression analysis show a significant relationship between the observed and theoretical expected weights ($p<0.0001$), meaning that the expected weights calculated could be used as a predictor of pup condition. An ANOVA was used to test for a difference in Condition Indices for pups each year at Tonga Island and showed no significant difference over different years ($p<0.99$). Over the last two seasons at Ohau Point there was no significant difference ($p<0.9274$) in Condition Index of the pups (Figure 4.12).

The mean condition indices for the two colonies in 2000 were 1.013 and 1.014 for Tonga Island and Ohau Point, respectively, and in 2001 were 1.015 and 1.017 showing no significant difference between sites or between years ($p<0.9274$). The observed weights for the pups were close to that predicted ($p<0.0001$) (Figure 4.13).

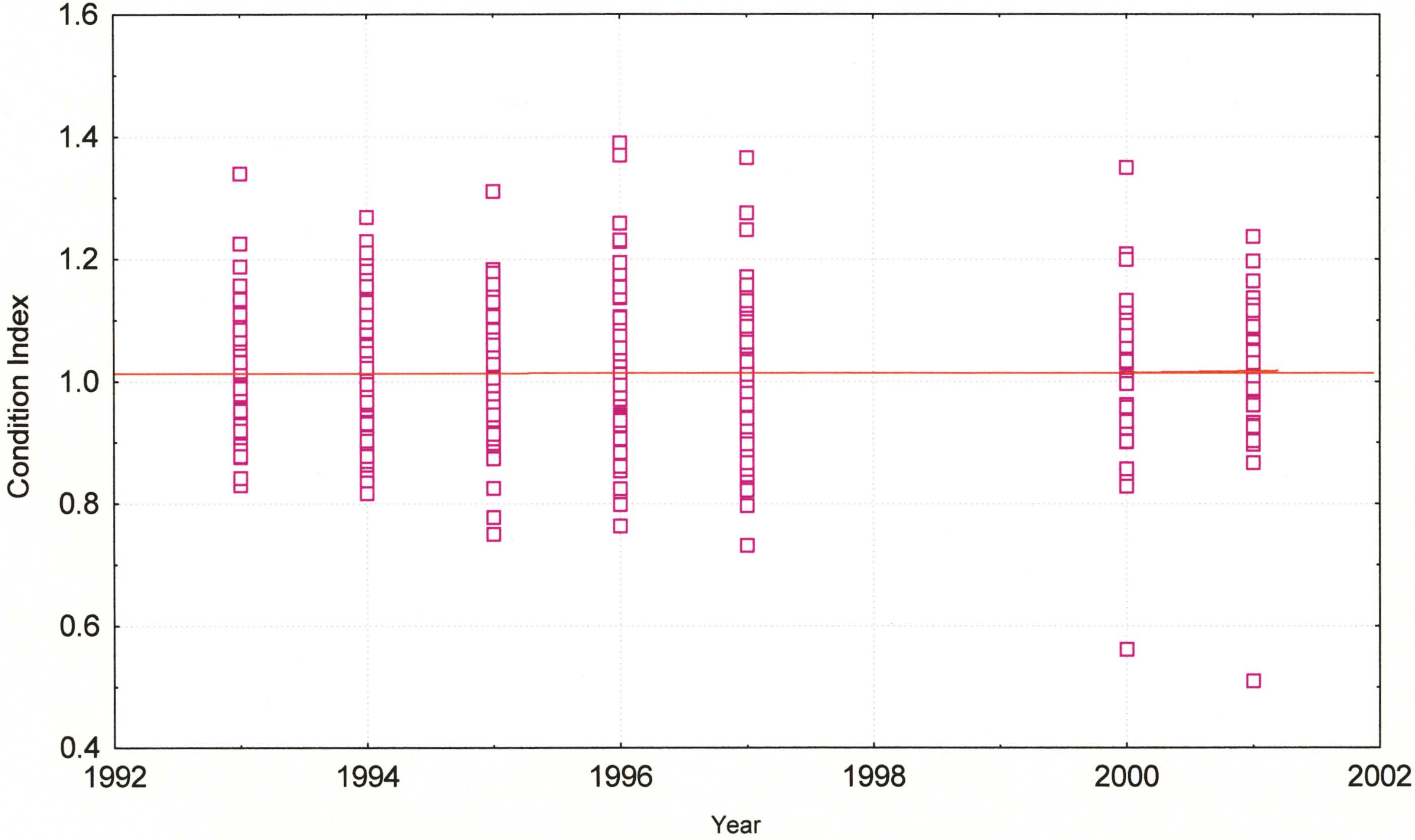


Figure 4.11. Condtion Index of Pups Sampled at Tonga Island from 1993-2001

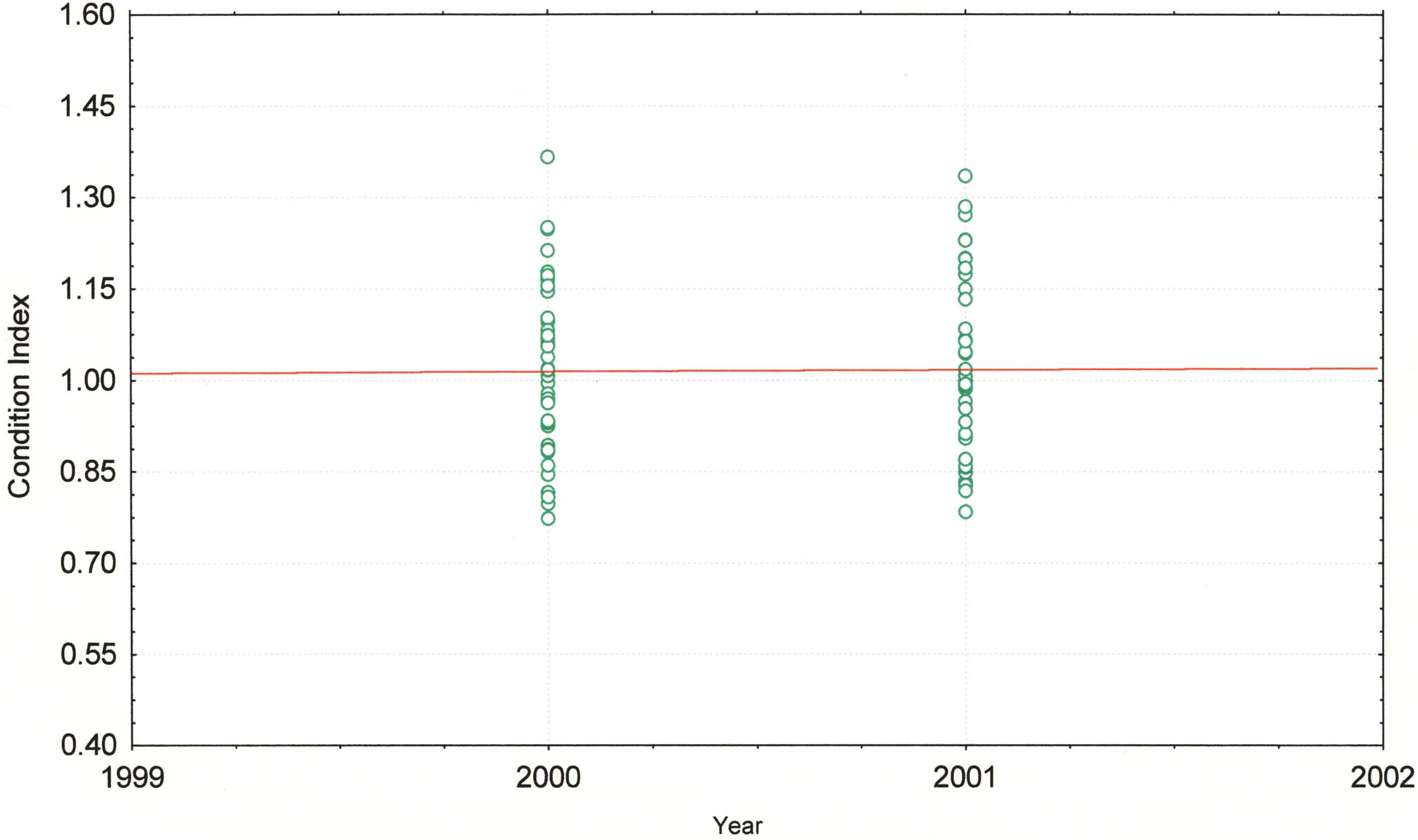


Fig 4.12. Condition Index of Pups Sampled at Ohau Point in 2000 and 2001.

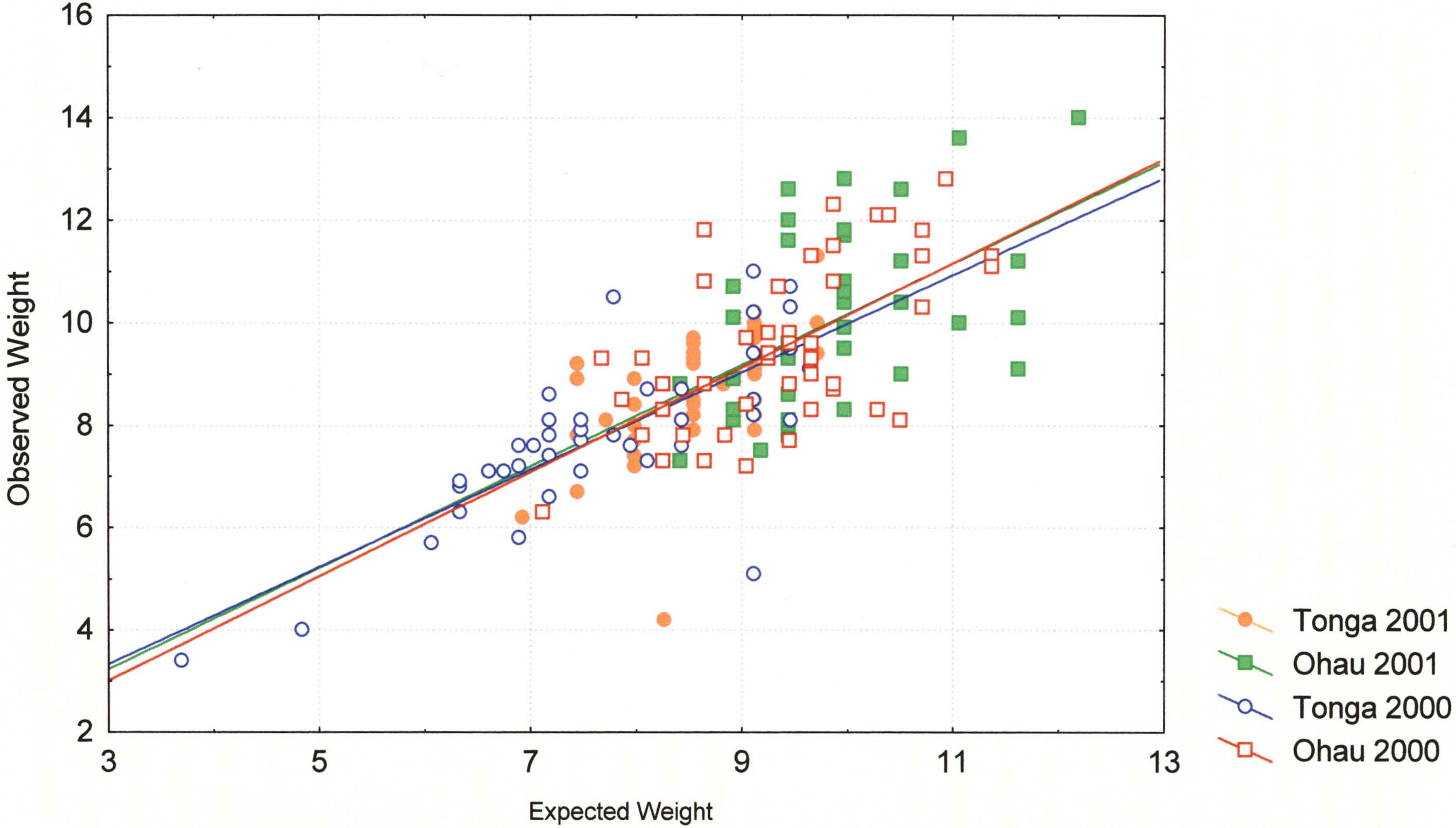


Fig. 4.13. Condition Index for Pups Born at Tonga Island and Ohau in 2000/2001

4.3. Discussion of Experimental Data

The results from the experimental portion of this thesis provided important baseline information on how tourism affects New Zealand fur seals. First, there was an observable difference between approach types. Also, many factors affect how a fur seal will respond to an approach including: the age and sex of the animal, behaviour prior to the approach, proximity to other seals, type of approach (land vs. sea), the profile of the approach (height above seal), time of year, and prior experience. The results from the guided walk, seal swims, group size approaches and frequency of approach illustrate how various tourist dependent factors influence the response of seals. The data from the controlled approaches were also used to calculate more acceptable minimum approach distances. The mark-recapture data suggests that further monitoring is required in order to understand the relationships between environmental variation, tourist activity and fur seal breeding success.

4.3.1. Approach Types

Approaches by land appeared to be more detrimental to the seals than the other approach types. This trend was observed at all sites, but was most dramatic at Whakamoa, where avoidance responses were highest (70.3%), which probably reflects the very low level of human/seal interaction that occurs at this site versus the others (See Figure 4.1). Behavioural changes and avoidance responses were lowest at Kaikoura, most likely due to habituation through the great amount of land traffic that the seals are exposed to here, up to 4000 visitors per week (Barton *et al.*, 1998), in comparison to the other sites where foot access is restricted.

While the number of seals approached at Tonga Island was low, the numbers were sufficient to include the site in a statistical analysis with the other two sites, to look for any site differences (See Table 4.1). Landing is not permitted at Tonga Island, and although it does occasionally happen it is not a common occurrence. Furthermore, Tonga Island is a high density breeding colony so, when someone does land it has a dramatic impact as was seen from the individual approaches (See Table 4.1), the traffic observations (See Figure 4.3), and the response of seals during the mark-recapture experiment.

Controlled kayak approaches were less disruptive than boat approaches, however, from the traffic data, boats appeared to be less disruptive than kayaks (See Figures 4.1b-c., and 4.3). Under controlled circumstances with experienced operators, kayaks can approach quietly and may not seem as great a threat as a large boat with a motor. However, kayaks are smaller than motor boats and can usually get closer to shore where they may be perceived as a greater threat than a powerboat that is tens of metres offshore. This is particularly noticeable with inexperienced kayakers who are not able to control their distance from rocks very well. Consequently, in some instances, seals may react more strongly than they normally would if they had been aware of the approaching kayak earlier. Motor boats, on the other hand, are generally being operated by an experienced driver who can control the distance between the boat and seals on the rocks. As mentioned before, there is concern that the swimming behaviour of cows is being affected by the increase in kayak and boat traffic at Tonga Island (See Section 3.3.3. Seasonal Differences). It is quite possible that this is happening since fewer seals were seen swimming in the second season and boats and kayaks need to be made more aware of the threat they present to seals.

Seals, like other marine mammals, are naturally inquisitive in the water (Constantine, 1999), which is the most likely reason for the higher number of interactive responses with swimmers than any other traffic type (23.7% vs. 0% [land] 0.57% [kayak] or 0.1% [boat]). Swimmers can also approach seals that are on land, which typically results in a high amount of neutral responses (59.3%-82.7% for commercial swims) and no interactive responses (See Table 4.4).

Overall, fur seals changed behaviour least in response to sea-based approaches: swim (5.8%) kayak (31.0%) and boat (36.9%) than to land approaches (76.6%). The reason for this may relate to an animal's perception of threat. Fur seals are agile swimmers and are in their natural element in the water, whereas on land they move less efficiently and are more vulnerable. Therefore, when seals are approached on land they may respond from further away to give themselves a greater margin of safety.

4.3.2. Seal Dependent Response Variables

Gender and age play a big part in a seal's reaction to an outside disturbance. Cows and pups will typically head into the sea or hide, while males will typically stay and fight. These differences are likely to be a consequence of seal social organisation and the mating strategies adopted by male and female seals. Within a typical fur seal breeding colony, dominant bulls stake out territories where they defend either females or the resources that females are dependent upon (Carey, 1989). Bulls expend considerable resources obtaining and defending a territory, and on average will only hold territories for a small part of their reproductive life (Riedman, 1990). Therefore, bulls are more likely to stand their ground when exposed to an outside disturbance, as the costs associated with leaving a territory are very great (Crawley and Wilson, 1976). In contrast, cows and pups are smaller and more submissive, have no specific investment in any given site, and are more likely to flee, for if they can avoid danger then they may be able to reproduce again.

The prior behaviour of a seal was also an important factor in determining its response to a given stimulus. If a seal was sleeping prior to the approach, the chances of it not responding were predictably higher. Many animals remained sleeping, but those that did wake and became aware of the approacher reacted instantly. If a seal was active prior to an approach, it would become aware and watchful of the approacher(s) long before changing behaviours.

Neighbouring seals also alerted other seals when an approacher was in the area. This trigger response, also termed the domino effect (Barton *et al.*, 1998), increased with increasing density of seals. For example, the beach at Whakamoa has a large haul-out area above high tide. There were usually 2-6 individuals hauled out at a time and spaced far apart. As a result, the target seal, if it was resting with no other seals nearby, was rarely alerted to an approacher. In contrast, on one occasion there were four seals within 10 m of each other and a nearby seal triggered the targeted seal to sit alert, vocalise and flee from the approacher. From this and other similar scenarios, it appears that, if the density of seals was higher, then the target seal would be more likely to respond to a disturbance regardless of prior behaviour.

Many of the sites at Kaikoura do not have a large high tide haul-out zone, so the animals are in close proximity, resulting in neighbouring seals triggering an avoidance response to a human approaching, than on a beach where the animals are more spread out. This is also true when comparing breeding to non-breeding sites. During the peak months of the breeding season the density of breeding colonies is high compared to non-breeding sites (Riedman, 1990; and Barton *et al.*, 1998) and the likelihood of triggering several seals to become active is consequently a lot higher. This is supported by Shaughnessy *et al.* (1999) who found that the chance of seals 'moving' increased with an increase in colony size for a colony of New Zealand fur seals at Montague Island.

The profile of the approach, how high above the horizon or a seal's eye-level the approacher is, also contributes to how an animal responds. For example, while carrying out group size approaches at Barney's Rock, I observed that seals that saw the approach coming from above them would change behaviour straight away. The experimental group approaches were carried out starting from the top of the hill above the haul out area, rather than the car park or boat ramp, so as not to attract tourist attention. Regardless of group size, as soon as the seals saw the approachers coming over the hill they began to change their behaviour with most response distances falling between 10-20 m. Many animals view size or height as a form of dominance (i.e. rearing behaviour of adult male seals) and thus a submissive seal will lower themselves into a particular posture in the face of a dominant seal (Stirling, 1970). Approaches higher than the seals eye level may be perceived as more of a threat resulting in seals altering their behaviour quickly.

Another important factor, was the approach angle. It is recommended by DOC that people do not get between a seal and the sea, as this blocks the seal's escape route and may cause undue stress. Most approaches were not made between the seals and the sea, but the few that were caused all the seals to sit alert and vocalise at the approacher.

The controlled approaches showed differences in seal response repertoire between sites with more behavioural changes occurring at Whakamoa, and a great variability in responses between individual animals within a site. This agrees with the findings of other studies on phocid (Kovacs and Innes, 1990; Lidgard, 1996; Young, 1998; Born *et al.*, 1999; and Suryan and Harvey, 1999) and otariid seals (Barton *et al.*, 1998), as well as cetaceans (Richardson and Würsig, 1997; and Constantine and Baker, 1999) and some bird species (Kazmierow, 1996) which will be discussed in more detail in Chapter 5: General Discussion.

4.3.3. Concerns Related to Sea-based Approaches

Cows in the water at Tonga Island were observed "balling" (bunching up with each other or else to a boulder or the edge of the island) in response to kayak approaches. As the kayak moved away, the seals spread apart and moved away from the land. Only cows swimming in groups exhibited this behaviour. The reason for this is unknown, however, it may be for security or defence. These animals have a well developed flight response (Barton *et al.*, 1998) which will normally result in an animal entering the water for safety. However, if the stimulus is also in the water, the animal may feel threatened even in the water so they huddle together or against something perceived as being safe. Southern sea lions (*Otaria valescens*) were observed exhibiting a group following behaviour in response to Orca (Harcourt, R., pers. comm., 2001a), and a similar behaviour was also seen in Australian fur seals in response to a tour boat. However, it is not known if the Australian fur seals in this scenario or the new Zealand fur seals in this study could be transferring an antipredator response to boats. Tour operators at Tonga Island and researchers carrying out tagging in the past are concerned that the swimming behaviour of the cows has been changing over the years (Barton, K., pers. comm., 1999; and Clapshaw, A., pers. comm., 2000). Balling may be a significant behavioural indicator of animals under stress.

A small level (3.3%) of interactive responses towards boats were observed at Tonga Island. This was the only site where this behaviour was observed. The causes for this response are unknown, but it is possible that Tonga Island fur seals may be associating boats with food. No one was observed feeding seals at Tonga Island, but this may be something worth investigating if interactions between seals and boats increase in the future, since such associations can be serious. For example, in a study on Alaskan brown bears, Olson *et al.* (1997) showed that habituation may be facilitated by the bears associating humans with food. This association or "food-conditioning" presents quite a problem in any large animal and has been implicated in many bear attacks on humans (Herrero, 1985). Pinnipeds can become conditioned to food relatively quickly as they can easily be trained through food rewards for husbandry, cognitive research and human aid purposes (Riedman, 1990; and Schusterman and Kastak, 1998). While the problems associated with food-conditioning of a seal species are unlikely to be as severe as observed in bears, if it became commonplace it could lead to a significant change in seal behaviour.

Food association is a problem often related to tourism that has been documented in many species including mule deer, big horn sheep, ground squirrels, baboons, vervet monkeys, (Edington and Edington, 1986), dolphins (Connor and Smolker, 1985), racoons (McLean, 1975), long tailed macaques (Spencer, 1975), elephants (Grzimek, 1964), coyotes (Glick, 1991), bears (Herrero, 1985), and iguanas (Harris, 1973). In all these cases the end result was that the animals began to beg for food. In some situations, the way the animals were viewed by humans rapidly changed following the development of food association behaviours. Ground squirrels (*Citellus* spp.) carry the bacteria causing sylvatic plague (*Yersinia pestis*) that poses a health risk to humans (Edington and Edington, 1986). Some of the larger species, such as, baboons, elephants, coyotes and bears begged aggressively resulting in the animals being put down.

4.3.4. Group Size

During the preliminary investigation during the 1999/2000 field season there was no significant difference in the responses of seals to changes in the size of the group approaching. This agrees with Barton *et al.* (1998), who also found that the responses of seals were not affected by group size. Seals showed no change in response to larger group sizes, and may result from males defending a specific territory regardless of the number of approaching tourists. This can be illustrated in an example of group size approaches being carried out with a sub-adult male on the rock flats by the Kaikoura Peninsula carpark. The resting target seal vocalised at a similar distance of 5 m for each approach regardless of group size. In the case of males the cost of leaving a territory may be great enough that they will stay and defend their territory to any number of approachers. Cows and young animals have a lower threshold level by which they measure a perceived threat (Barton *et al.*, 1998) and may react as strongly to one person as to ten. The difference more than one person makes to this reaction may not be visible although there may be a stronger physiological response.

The initiation of guided tours to view seals at Lynch's Reef, Kaikoura, provided an alternative method for investigating the impact of group size. The advantages to a guide, is that they provide a more controlled situation than if tourists approached on their own. Also, the trips are typically staggered, so the seals typically have an hour or more between subsequent trips, which may decrease the likelihood of short-term habituation. Significantly more seals changed behaviour or avoided groups of 7-9 tourists, and it seems clear that this method has considerable potential as long as adequate numbers of walks are observed (See Figure 4.8b).

Multiple observations are crucial, as the main problem with using guided walks to asses the impact of group size was the inability to isolate factors, such as, distance and group size, and one variable may be confounding the other. To successfully isolate these factors while observing the guided walk, one would need to have several replicates for each possible group size so that variability of distance could be compared within each of these and vice versa. However, if seals respond to differing group sizes at different distances, it is not practical to have a different approach distance guideline for each group size.

One problem with guided walks was that as the group size increased, the tour guides control over the group decreased. Tourists would wander off to a group of seals on their own, often approaching too close. Another confounding problem was that when group size was large, private tourists would often join and follow the tour. As such behaviours lead to a decrease in the tour guide's control of the group, it is recommended that group size be more closely regulated in the future.

4.3.5. Recovery Period

When investigating the impact of the frequency of approach, seals that did not leave after the first approach still exhibited a greater change in behaviour to the second approach, even with 45 minutes between approaches. This suggests that it may take over 45 minutes for recovery from an interaction to occur. Observations of seal behaviour during mark-recapture and actual tourist/seal interactions during the 1999/2000 season have shown that the seals often watch from the sea until the approacher has left, and it may take over an hour for the seals to return to land. This recovery period, however, depends on the intensity of the interaction and how long the tourist remains viewing the seals. For instance, a seal moving into the sea will take longer to recover than a seal that sat up, and recovery will take longer for a seal if the disturbance remains viewing the seals than if the tourist left immediately. This is supported by the range of recovery times (3-90 min) reported by Barton *et al.* (1998), however, the average recovery time for that study was 17.7 min. It is possible that the increased response in the seals approached 45 minutes apart may be evidence of a phenomenon known as spontaneous recovery, whereby if a stimulus is not present for some time, when represented the animal exhibits a heightened response (Hearst, 1988).

4.3.6. Effectiveness of a Guide and Tourist Dependent Response Variables

When comparing guided versus unguided approaches to seals, the presence of a guide decreased the chance of a seal changing behaviour or showing an avoidance response by as much as 15% (See Figure 4.8c), suggesting that guided walks are a successful way of controlling and reducing the detrimental effects of tourist approaches to seals. Evidence for this was also observed with seal swim programmes.

Seal swim programmes can impact on seals in four different ways: 1) people in water interacting with seals in water, 2) people in water interacting with seals on land, 3) people on land or in boat interacting with seals in water, and 4) people on land or in boat interacting with seals on land. When the tourists are in the water, commercial seal swims elicited significantly fewer avoidance responses than private seal swims (<24% for commercial swims vs. 72.4% for private swims and seals in the water; and <41% for commercial swims vs. 78.6% for private swims and seals on land). This is mainly due to the lack of a guide present in private seal swims and the subsequent lack of knowledge of appropriate behaviour around seals. Private seal swims resulted in no interactions with approximately 75% of seals in the water and on land avoiding the swimmers. The avoidance responses resulted from specific behaviours of the swimmers, such as moving closer than the recommended 10 m to the rocks, splashing seals, standing up in shallow water or landing on rocks, and chasing seals that are in the water. While some of these behaviours were occasionally seen in the organised swims, the guide quickly stopped them.

The response of seals to swims organised by the different companies did not differ, but 'Company C' appeared to have fewer interactions and neutral responses, as well as the greatest number of avoidance responses. Rough sea conditions around

Kaikoura made boat based trips for this company rare in the 2000/01 summer season and subsequently only three swims were monitored. Within each swim, anywhere from 0-10 seals were observed in the water with the swimmers, and although only 3 swims were monitored, observations were collected on 299 swimmer/seal encounters. The high variance in the impact of 'Company C' swims resulted from the sporadic use of guides with the swimmers. In most cases (66.7%), the company simply uses a boat operator who watched the swimmers and stopped inappropriate behaviour. On one of the swims observed, when a guide was present, 76% of the encounters (n=289) resulted in neutral behaviours and the remaining 24% resulted in interactive behaviours. On another swim, when no guide was in the water, one swimmer chased seals that were in the water, splashed seals on land and approached seals on rocks to 'get them to interact.' This resulted in 70% of the seals avoiding the swimmers, 20% interacting and the remaining 10% showing a neutral response.

From this and other private and commercial swims which resulted in avoidance responses, several human behaviours were observed that were more likely to elicit avoidance responses. These included: chasing seals in the water, encircling the seals in the water, moving too close to seals on the rocks, purposefully splashing seals on the rocks with their flippers, standing on shallow rocks next to seals, and attempting to touch the seals. Private swims exhibited all of these behaviours and this was also the cause of the high avoidance behaviours seen in one of the 'Company C' seal swims. Swimmers with guides present only occasionally displayed some of these behaviours and the guide quickly stopped them.

The Tonga Island seal swim (Company A) provided a guide in the water and the boat operator also monitored the behaviour of the tourists resulting in very low avoidance to swimmers from seals in the water (3.6%) and on land (17.3%). Some human behaviours lessened the level of avoidance from the seals. These were: moving between different places throughout the swim to relieve pressure from one group of seals, and providing seals with an escape route so that they have the option to interact. Providing animals with a choice is more likely to result in interactions rather than forcing the animals to interact, as was found to be the case in swim-with-dolphin programmes in the Bay of Islands (Constantine and Baker, 1999).

The 'success' of a swim can be defined in different ways, which are not always complimentary. Tourists seek levels of 'high interactions', while the success of the seal colonies mainly require 'low avoidance.' The success of a swim for both humans and seals depends on a number of factors including: air and sea temperature, sea conditions, water clarity, time in the reproductive cycle of the seals, prior exposure of the seals to tourists, and behaviour of the tourists. 'Company A' runs swims as early as November while the other companies wait until December. Swims early in the season resulted in low interactions and high neutral responses because the seals in the water were mainly bulls moving between territories. The level of encounters eliciting interactions increased during the summer after the pups were born, and continued to increase as the pups became more confident swimmers.

4.3.7. Site and Seasonal Differences in Seal Responses: Evidence of Habituation

The controlled approaches indicated that previous exposure to a specific type of approach was the major factor regulating how the seals responded, and this varied a great deal by site. For example, when testing the frequency of land approaches at Shark's Tooth, 43% of the animals moved into the sea immediately upon the first approach, and the remaining 57% vocalised, moved away or entered the sea upon the second approach (See Table 4.2b). Seals at Shark's Tooth, although they receive a lot of foot traffic on the peninsula walk-way, appeared unsure of the first approach, resulting in a high percentage of them moving straight into the sea. This result is strengthened by observations of tourist interactions with these seals, for example in 1999/2000 two tourists approached a small group of ten seals, three seals entered the water immediately while the other seven moved away and sat alert. Also, during investigations of group size on these seals, 20 seals out of approximately 40 moved into the sea upon approaching. This may result from seals being visited infrequently when the tide is high. The seals at Shark's Tooth are isolated from the peninsular walk-way, and when the tide is low, only a small portion of the tourists walk out as far as this particular group of seals as there are usually seals close to the cliffs for tourists to view. In comparison, no seals at Barney's Rock immediately entered the sea after the first approach, and nearly 50% showed no behavioural change when approached a second time. This may be due to prior exposure to foot traffic at this location and long-term habituation.

Unlike land approaches, kayak approaches elicited an interactive response at all sites, where the seal followed or approached the kayak in a curious manner. This was most likely related to the prior behaviour of the animal, as only seals already swimming would move towards the kayak. The high number of neutral responses exhibited at Tonga Island to kayaks is most likely explained by a degree of habituation due to constant exposure. In contrast, kayaks are novel to the seals at Whakamoa and approaches to seals on land at Whakamoa elicited a high number of avoidance responses with 11/12 mother/pup interactions being disrupted. Although there were a few seals in the water at Whakamoa that exhibited interactive responses, this was the only site where the approacher was charged by a seal in the water. Kaikoura showed an intermediate change in activity level in response to kayaks, with 9.9% of the fur seals exhibiting an avoidance response, and 32.1% changing behaviour when approached. There is only one kayak operation in Kaikoura and it has only been running for two years, so, for many animals at Kaikoura, kayaks are still novel. These results suggest that prior exposure to a stimulus, such as kayaks, may eventually lead to habituation or decreased response to the stimulus.

At both Kaikoura and Tonga Island, the activity levels of the seals in response to boat traffic does not appear to increase above 17%. The responses of seals at Kaikoura do not change dramatically in the two field seasons when approached in a controlled manner by motor boat (21.3% season 1, and 23.1% season 2), however, in response to tour boat traffic they appear to respond less, the major reason for this is that controlled approaches included sites that do not always receive a large number of tour boats and are not as habituated to boats as the seals at other sites. For example, Barney's Rock and Lynch's Reef not only receive tourist boats on an almost daily basis, but also private and fishing boats. Seals at Ohau Point, on the other hand, only receive sporadic visits from a few fishing vessels and these seals do not show the levels of habituation seen in seals at other sites. Traffic occurred at all three sites, but most was at Lynch's Reef where seals show a great deal of habituation and this might explain the differences observed in response to boat 'traffic.'

Hearing for seals is an important sense, and is commonly utilised by cows and pups to reunite after the cow has been at sea feeding (Stirling, 1971; Insley, 2000; and Phillips and Stirling, 2000). Often hearing is the sense that makes a seal aware of an approach. It is suggested that people remain quiet on seal swims, so as not to alarm the seals. Quiet talking around seals would usually alert a seal to the presence of an approach before the approacher was close enough to startle a seal. In this case, quiet noises are more beneficial than loud or sudden noises. Once again, the data suggest that habituation is occurring. Seals at Kaikoura may have habituated to traffic noises including cars and trucks, aeroplanes and trains, while some noises (rock music, phone ringing, loud talking and dogs barking) still appear to be threatening. Vehicle traffic may not be as threatening because they are lost in the ambient sound of the waves, whereas humans talking, loud music, and dogs barking are more likely to be heard above the waves and alerts the seals to a possible disturbance.

Seasonal differences were also observed in the controlled approach data. The increase in seal responses at Tonga Island to kayak approaches in the second season (See Figures 4.5a-b) is not fully understood and further study is required to determine if the increase in activity persists into the future. Although seals at Tonga Island appear very habituated, there is a lack of area for them to move to if they feel the kayak traffic is a threat. The increasing occurrence of close encounters within the current 10 m guideline (43.2% of kayak traffic approached within 10 m in the first season n=354, compared to 75.9% in the following season n=497) may be heightening the seals' response to the kayak approaches (Groves and Thompson, 1970), which are perceived as more of a threat.

A second explanation could lie in the dual process theory of habituation and sensitisation. Habituation is the decrease in response to a repeated stimulus. The reason for the decrease is that upon repetition of the stimulus, the animal learns that this stimulus is not causing any harm, and therefore it is energetically costly to continue to respond (Shalter, 1984). Habituation is a phenomenon which is stimulus specific, this means that in the case of type of approaches (i.e. land, kayak and boat), seals will habituate to each approach type on it's own, rather than habituating to one approach type and transferring the subsequent decrease in response to other approach types (Groves and Thompson, 1970). The dual process theory of habituation and sensitisation explains how the two phenomena work together. Sensitisation occurs when a stimulus causes a response, such as a startle or avoidance response. This stimulus results in an increase of response behaviour, exactly the opposite to habituation. Sensitisation however, is not stimulus specific and therefore the result of an increase in response will be transferred to other similar stimuli (Groves and Thompson, 1970). The workings of these two processes of learning may explain why seals habituate to certain approach types and respond a great deal to others. In this case there may be some seals at Tonga Island that have become sensitised to detrimental tourist encounters and as a result are responding more to kayak traffic.

Another possible explanation for the increase in responses to kayak traffic might involve the decrease in pup production to the lowest it has been since 1993 (See Figure 4.10). If there is a reduced food supply that is affecting the cows ability to reproduce and successfully rear their young, the colony might already be under a lot of stress and, therefore, might alter behaviour or avoid tourist interactions more than in previous years. In a study investigating the impact of the El Niño Southern Oscillation (ENSO) related food shortages on maternal investment in California sea lions (*Zalophus californianus*), Ono *et al.* (1987) found that females spent more time at sea foraging and less time ashore attending their pups and as a result the pups grew more slowly and suffered a high mortality rate in the food shortage year. If the seals at Tonga Island are not in peak condition, then they may be more susceptible to outside disturbances such as tourists. While no long term studies have been carried out comparing animal condition to levels of tourism, Kuss *et al.* (1990) suggested that a stressed animal may be less resilient to a disturbance, a view that is also supported by Barton *et al.* (1998).

Seals at Tonga Island responded less to boats over the course of the study and may be due to habituation of the seals, but could also be related to precautionary measures taken by the Department of Conservation during the second field season (2000/2001). Written warnings had been sent to all tour boat operators reminding them of the guidelines, and park rangers also spent more time monitoring the behaviour of boat and kayak operators around the island in the second season. However, this initiative does not appear to have reduced the number of boats approaching too close since the proportion of boats approaching closer than 15 m increased from 18.5% (n=610) in the first season to 51.3% (n=1325) in the second season.

4.3.8. Minimum Approach Distances

In calculating an appropriate minimum approach distance, it is important to base the calculations on a number of sites with differing degrees of tourism. There are several areas along the coast where tourists might find seals where there is no established form of tourism and no way to monitor tourists' behaviour around these seals. Minimum Approach Distances need to be precautionary in order to encompass all seal colonies, which may be exposed to human disturbances. While there is a distinct difference in the way in which different gender or age classes of seals alter their behaviour in response to tourists, it is not practical for management purposes to devise guidelines that vary depending on the age or gender of the seals to be approached as this would require the public to be able to determine the gender of a seal, or at the very least, the type of colony. More general guidelines are required that cover all possible cases. Although distances cannot always be adequately enforced, having precautionary, distances will enable DOC to more easily and consistently enforce the regulations and prevent further habituation from occurring.

In the past, land approaches were regulated by DOC at a minimum distance of 5 m. Following the Barton *et al.* (1998) study based at Kaikoura, it was found that many seals are still modifying their behaviour at 5 m and that to limit this impact, a new minimum approach distance of 20 m was recommended. This was not considered to be a very practical distance to implement around Kaikoura, so a compromise distance of 10 m was implemented. The data gathered during this study suggests that 10 m remains too close. Seals at both Kaikoura and Whakamoa responded significantly to approaches up to 30 m away (Figures 4.4a and 4.7a) suggesting that a minimum approach distance of 30 m is required to minimise the occurrence of seals modifying their behaviour in response to tourists. The results from the distance analysis of data collected on the guided seal walk suggest that more than 17% of the seals became active at 20-30 m (See Figure 4.8a). This reinforces the minimum approach distance of 30 m suggested based on the controlled approach data. Also, based on the significant impact land-based approaches have on seals, land-based tourism should be prohibited in breeding colonies, where the high densities of cows and pups promote a situation where any extrinsic disturbance will have a significant impact on the colony. This is supported by Barton *et al.* (1998) and Shaughnessy *et al.* (1999), who both recommend that land approaches be restricted from breeding colonies.

Kayak approaches are currently restricted by DOC to 10 m for Tonga Island and non-breeding sites in Kaikoura, and 20 m for breeding sites in Kaikoura. Controlled approaches by kayak show seal responses at Whakamoa, Kaikoura and Tonga Island to be exceeding the 17% APAL at approximately 30-40m, 20m, and 10m respectively (See Figures 4.5a-b). Kayak tourist approaches at Kaikoura and Tonga Island again showed significant increases in activity level at 20 m and 10 m respectively. In comparison to land approaches, kayaks did not cause seals to respond until closer distances again suggesting that they are less detrimental than land approaches. However, seals at breeding sites, including Lynch's Reef and Island Bay, were responding to kayaks as far as 20 m away, suggesting that 20 m may be a more effective approach distance than the current 10m guideline.

Boat approaches are not regulated in a consistent manner around New Zealand and recommended approach distances to seals vary by site. The recommended minimum approach distance at Kaikoura is 20 m versus 15 m at Tonga Island. In the first season boat approaches resulted in an increase in activity levels at 30 m for seals at Whakamoa and Tonga Island, and around 20 m for seals at Kaikoura (See Figure 4.6a). In the following season activity levels increased above 17% (APAL) at 40-50 m for seals at Whakamoa and around 10 m for seals at Kaikoura, while seals at Tonga Island never increased in activity above 17% suggesting the possibility of further habituation to motor boats (See Figure 4.6b). Although seals at sites such as Kaikoura and Tonga Island appear to be habituating to approaches by boat, seal responses at Whakamoa exceeded the 17% APAL as far away as 30-50 m to controlled approaches and at 40-60 m in response to the few occurrences of boat traffic in the bay. While seals at the experimental sites have shown considerable habituation in the course of two field seasons, it is not necessarily appropriate to decrease the minimum approach distances to fit with the second season data, as safety precautions for the passengers of the boats need to be considered. From the data collected it appears that the current guideline of 15 m at Tonga Island is probably too close and in order to account for variability within sites that are accessible to private boat owners a universal minimum approach distance of 30 m would be more adequate.

Another way of testing the effectiveness of the current minimum approach distances was to compare the responses of seals to approaches that followed DOC guidelines and those approaches not following the guidelines (See Table 4.3). In the case of land approaches, the recommended distance (10 m) does not appear to be mitigating seal activity as 33.6% of seals respond to tourist land approaches that are further away than 10 m. Kayak approaches just barely appear to be mitigating disturbance, with 16.8% (nearly 17% APAL) of seals observed to change their behaviour in response to kayak traffic further than 10 m away. The DOC guidelines for boat approaches on the other hand appear to be minimising seal disturbance and the percentage of seals responding (7.1%) is low for distances greater than the DOC recommended 15 m.

In general, the percentage of seals responding to approaches which followed the recommended guidelines decreased from land to kayak and then boat. From Chi-squared tests of independence for all three approach types, there were significant differences in the number of seals changing behaviour or avoiding approaches that follow or disobey the DOC recommendations (χ^2= 19.996 for land, 27.717 for kayak, and 67.48 for boat). How strongly or consistently the guidelines are adhered to may be a key issue, and one that needs further study since regular disregard for the recommendation may lead to the seals learning or habituating to these closer distances (Toates, 1986; and Hearst, 1988).

4.3.9. Pup Production and Condition

The mark-recapture data from successive years at Tonga Island showed a significant difference between years. The major difference, a low pup estimate for 1993 (92 pups) coincided with the middle of a long El Niño event (1991-1994) (NIWA, 2000). The increase in water temperatures as a result of the El Niño Southern Oscillation (ENSO) (Nichols, 1992) may cause the common fur seal prey to move into cooler waters, either north or south, or vertically in the water column (Ono and Trillmich, 1991). El Niño events are widely known to reduce food available on the East coast of New Zealand and similar findings have been found throughout the pacific (Ono *et al.*, 1987; Trillmich, 1990; and Costa *et al.*, 1991) and can impact the ability of cows to feed and rear pups. A medium to long-term decline in food availability may also increase abortion rates as the cows are not fit enough to carry a foetus to full term (Lunn and Boyd, 1983; and Trillmich, 1990) and may also affect the survival of immature seals which are old enough to be foraging on their own but not as skilled at foraging as the adults (Trillmich and Dellinger, 1991). Another El Niño event occurred in 1997-98 (NIWA, 2000), which may be responsible for the observed decrease in pup numbers in 2000 (121 pups) and 2001 (86). In contrast, the weak La Niña in 1996 (NIWA, 2000) may be related to an increase in local prey abundance and the observed increase in pup numbers, which reach a high in 1998 (175 pups). Therefore, weather patterns appear to be the dominant factors regulating the trend in fur seal numbers between 1993 and 2001 at Tonga Island.

Pup production at Ohau Point did not appear to be as affected by the 97-98 El Niño event as the Tonga Island colony. This is probably due to the presence of the Kaikoura Canyon (Lewis and Barnes, 1999) off the coast of Kaikoura, which creates an abundant food supply of mictophids (lantern fish) and other deep-sea fish, which fur seals feed upon (Carey, 1991) that may buffer the effects of an El Niño event. However, in 1996, as well as 1999 and 2000 (Barton, K., pers. comm., 2000), pups continued to suckle longer than the expected, weaning in October rather than August/September (Stirling, 1971; and Harcourt, 2001a), suggesting that food may have been limited during the winter season. Therefore, while the Kaikoura Canyon may buffer the overall effects of El Niño at Kaikoura, the seals may still have to adjust foraging patterns and maternal strategies, (Ono *et al.*, 1987) including increasing the lactation period (Boness and Bowen, 1996).

To discern whether or not changes in pup production are related to human-induced disturbances such as tourism, mark-recapture and pup condition data collection needs to be carried out long-term in order to eliminate confounding variables such as climate and prey abundance. It is also helpful to compare patterns between several colonies so that colonies that are affected by weather patterns, such as ENSO, in similar ways are compared with colonies on other coasts, which may be effected in opposite ways. By using a comparison such as this, it would allow the factors influencing pup production to be better understood, and variations resulting from

ENSO could possibly be separated from variations resulting from outside disturbances.

Results on pup condition showed no significant differences. All average condition indices were between 1.01 and 1.02, meaning that the observed weight of the pup was slightly greater than its expected weight, given its length. Comparing the pups from the two sites in the 2000 and 2001 season it appears that although there is no difference in pup condition, the individuals at Ohau Point are larger. Longer lengths and greater weights were evident for some of these individuals, with weights averaging 9.49 +/- 0.2 kgs in 2000 and 10.04 +/- 0.3 kgs in 2001 with some individuals as heavy as 14 kgs. At Tonga Island, although a few individuals were about 12kgs, the average weight for 2000 was 7.78 +/- 0.3 kgs and for 2001 was 8.54 +/- 0.2 kgs with some individuals as light as 3 kgs, much lighter than those at Ohau Point. The lightest individual recorded at Ohau Point from either season was 6.3 kgs.

The larger individuals observed at Kaikoura are most likely supported by the rich food supply available because of the Kaikoura Canyon. Therefore, these pups are probably buffered from the effects of the ENSO events, whereas, the pups from Tonga Island are more susceptible to climatic impacts on food availability. If colonies on the Kaikoura coast are more sheltered from the impacts of El Niño events, then it may be possible to discern the impacts of humans on the colonies survival over a period of time by comparing mark-recapture and condition index results to a colony with a similar food supply but different levels of tourism.

4.3.10. Conclusion

The results of the experimental data proved much more useful than that of the behavioural sampling. By manipulating the factor to be investigated in a controlled manner, one can obtain useful information on the short-term behavioural changes exhibited by a target species resulting from tourist disturbance. Although the data shows that seals are altering their behaviour in response to tourists, they cannot fully explain how these disturbances impact the long-term success of the species. The following chapter relates the findings to the initial questions this thesis set out to answer, discusses New Zealand's eco-tourism legislation in comparison with other countries, and makes recommendations based on the information and data presented.

Chapter 5: General Discussion

From the data collected in the past two seasons (1999/2001), some of the key questions this thesis set out to address have now been answered, but by and large these have identified further areas of uncertainty. In this chapter, I will revisit the four questions raised in the introduction and discuss the answers found and the new questions that have arisen from this research.

5.1. What Responses are Directly Attributable to Tourists?

5.1.1. Response Repertoire

Animals are not predictable and, despite our best efforts, we can rarely predict the response of a seal to a particular stimuli (Barton *et al.*, 1998). The most important task ahead is to try to better understand how specific factors affect the variability of animal behaviour. Such information would not only help alleviate unnecessary stress on the animals, but may prove beneficial to eco-tourism if it could lead to enhanced interactions between humans and seals.

The typical responses observed in this study were categorised in the following way: An 'Interaction' was any curious or non-aggressive movement of the seal towards the stimulus. A 'Neutral' response occurred when the seal showed no apparent change in behaviour, which does not include any biological changes such as an elevated heart rate, it simply means that from observation of the animals' behaviour, there was no apparent change. A 'Change in Behaviour' included looking at the stimulus, sitting up and becoming alert or any time that the seals' behaviour prior to the stimulus changed that were not interactive or avoidance responses. 'Avoidance/Aggression' was a dramatic change in behaviour, which included entering the water, moving away from the stimulus, a vocalisation, a charge or threat. The responses of individual seals varied depending on a number of different factors including: the gender/age of the seal, the type of colony, and variation within the stimulus presented.

5.1.2. Gender Differences

A previous study on New Zealand fur seals at Kaikoura (Barton *et al.*, 1998) suggests that the responses of the seals depended on the gender or age of the individual being approached.

This thesis found that gender and age do indeed play a large part in a seal's reaction to an outside disturbance, and as discussed in Chapter 3 (See Section: 3.3.1. Gender/Age Differences) the difference in response appears to reflect the differences in the costs associated with fleeing a territory by the different genders and age classes.

Work on grey seals, (*Halichoerus grypus*) at Donna Nook, Lincolnshire, UK by Lidgard (1996) showed that females preferred to come ashore early to give birth in areas of low disturbance. The cows that did so produced pups with a greater weaning mass, greater mass gain and longer lactation period than those that came ashore late. The cows that gave birth later in the season were more vigilant in the presence of tourists, spent significantly more time in close proximity to their pups and were subject to increased male aggression accentuated by the time in the season and the presence of tourists. Once again, it appears that the time in the breeding cycle is an important factor in how the seals respond to disturbance.

5.1.3. Age Differences

A seal's level of experience will also influence its response to a stimulus. Habituation is an issue that has not been well documented in natural populations. It occurs when an animal ceases to respond to a stimulus through continued exposure to the stimulus, and is a concern in many species targeted by tourism. For example, an experiment on Magellanic penguins, (*Spheniscus magellanicus*) found that birds that were exposed to high levels of tourism during the breeding season for at least 20 years did not respond to human presence as a stressor, suggesting that these animals have habituated to the presence of tourists (Fowler, 1999). In contrast, birds exposed to moderate levels of disturbance over a period of a few years had not yet habituated

(Fowler, 1999), a notion supported by Giese's (1996) work on Adelie penguins, (*Pygoscelis adeliae*).

At the moment, not enough is known about how habituation occurs and how it impacts on a species over time, but there is definite evidence that it is happening in New Zealand fur seals. Seals at the study sites respond to tourists infrequently, often respond less dramatically and at closer distances than seals at the control site (See Figures 4.1 and 4.4-4.6). To manage tourism sustainably it is important to address habituation. Some might argue that habituation is good because it supports some factors that the industry relies upon, the presence of the species and its curious, interactive manner in the water (Young, 1998). Habituation however may in fact degrade the long-term survival and integrity of the species (Edington and Edington, 1986). To ensure that a respectable proportion of fur seals truly remain "wild" as opposed to conditioned, colonies should be protected, by limiting eco-tourism to areas already habituated (Orams, 1995), and where breeding is not occurring.

5.1.4. Site Differences

Seal responses to tourist traffic varies depending on whether the colony is a breeding or non-breeding colony. Breeding seals need to be able to focus on holding territories, maintaining condition and rearing young (Riedman, 1990). Tourist encounters can take time away from the seals that is important for individual survival and the survival of the progeny (Barton *et al.*, 1998). Time spent resting is important for maintaining condition to effectively forage and hold a territory, also the time that a mother spends with her pup is important for the successful growth and survival of the pup (Taylor *et al.*, 1995). Different sites also experience different levels of exposure to a stimulus and therefore, seals at some sites are habituated to the stimulus while others aren't. This habituation could possibly work in a negative manner in a breeding colony if the individuals become either too trusting of humans or if they stop defending themselves in a potentially dangerous situation.

Non-breeding sites are important for the preservation of the species, since these sites often include adult males who are regaining condition lost between breeding seasons, and immature seals, who will one day breed (Riedman, 1990). These seals are all trying to reach or regain breeding condition and is important for them to live with minimal disruption. While their response to an external stimulus may not be as dramatic as cows and pups at a breeding colony, the degree to which these seals flee or stay and fight may depend upon their prior experience with tourists (whether or not the site is already habituated) and the space available to these seals.

Similar findings have been observed in other pinniped species. For example, Kovacs and Innes (1990) showed that the timing of tourist activities in the Gulf of St. Lawrence negatively impacts upon harp seals, (*Phoca greolandica*). Female attendance was low in the presence of tourists and those females that did stay with their pups remained alert and rarely nursed their pups. Pups were more active in the presence of tourists, changed location more and were more likely to engage in aggressive behaviour towards each other. It was recommended that tourists be restricted from the area early in the pupping season to ensure that the cows and pups could sufficiently bond, reducing the risk of pup abandonment or injury by a fleeing female. It was also suggested that a minimum approach distance be implemented although no distance was explicitly stated. They also recommended that an effort be made towards educating tourists on how to behave around the seals including: reducing their noise levels, and moving slowly as these actions greatly reduced disturbance to the seals (Kovacs and Innes, 1990).

Variation in seal responses also depends on the space available to seals and the subsequent density of seals at these colonies. Theoretically, scanning behaviour should decrease with increasing colony size (Terhune and Brillant, 1996), however, in this study that was not found to be the case, as the behaviour of seals at habituated sites will affect this outcome. What appeared to be more important was the seals' position within the colony and the density of the colony, as neighbouring seals will typically alert target seals when an approacher is in the area. The magnitude of this trigger response increases with the density of seals. Therefore, if the density of seals were higher, then the target seal would be more likely to respond to a disturbance regardless of prior behaviour (Fogden, 1971; and Barton *et al.*, 1998). When comparing breeding to non-breeding sites, during the peak months of the breeding season the density of breeding colonies will be high compared to non-breeding sites and the likelihood of triggering several seals to become active is consequently higher at breeding colonies.

Shaughnessy *et al.* (1999) tested the impact of colony density on the response repertoire of the Australian and New Zealand fur seals on Montague Island to boat approaches. Large-scale disturbances were only observed in one colony during the spring months as, at this time, the colony was at its largest and many young animals were ashore.

5.1.5. Human Behaviour or External Stimulus

Constantine and Baker (1999) found that the way in which dolphins in the Bay of Islands responded to swim-with-dolphin programmes varied by species and gender class, and were also influenced by human behaviour such as the place of entry by the swimmers. They suggest that human behaviour that allows the target animals the option to interact was more conducive to a successful swim session. Forcing the dolphins to interact resulted in more dolphins changing their course and avoiding the swimmers.

Born *et al.* (1999) found that ringed seals, (*Phoca hispida*) responded differently to particular types of aircraft. The size of the aircraft and the noise it produced affected the distance at which the seals would respond to the craft. Harbour seals at different islands in the Strait of Georgia were found to respond differently to boat approaches (Suryan and Harvey, 1999). This difference could be related to the islands isolation from human activity and, therefore, prior exposure to the stimulus, leading to certain colonies showing tolerance to human activity.

A study investigating boat-based seal viewing in the UK and Ireland showed that the responses of seals at different sites depended on the way in which boats were handled, the minimum approach distance, and the regularity of the trips (Young, 1998).

The type of approach also plays an important role in how seals respond. Seals are well adapted to life on land and in the water, however, they are more agile in the water. The typical escape route of a seal is the sea and even if the approach is coming from the sea, the seals can dive and resurface well away from the approacher. Land approaches, on the other hand, pose a greater threat to the seals, and cows and other immature seals will move into the sea, while pups hide in crevices. Seals avoided approachers on land significantly more often than any other approach type. Swim programmes also elicit very few avoidance responses from the seals (See Chapter 4: Section 4.2.5. Seal Swims). The reason for the different responses to certain approach types may relate to prior experience of the seals and the processes of learning and habituation. Many seals show habituation to humans approaching on land, however the high percent of avoidance responses may be because there are enough 'negative reinforcements' including: throwing rocks, whipping, beating or even shooting, that still occur that cause seals to be sensitised or wary of land approaches (Sternberg, 1995).

The results of this thesis agree with several of the previous studies on tourism impacts in that the seals' responses depended upon a large number of factors. The key elements identified to date include the:

Tourist Dependent:

- Angle of approach
- Noise level during approach
- Distance of approach
- Height above seals level
- Type of approach; land, kayak, or motor boat
- Handling of vessel

Seal Dependent:

- Breeding or non-breeding colony
- Density of colony
- Time in relation to breeding season
- Colonies prior exposure to each stimuli

5.2. What Responses are Significant in Terms of the Ecology and Behaviour of Fur Seals and Why?

5.2.1. Modification of Behaviour

This study has shown that the short-term/immediate impact of fur seal tourism results in a modification of behaviour such as looking up, sitting alert, vocalising, charging or moving away from the stimulus. It has also shown that repeated exposure to a stimulus will result in habituation, which is a modification of behaviour. This change may result in seals becoming too trusting of humans and not responding appropriately when necessary (Edington and Edington, 1986).

Entering the water an excessive amount of times due to a tourist approach may alter the foraging pattern of a seal. For example, if the cost of entering the sea in response to tourist encounters is high enough, seals may alter their foraging patterns to feed or be away from the colony during tourist encounters, and come ashore to rest and nurse their young when tourists are not around. A similar situation was documented in harbour seals at Strawberry Spit, California, where the seals changed from a diurnal to a nocturnal haul-out pattern, presumably in response to increased human disturbance, which could potentially cause a seal to relocate as well (Allen *et al.*, 1984). Further work is required in this area, using time-depth recorders (Harcourt *et al.*, 1995; Boyd *et al.*, 1997; and Georges and Guinet, 2000) to investigate the possibility of seals altering their foraging patterns in areas of high tourist activity.

Other studies have shown similar behavioural modifications that came about because of tourism. In National Parks in Africa, it was reported that lion and cheetah hunting behaviour was disrupted when six or more vehicles surrounded the animals, ultimately changing their foraging behaviour (Western and Henry, 1979). The chances of this occurring with New Zealand fur seals are not very high considering that most of their foraging occurs at night and offshore (Crawley and Wilson, 1976; and Harcourt *et al.*, 1995).

The changes associated with artificial feeding, as mentioned in Chapter 4, result in a modification of behaviour. This has resulted in new, unnatural behaviours being established in species such as begging, and changes in the level of natural behaviours occurring for instance, increased aggression and decreased provisioning of young, the later ultimately leading to a decrease in recruitment (Grzimek, 1964; Harris, 1973; Spencer, 1975; Connor and Smolker, 1985; Herrero, 1985; Edington and Edington, 1986; and Glick, 1991).

Another documented change in behaviour because of tourism is a decrease in the mother defending the offspring. The mother would move away as a consequence of tourist intervention and in her absence a predator would come in and take the offspring or egg. This has been observed in animals such as king shags (*Phalacrocorax albiventer*), Magellanic penguins (*Speniscus magellanicus*), brown pelicans (*Pelecanus occidentalis*), Nile crocodiles (*Crocodilus niloticus*) and cheetahs (*Acinonyx jubatus*) (Cotts, 1969; Kury and Gochfield, 1975; Anderson and Keith, 1980). In all of these cases, the predators had learned that in the presence of tourists their prey would stop guarding. Although this sort of scenario might not be of concern in fur seals, the seals fleeing from a disturbance in a breeding colony has been known to cause mortality to the young through trampling (Mattlin, 1978). Adult female fur seals often compete for cooling substrates for thermoregulation (Carey, 1992) as well as to defend their offspring from conspecifics (Harcourt, 1991). It is suggested that an increase in female-female aggression related to movement within the colonies for purposes such as thermoregulation enhance separation of mother/pup pairs and pup mortality (Harcourt, 1992). Therefore, if an outside disturbance elevates the activity within a colony, and causes individuals to move into the sea, it may also increase aggression, mother/pup separation and subsequent pup mortality.

Figure 5.1a. Man Having Picture Taken with Seal at Kaikoura Peninsula

Figure 5.1b. Man Moves Closer to Seal, Seal Flees

5.2.2. Reproductive success

Modification of behaviour may impact on the reproductive behaviour and success of the seals. For instance, if male seals are spending time responding to disturbances, their time spent defending territories from other males or involved in copulatory behaviour may be limited (Barton *et al.*, 1998). This may in turn lead to a decrease in pup production. Although seals at Tonga Island have shown a decrease in pup production since 1998, it is not possible to determine whether this is a result solely due to the ENSO weather patterns. Another way to assess the reproductive success of a colony would be to count copulations as in indicator of male reproductive output, and compare these data to other sites with varying degrees of tourist activity. Lower copulatory rates, and high activity levels at sites of high tourist activity might suggest that males are spending more time responding to outside disturbances than to defending their territory and breeding (Harris, 1973). While studies have looked at the impact of tourism on mother/pup interactions (Kovacs and Innes, 1990; and Lidgard, 1996) few have investigated the impact on male reproductive behaviour. Energetic impacts of tourism may also be at play here but several more seasons of data would be required to separate out the degree to which each component is impacting pup production.

A decrease in reproductive success due to tourism has been observed in other species, where the disturbance caused a segregation of the genders, which in turn led to a decrease in reproductive behaviours. This was documented in Thomson's gazelle (*Gazella thomsoni*) in East Africa. Walther (1969) observed that the females startled easily resulting in a separation in the sexes and a decrease in breeding success. In another instance, feeding by tourists resulted in a breakdown of the territorial system and subsequent decrease in reproductive success for Galapagos land iguanas (*Conolophus subcristatus*) (Harris, 1973).

5.2.3. Maternal investment

Of great concern is the impact that tourism may have on maternal investment (Kovacs and Innes, 1990; Lidgard, 1996; and Barton *et al.*, 1998). The results of the focal animal mother/pup pairs did not show any significant difference in mother/pup association time between sites. The low numbers of seals seen on Tonga Island in the second season (scans in the first season would reach 80-120 seals visible on the West side, scans in the second season rarely showed above 60 seals visible on the West side) and the reduction in cows seen 'loafing' off the island, suggest that the females may be altering their strategies for pup rearing. Further work would be needed on a tagged population, using time-depth recorders to work out patterns of female attendance, to see if the females are altering their behaviour where tourist numbers are high.

Previous work on pinniped tourism in the Northern Hemisphere has found that tourism too early in the breeding season of harp seals could interfere with the ability of the cows and pups to develop a bond, which is important for the subsequent survival of the pup (Kovacs and Innes, 1990; Insley, 2000; and Phillips and Stirling, 2000). This bond allows the pair to reunite after the female has been at sea feeding (Kovacs and Innes, 1990). Other studies have suggested this as well. Whale watching vessels have the potential to break up gray whale (*Eschrichtius robustus*) mother/calf pairs and if this occurs before the pair has sufficiently bonded then the separation might be permanent and lead to a decreased survival for the offspring (Noris *et al.*, 1977; McCloskey, 1983). Similar scenarios have been observed in hoofed mammals in Africa, where tourist vehicles caused a separation between the mother and offspring. If this happens after initial bonding has taken place the problem is not as severe, the pair has a better chance to re-unite, however if the disturbance occurs before sufficient bonding has occurred, the female might not be able to find her young after the separation (Lawick-Goodal and Lawick-Goodal, 1970).

Lidgard (1996) showed that grey seal females change their foraging and pup rearing strategies in order to avoid raising a pup in peak tourist season (Oct-Dec). Several females began to come ashore earlier to pup to avoid the tourists while females that came ashore late in the season were more vigilant and spent more time protecting the pup than normal. While exact numbers of tourists visiting seal colonies are not known it was estimated in 1993 that as much as 10,000 people visited the Donna Nook colony that year and that the number was expected to increase each year (Lidgard, 1996). In comparison, a recent survey carried out in 1998, estimated the number of tourists visiting the Kaikoura seal colonies to be around 325,432 annually (Simmons *et al.*, 1998), illustrating the increasingly high number of tourists viewing seals in New Zealand, and the importance of understanding the impact tourism has on maternal investment in New Zealand fur seals.

With so little work done on the impact of tourism on fur seals in New Zealand, many long-term concerns have not yet been addressed yet, most importantly the possible impact on reproductive output and maternal investment. It is apparent that animals targeted by tourism are adapting in different ways by habituating and effectively ignoring the stimulus, or by altering behaviour to avoid the disturbance. Fur seals, especially adult females, are tied to a location for a good portion of the year for biological purposes and because of this, it is possible that habituation is a better option for them in order to successfully feed and rear their offspring. However they could very well be altering their foraging patterns and when they come ashore to feed their pup. The focal animal aspect was unable to fully investigate these sorts of behaviours and further detailed work on female attendance is recommended.

Figure 5.2. Mother and Pup at Ohau Point, Kaikoura

5.3. What Level or Type of Fur Seal/Tourist Encounters are Acceptable?

Tourism may be beneficial in boosting conservation efforts by educating the public about the current issues relating to conservation (Edington and Edington, 1986; WTO, 1992; Barton *et al.*, 1998; and Young, 1998). This method of spreading awareness has the potential to be very successful, however, the tourism industry needs to be managed in a way that provides a safe environment for both tourist and the target species. In the case of fur seals, certain encounters are acceptable while others are not. It should be a goal of the tourism and conservation industries to limit the amount of avoidance interactions. Behaviours such as throwing things at seals, chasing them, surrounding them and trying to pet them should be prevented. While a good percentage of these more invasive encounters may result from people's lack of concern and are beyond the control of regulating bodies, the frequency of these occurrences may be reduced through an increase in the educational material available to tourists at the seal colonies or on seal viewing trips.

To manage fur seal tourism in a sustainable manner, it is in the best interests of the tour operators to have as little impact as possible (Beach and Weinrich, 1989). Operators rely on the seals being easily accessible, and if tourist interactions reached a point where it was energetically too expensive for the seals to remain at that site then they may move out of the area. The fact that fur seals are highly site faithful may limit the chance of this happening, however, several operators have voiced their concern stating that they want to minimise their impacts so that the seals will still be there and the operators can remain taking tourists to see the seals for years to come.

Only a few studies have looked at displacement as a possible long-term impact, however, it has been documented in Glacier Bay, Alaska where humpback whales once spent their summer feeding season. The summer of 1977 showed an increase in the number of boats entering the bay, approximately 103 large ships plus several small, private boats. The following season the whales were not seen, and in 1979 only a few whales were seen so it is possible that with increasing tourist pressures the target animals could be relocating (Johnson, 1983). It has since been suggested that changes in prey abundance might have been the cause of the whales leaving the area (Baker *et al.*, 1988). Despite the lack of evidence linking tourism to the decrease of humpbacks seen in Glacier Bay, more studies were carried out to investigate the impact of boat traffic on the whales and reported both the occurrence of short-term avoidance behaviours as well as habituation (Reeves, 1992).

Constantine and Baker (1999) observed short-term behavioural changes in dolphin responses to commercial swim-with-dolphin vessels and that in light of this, further work is needed to fully understand the migratory patterns of dolphins in the Bay of Islands, to assess the possible long-term impacts of seasonal boat traffic and swim-with-dolphin programmes.

Many otariid species show strong site fidelity, and in the case of Northern fur seals (*Callorhinus ursinus*), their philopatric or site faithful nature has lead to a tolerance of human activity (Gentry, 1998). Therefore, site fidelity of New Zealand fur seals is likely to promote habituation to human disturbance.

Habituation is not uncommon and is perhaps the most basic form of behavioural plasticity (Groves and Thompson, 1970), although scientists are still working hard to understand the principles of how it works and much of the research on it has been carried out in a laboratory situation (Toates, 1986). This study has shown evidence that it is occurring in New Zealand fur seals at popular tourist destinations (See Chapter 4: Section 4.3.7). While many believe that habituation is nothing to be concerned about, habituation is a detrimental impact of tourism as it represents a seals' decrease in response to regular visits by tourists, and is a change in behaviour from the way non-habituated seals would normally respond to similar stimuli. Habituation has been documented in a number of ecotourism studies (See Chapter 1) and new or unnatural behaviours have been observed in habituated populations in some cases. Connor and Smolker (1985) observed the behaviour of a group of habituated bottlenose dolphins (*Tursiops truncatus*) at Shark Bay in Western

Australia. They observed dolphins interacting with humans, and although most interactions involved the dolphins receiving physical contact from the humans, some did result in dolphins mouthing and biting humans. They also observed a behaviour never before documented in wild dolphins, that of 'begging' for food from other dolphins. These changes in behaviour may be more strongly related to the fact that the humans are feeding the dolphins, and the long-term impact of this has been found to be severe. There has also been a documented increase in mortality of juvenile dolphins born to provisioned mothers, most likely because they did not learn proper foraging techniques and the mothers invested less time in rearing and protecting their offspring (IFAW, 1995). Although there is currently no 'seal feeding' venture in New Zealand, further habituation of seals to humans may prove to be detrimental to the survival and integrity of the species.

Seal swim ventures, like other marine animal 'swim-with' programmes, consider a swim successful if the target animal comes close to and interacts with the swimmers (Constantine and Baker, 1999; Chambers, G. pers. comm., 2000; and Stanford, D., pers. comm., 2000). The increased success of these ventures relies on the high interactions with the target species. From this study, the seal swims proved to be the form of seal tourism that elicited the most interactive responses from the seals and the fewest occurrences of avoidance. Specific behaviours on the swimmer's part were observed to elicit avoidance responses from the seals (See Chapter 4: Section 4.3.6). Minimising the occurrence of these behaviours by a knowledgeable guide helps to maintain the success of seal swimming operations and minimise the overall impact of these ventures.

5.4. What management measures could be introduced to reach the above goals?

5.4.1. Tourism Legislation and Eco-tourism Case Studies

Many countries have some sort of legislation in place to protect their natural areas, for example; the Tasmanian National Parks and Reserves Regulations (1971), Western Australia's Environmental Protection Act (1971), South African National Parks and Wildlife Act (1974), the Bahamas National Trust Act (1959), the

Bangladesh Wildlife Order (1973) and the Marine Mammal Protection Acts of America (1978) and New Zealand (1978). Many of these say something to the effect that:

"No person shall- 'take' a protected animal"

with the definition of 'take' ranging from:

"Hunting, trapping, laying snares, taking eggs, shooting, driving or chasing animals" (Bahamas)

to:

"Harass, hunt, capture or kill, or attempt to harass, hunt, capture or kill" (America).

Few specifically refer to tourism, and animal viewing. The New South Wales Ordinance No. 82 dealing with protection of reserves goes a little further stating that:

"No person shall injure or 'molest' any flora or fauna in a public reserve."

While the Tasmanian National Parks and Reserves Regulations 1971 Pt. 2 Conservation Areas states that:

"No person shall:

d) *'interfere' with the nest, breeding place, or habitation of any life form or-*

e) *intentionally rouse or disturb any form of wildlife."*

The New South Wales National Parks and Wildlife Act 1974 Sect. 112G actually goes as far as to address marine mammal tourism, and 'approaching a marine mammal:'

"A person must not approach a marine mammal any closer than such distance as may be prescribed by the regulations or 'interfere' with a marine mammal."

Now we begin to run into the problem of what is an appropriate definition for:

Harass, Interfere or Molest?

The NSW National Parks and Wildlife Act defines interfere as:

> *"To harass, chase, herd, tag, mark and brand."*

The USA Marine Mammal Protection Act 1978 (MMPA) defines harassment as any:

> *"Act of pursuit, torment or annoyance which –*
>
> *i) Has the potential to injure a marine mammal stock in the wild; or*
>
> *ii) Has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioural patterns, including but not limited to migration, breathing, nursing, breeding, feeding or sheltering."*

And for New Zealand the definition is:

> *"Actions that disrupt significantly, or are likely to disrupt significantly, the normal behaviour patterns of an animal."*

There has been great difficulty in defining harassment and as a result it is equally difficult for these regulations regarding animal viewing to be enforced. As mentioned in some of the legislation there is a prescribed distance for approaching animals. However the specifics of these are not given in the legislation as they tend to be dealt with on a local scale.

In the UK and Ireland current legislation on marine mammal viewing is based on a voluntary code drawn up by the Department of the Environment, Transport and the Regions. It has not sufficiently protected dolphins to stop them being surrounded by 25 boats nor does it adequately protect seals from the increasing amount of tourism (Nuttall, 2000). There have been several suggestions to develop some form of legislation and to enhance the conservation and educational values of the tours but as yet nothing has been implemented (Young, 1998; Nuttall, 2000).

Although New Zealand has in place more formal legislation than countries such as the UK, in comparison to countries such as the USA, New Zealand's eco-tourism and legislation is very lenient. Under the USA-MMPA any swim-with-dolphin or pinniped programmes would be considered harassment and are consequently illegal (Young, 1998).

Eco-tourism takes many forms in various countries from snorkelling and tramping to viewing animals. In general the major aspects of tourism that can directly affect the ecosystem or wildlife therein are (WTO, 1992):

- Overcrowding/ over-use
- Vehicle traffic: cars, boats, kayaks
- Land traffic: environmental degradation and disturbance to animals
- Feeding of animals

To illustrate common problems faced in other countries and their specific remedies, I will discuss four case studies; Australia, Kenya, Costa Rica and Yellowstone National Park.

5.4.1.1. Australia

Issues: Habitat degradation through development and overuse

One major issue that is of concern in Australia is the development and overuse of beaches. The Great Barrier Reef is a popular tourist destination and has suffered from destruction of coral from diving, and also from 'souveniring' where people collect and take away shells and coral (Burns, 1989). This led to the establishment of the Great Barrier Reef Marine Park (GBRMP) in 1975. Collecting shells/coral from the GBRMP is illegal, the number of permits issued is kept to a minimum, and 4 out of 14 islands within the park are closed during the nesting periods of birds and turtles. Efforts have also been made to educate divers to reduce their impact on the coral and other wildlife (Orams, 1999).

5.4.1.2. Kenya

Issues: Poaching, Enforcement and funding not sufficient

The wildlife in Africa is a huge draw card for tourists, with the life of one elephant being worth US$ 900,000 in tourist expenditure. However, in the early days of national parks there were initial problems, there was not enough funding for proper enforcement, and poaching was quite common. There were also problems with overuse in the parks. In 1978 hunting was banned and tour operators tried to draw tourists to come "shooting to Kenya with your camera." In 1989 the Kenyan Wildlife Service (KWS) was formed to manage parks on the local level. Income and assets are under the jurisdiction of KWS so they can insure that money goes back into the park for maintenance. With local management they are able to limit access in various parks for specific use in effect having some as sacrifice areas, and others completely protected. An effort is also being made to stop illegal hunting, and KWS is attempting to work out a 'carrying capacity' for parks in order to control the number of tourists in the parks (Olindo, 1991).

5.4.1.3. Costa Rica

Issues: Habitat degradation through overuse and tourist disruption of wildlife

Costa Rican parks have had problems with overuse and the public disrupting wildlife. Informal regulations have since developed; groups must have a biologist or natural history expert guiding them, and groups must be kept to a manageable size. Carrying capacity has been worked out for the parks and it must be respected. Unfortunately compliance is self-motivated and the eco-tourism industry of Costa Rica continues to grow with little planning for the future. The National Tourism Board governs general tourism, however, this does not govern parks, as they are all required to have their own regulations and management. In fact, these sorts of regulations only exist in a few parks. In order to deal with the problems and form more consistently enforced regulations a co-operative board was formed in 1990 to focus on eco-tourism issues (Rovinski, 1991).

5.4.1.4. Yellowstone National Park

Issues: Habitat degradation through overuse and tourist disruption of wildlife

The 14 million acres of the Greater Yellowstone Ecosystem have faced a number of problems over the years associated with eco-tourism. In 1990 the first coyote attack of a human was reported, and subsequent ones followed. Upon investigation it was found that tourists had been feeding the coyotes and they had begun to beg aggressively. The coyotes were shot, and a ban on feeding animals was put in place, however, it still occurs. Fishing Bridge campground, a popular feeding site for grizzly bears was also a popular fishing site for tourists and eventually over-fishing by humans forced the grizzly bears to move elsewhere. An attempt was made to separate human and bear fishing grounds by promoting sites for tourists, which the bears do not regularly use. However, the local town that benefited from tourists coming to Fishing Bridge did not approve and facilities there have been improved to keep tourists coming, it is still a popular tourist site and several 'bear regulations' have been put in place and thus far have been successful in minimising conflict. Over-use was also a concern in Yellowstone and in 1978 the US Congress required all National Parks to establish a carrying capacity for each of the parks to control the number of tourists visiting. Educational strategies have also been put into action including making tourists aware of visitor guidelines. These educational strategies have helped to lessen the impact of back-country use and guidelines for future planning in the park are led by federal, state and local government and private organisations (Glick, 1991).

Another form of management for protecting wildlife and historic sites, is the World Heritage Trust, which was formed in 1972 to protect sites which are deemed essential for the whole of humanity (Everhart, 1983). These areas are entitled to all necessary assistance from the world community for the protection and maintenance of the areas. By 1983, 100 sites were listed with the World Heritage Trust and currently there are 690 sites protected worldwide. New Zealand has three World Heritage Sites; Te Wahipounamu (Southwestern New Zealand) and Tongariro

National Park were both listed in 1990, and the New Zealand sub-Antarctic Islands were listed in 1998 (UNESCO, 2001).

New Zealand offers many more opportunities to view and interact with seals than many other countries, but because of this, seals here are more prone to disturbance by humans and it is in our best interest to manage the tourism industry in a sustainable and educational manner. At the moment precautions are taken to attempt to limit the impact tourism has on New Zealand fur seals. There are recommended minimum approach distances, foot traffic is not advised for dense non-breeding colonies or any breeding colony. People are reminded that seals are wild animals and should be treated as such. On seal swims tourists are advised not to scream or make loud noises, it is also advised that dogs should not be taken on the Kaikoura peninsular walk. These guidelines however, do not appear to be working. People have been observed walking into the breeding colonies, going within the prescribed approach limit, and even throwing rocks at seals. At the moment information signs for viewing fur seals are inadequate and poorly displayed. In many cases they are positioned where they are easily overlooked, they do not convey the appropriate information to non-English speaking tourists, and in the case of the Kaikoura Peninsula the old sign which, recommends a 5 m approach distance is still up less than 100 m away from a new sign with the 10 m approach distance. In Abel Tasman National Park, DOC is reliant on the various tour operators to remind their clients of the regulations for seal viewing around Tonga Island.

From studies on the environmental impacts of marine tourism, Orams (1995) categorises the available management strategies into 4 major areas: Regulatory, Physical, Economic and Educational. Regulatory measures include limiting tourist numbers and recommended behaviour and minimum approach distances. Physical measures include refurbishing the site to handle the amount of tourism it is receiving, removing facilities from areas where the goal is to keep tourist traffic to a minimum, and having 'sacrifice areas' that take the brunt of the tourists in order to keep other areas pristine. Economic strategies include admission fees, damage bonds, fines for inappropriate behaviour and rewards for turning in inappropriate behaviour. Educational strategies include printed material, signs, visitor centres, guided walks and activities, and personal contact with trained/educated staff. The major recommendations from this thesis fall into the Regulatory and Educational categories.

5.4.2. Minimum Approach Distances

Minimum approach distances are designed to keep people at a safe distance where neither the tourist nor the seal should feel threatened. It is also meant to be the closest approach distance that will not interfere with the seals' normal behaviour and will not result in forcing them out of their territory (Barton *et al.*, 1998; and Barber, F., pers. comm., 2001).

From the data obtained, recommended approach distances were calculated for approaches by land, kayaks and motorboats. While seals at different sites respond at different distances depending upon prior experience with the stimulus, many seals at Sharks Tooth, the control site and all breeding colonies responded as far away as 30 to 60 m to approaches from land, with a significant increase in activity levels occurring at 30 m. Whatever the updated minimum approach distance is, it needs to be consistent between all sites in New Zealand and needs to be better enforced with all educational signs in agreement of the appropriate approach distance. In the United States people are not to approach within 100 yards (91 m) of seals in a haul-out, and they are required to move back if the seal responds (Carlson, 1996). On guided walks to view elephant seals at Año Nuevo, tourists are required to stay 25 feet (8 m) away from all seals (Año Nuevo State Reserve, 2000) and in Yellowstone National Park tourists are required to remain 100 yards (91 m) from bears and 25 yards (23 m) from all other wildlife. In Australia, most seals are found on offshore islands and therefore land access is minimal. It is recommended that people do not land on these islands and in the case of Seal Bay Conservation Park, located on Kangaroo Island, South Australia, viewing seals from land is restricted to boardwalks and guided walks run by park rangers (Shaughnessy *et al.*, 1999; and NPWSA, 2001). Based on these distances and regulations enforced at parks overseas, the recommendations of 30 m for a Minimum Approach Distance to New Zealand fur seals at haul-out sites is not unrealistic.

Kayaks were found to be most disruptive to cows and pups and 20 m was calculated as an acceptable approach distance. As this is the current regulation for breeding sites around Kaikoura, it makes sense that this regulation should be consistent at other breeding sites around New Zealand, including Tonga Island. Furthermore, since many people cannot differentiate between breeding and haul-out colonies, the regulation should be applied universally.

Current approach distances for boats are not consistent between locations, and are too close to be safe for seals and tourists. The distance calculated for boat approaches was 30 m. This is adequately close to view the seals and also ensures the tourists safety by keeping the boats further from out-lying rocks. Many of the seals at Tonga Island are very habituated to the presence of boats and do not respond until the boat is quite close, however, several seal colonies around New Zealand are not regularly exposed to this stimulus. To successfully enforce a minimum approach distance by tourist and private boats it once again, needs to be consistent around New Zealand and the information needs to be made available to the private boat owners as well as the tour operators. In other countries, boat-based tourism has certain restrictions for viewing wildlife, for example, in America, the National Fisheries Service set up guidelines for viewing California gray whales (*Eschrichtius robustus*) as follows (Edington and Edington, 1986):

- Minimum Approach Distance of 100 yards (91 m)
- The speed of the boat shall not exceed that of the slowest whale in the group, and
- Vessels should never separate a cow and calf pair

For humpback whales the regulations are not as lenient, in Glacier Bay, Alaska there is a limit on the number of vessels that may enter the bay at a time and the Minimum

Approach Distance is ¼ of a mile (approximately 400 m) (Marine Mammal Commission, 1982). The current minimum distance recommended for approaching whales in New Zealand is 50 m, and no more than three vessels are to be within 300 m of a whale at any one time (Donoghue, M., pers. comm., 2001).

In a study of waterfowl at Lake Rotoiti, Rotorua, Montgomery (1991) observed the behaviour of a number of bird species when boats approached, calculated the distance at which the birds became 'alarmed' and the distance at which they 'fled.' From these data, Montgomery (1991) calculated a Minimum Approach Distance for four species: coot, scaup, dabchick and little shag. The 'Distance Alarm' average for each species ranged from 30-70 m and the 'Distance Flee' average ranged from 26-62 m for the four species.

In Australia seal viewing by boat is a popular activity, however, it is managed on a regional basis, resulting in multiple approach guidelines. For a habituated colony of Australian fur seals at Seal Rocks off Phillip Island, Victoria, tour boats may approach to 10 m. In other regions where seals may be less accustomed to tour boats the guidelines are more stringent, for example, in Tasmania the minimum approach distance is 50 m unless in the months of November and December, when pupping occurs, during these months boats are restricted to 100 m (PWST, 1999) A study investigating boat disturbance on harbour seals (*Phoca vitulina*) at Bolinas Lagoon, California found that seals would enter the water when boats (including kayaks) were as far away as 100 m (Allen *et al.*, 1984). Again, based on these distances and those stringent regulations of whale watching in America, 30 m is not an unrealistic distance to recommend for boats approaches to New Zealand fur seals.

The data collected in this thesis and the subsequent Minimum Approach Distances calculated were only collected on New Zealand fur seals and different factors will need to be addressed if looking at a different species (i.e. Hooker sea lions). When revisiting these distances certain aspects need to be taken into consideration:

- Distance needs to be based on safety of target species as well as tourists
- Regulations need to be consistent between tour operators as well as locations
- Distances should be conservative to prevent tourists from pushing the limits too close
- It is better to try to prevent a dangerous situation than to try and fix it once it has already occurred
- Minimum Approach Distances need to be precautionary and therefore encompass all possible variations within approaches, this will make distances easier to enforce and will better serve to protect animals that are easily accessible to humans but not near a popular tourist destination
- Approaches should also be restricted from sites where habituation has not yet occurred

For these reasons the following approach distances are recommended:

- Land approaches --- 30 m at non-breeding sites, prohibited at breeding sites
- Kayak approaches --- 20 m at breeding sites
- Boat approaches --- 30 m at all locations

5.4.3. Educational Options

Education is the key to mitigating human impacts on any species. Teaching appropriate approach behaviour to both tour operators and the public in general may lessen the overall impact of tourism and instil an appreciation for the environment in the operators and tourists involved.

Conservation and tourism need to be able to work together to more effectively manage species like the New Zealand fur seal. It is important that tour guides understand the basic biology and behaviour of the target species. They need to be giving tourists consistent information as well as being able to understand the behaviours they are observing in the seals. By doing this, they will be able to function better as leaders and role models for the tourists. This can be addressed by pamphlets approved by DOC and a course or workshop that tour operators would have to participate in to keep their permit.

Tourists need to be provided with consistent and appropriate information. Appropriate approach behaviour should be addressed at any place where close interaction may occur. "Common Sense" guidelines are in place for dolphins and something similar should be provided for fur seals. Particular behaviours observed in seal swims were more likely to cause seals to avoid the swimmer, these being:

- Chasing seals in the water
- Approaching <10 m to seals on the rocks or landing on the rocks
- Splashing seals with flippers
- Encircling the seal(s) and
- Loud or sudden movements towards the seals

An attempt to educate tourists and tour operators on what behaviours are appropriate when swimming around seals would help to reduce the occurrence of these behaviours. Regulatory signs need to be placed at all access points to a major tourist colony and at eye level. Many that already exist are in places where they are easily overlooked. These signs also need to convey the information to non-English speaking tourists.

Regulatory information needs to be easily accessible to the public, if not, how are they supposed to know what is appropriate behaviour and what isn't? An effort to educate the public on these matters is essential. Various State Parks in the United States have made information easily accessible to tourists via the Internet.

The web site for Año Nuevo State Reserve clearly states that:

> "Elephant seals are dangerous wild animals, never get within 25 feet of an elephant seal, and make sure your children don't either."
>
> (Año Nuevo State Reserve, 2000).

Yellowstone National Park provides a great deal of information on things to do in the park and safe animal viewing practices. It is clearly stated on their web site that one should:

> "Never approach closer than 100 yards (91 m) to bears and 25 yards (23 m) to other wildlife. Wild animals, especially females with young are unpredictable. Keep a safe distance from all wildlife. By being sensitive to its needs, you will see more of an animal's natural behaviour and activity. If you cause and animal to move you are too close."

Information is also provided on this web site on safety tips for tramping in bear country (US National Parks, Yellowstone, 2001).

On web sites in New Zealand, information such as this is hard to come by. The Royal Forest and Bird Protection Society used to show the original Minimum Approach Distance of 5 m for fur seals, but has since taken it off as it has changed, although it has not been updated with the current 10 m guideline (Forest and Bird, 2001). The Department of Conservation web site offers some educational material about seals commonly seen in New Zealand, but as far as appropriate behaviour around seals all that is mentioned is:

> "Leopard seals in general should be treated with respect. All seals should be treated with caution. They have large teeth and can become aggressive. They also move surprisingly well on land. Fur seals can bite with up to 2 tonnes/cm pressure. Always keep dogs and small children well away from seals. Do not feed seals."
>
> (Department of Conservation, 2001)

This is all very good information, however, simple guidelines such as the Minimum Approach Distance should be added, along with a statement about not walking between the seal and the sea in order to make this information easily available to tourists. This sort of information would help enforce regulations around sites where there is no tourism facility or educational sign.

Volunteer programmes have been successful at many zoological parks in educating tourists about the animals, as well as monitoring their behaviour around the animals. Approximately ten people each summer contact the Department of Conservation field station in Kaikoura looking for volunteer work (Barber, F., pers. comm., 2001). Talking to people at colonies has been successful in teaching people about the seals and explaining the regulations about them. Volunteers could also take guided walks around the peninsula and other non-breeding sites. Guided walks have been successful in America and Australia for introducing people to seals in a safe manner. Implementation of some sort of volunteer and/or guided walk programme would help reduce the amount of people walking into breeding colonies and getting too close to the seals as well as providing tourists viewing seals from land with more information about the animals. A guided walk is currently being run on a trial basis at the Kaikoura Peninsula, thus far it has helped keep tourists from walking into the breeding colony of Lynch's Reef and reduced the likelihood of seals changing their behaviour in the presence of tourists by 15% (See Chapter 4: Section 4.3.6).

In a report by the World Tourism Organisation some educational strategies are recommended including; brochures, specialised guides, keys or checklists, visitor centres and informal contact. Informal contact is used in New Zealand's Te Wahipounamu World Heritage Park to educate tourists about the ecosystem (WTO, 1992).

Based on the findings of this thesis, a summary of the recommendations for educating people on safe behaviour around wild animals follows:

- *Pamphlets* available to tour operators and tourists
- *Workshops* for tour operators
- *Code of conduct* for behaviour around seals including all possible approach types; land, kayak, boat and swim
- *Educational displays* that address current issues important to seals
- Regulatory signs at *all access points* of a colony
- Signs must be placed at *eye level* in places where they are easy to see
- Signs must be able to convey information to *non-English* speaking tourists
- *Volunteers* may be useful for talking to tourists and monitoring their behaviour
- *Guided walks* would ensure people are not approaching too close or entering breeding sites
- Regulatory information about viewing seals needs to be *easily available*, the use of the Internet would be a successful option

5.4.4. Human Behavioural Modification

There are currently a large number of operators viewing and interacting with seals at various sites around New Zealand. However, to make sure that eco-tourism is sustainable, the seals must not be "saturated" to the point that they might cease to interact with tourists or even relocate. It is important to base the number of permits on the number and accessibility of the target species in question. The number of operators and the frequency of visits to seal colonies should be closely regulated. Some sites may already be reaching their upper threshold and any more permits could possibly be detrimental to the seals and ultimately to the existing tour operators. As an example, the breeding colony at Lynch's Reef receives tourists: walking across the channel; two land-based seal swims that operate daily; occasional visits from a boat-based seal swim; occasional visits from whale watch vessels; daily whale watch flights during the summer; approximately 4 trips during low tide each day during the summer by the guided seal walk; and one kayak operator who works around the peninsula on a daily basis. Consequently, these seals can have tourists around them for a full day depending upon the weather. The guided walk of a northern elephant seal (*Mirounga angistirostris)* colony provided by Año Nuevo State Reserve in California runs once a day from December to March. This means a maximum of 7 supervised trips per week enter the breeding colony compared to the possible 247 trips per week that may interact with breeding and non-breeding fur seals in Kaikoura. Many other countries, including some mentioned earlier (See Section: 5.4.1.2-4) have worked out a 'Carrying Capacity' for the park in order to lessen the impacts caused by overuse. The WTO (1992) addresses this issue and gives an explanation on how to calculate the value for the park or attraction in question. Saturation or 'Carrying Capacity' (K) is equal to:

$$K = \text{area used by tourists/average individual standard } (m^2/\text{person})$$

the total number of allowed daily visits is:

$$\#\ \text{Daily Visits} = K^* \text{ rotation coefficient}$$

where the rotation coefficient is:

$$RC = \text{daily hours open/average time of visit.}$$

There will be a number of environmental and social factors involved that need to be taken into consideration for each individual area, however, the WTO provides a basis for dealing with the issue of overuse.

Other recommendations for fur seal tourism in New Zealand include staggering trips on a spatial and temporal scale. This may decrease the impacts of tourist activities at specific locations, but this policy is currently implemented in an ad hoc manner, with too much of the responsibility being left to individual tour operators. At Kaikoura it is recommended by DOC that seal swims should not be run consecutively or at the same site. This recommendation is not always adhered to and it would be beneficial to enforce this recommendation more consistently to give the seals some respite. It would also be wise to extend this recommendation to other sites in New Zealand, particularly Tonga Island in Abel Tasman National Park.

The seal swim at Tonga Island currently alternates the sites it uses and does drift dives down the coast of the island to give the seals some variety and release the pressure of using the same group of seals each day. This has provided them with more successful swim sessions. By organising motor boat and kayak visits to the island so that no more than 3 tour groups or vessels are viewing seals at a time, then the risk of seals moving away from "predictable" traffic may be minimised. A similar sort of practice is already in use at Great Barrier Reef Marine Park in Australia, where activities are restricted from specific areas during certain times of the year to relieve the pressure from breeding turtles and sea birds (Edington and Edington, 1986).

The Marine Mammal Protection Act states that no more than 3 vessels are to be within 300 m of a marine mammal at the same point in time. It is not uncommon to see two or more water taxis, a seal swim and 20 kayaks all within 20 m of Tonga Island at once. The seals at Tonga Island are exposed to such large amounts of boat traffic that many have habituated and no longer respond to a boat passing by or one group of kayaks. When they do respond it is usually because there is a large amount of traffic as opposed to one or two vessels.

The four major points for addressing habituation are:

- Restricting tourism to non-breeding sites that are already habituated to ease the pressure on breeders and non-habituated seals
- Base number of permits on the number and accessibility of the seals to ensure sustainability of the industry
- Stagger trips so that not all traffic arrives at the same time; it makes for a more enjoyable experience for the tourist and a more successful trip for the operator

- Vary locations for viewing, within the prescribed viewing, by not viewing the same group of seals on every visit. This will ensure that the same group of seals are not saturated everyday by all tour operators, and will provide some variety and reduce the risk of seals avoiding "predictable" traffic

5.4.5. Future Work on Long-Term Impacts of Colonies

Previous studies on tourism impacts have been carried out over short periods, generally one or two breeding seasons. Most suggest the need for further monitoring. At the moment, there is no concrete data that tourism is affecting the reproductive capabilities of any target species, however, with the increase in demand for tourist encounters we need to know if even the current level of eco-tourism is sustainable. As seals use their time ashore to rest, raise pups and maintain body condition (Taylor *et al*, 1995), it is critical that interactions with tourists do not interfere with these basic needs.

To see if there is an adverse impact on New Zealand fur seals, long-term monitoring is required. Involving estimates of pup production and condition along with pup survival at sites with and without tourism. At the moment, we do not know whether cows at study sites exposed to tourism spend less time interacting with and suckling their pups, than cows at sites without tourism. While the pups at Ohau Point had satisfactory pup conditions in 2000 and 2001, they were seen to be suckling less often than those of Tonga Island or Whakamoa. Long-term monitoring of important behaviours such as suckling would enhance the data obtained on pup production, condition and survival. Long-term monitoring would also help to remove much of the mystery surrounding habituation, how long it takes, what stimuli are easiest to habituate to, and how this impacts the behaviour of seals in a potentially harmful situation.

It is suggested that long-term monitoring be carried out with a control colony for comparison to answer the following questions:

- Do tourist interactions affect pup production, condition and survival?
- What is the general health of the colonies around New Zealand and is there any relation to the amount of tourism experienced at these sites?
- Are colonies under environmental stress more at risk to the impacts of tourism?
- How are biologically important behaviours, such as suckling, potentially impacted by tourist interactions?
- How easily does habituation occur and what are its possible long-term impacts?
- Do tourist interactions impact the foraging or migrational patterns of fur seals?
- How severely does repeated interactions with humans impact on the energy conservation and ultimately the survival of the seal(s)?

5.5. Summary

New Zealand fur seals are becoming more popular as a tourist attraction around New Zealand. Because the peak of the tourist season coincides with the seals' breeding season, it is imperative that we understand the implications that tourist/seal interactions have on the behaviour and reproductive success of the species. This thesis incorporated the use of behavioural sampling and controlled approaches to assess the impact tourism has on New Zealand fur seals. Two study sites, receiving varying levels of tourism were compared to a control site which received no tourism. Seals at the study sites responded less, responded less dramatically and responded at closer distances than seals at the control site. Minimum Approach Distances were calculated for approaches by land, kayak and motor boat based on the results of the controlled approach aspect. Investigations on the impact of guided seal walks, guided seal swims, the impact of group size, frequency of approaches and anthropogenic noise provided insights into particular behaviours that increase or decrease the response rates of the seals and can be used to formulate guidelines for tourists observing seals. Two seasons of mark-recapture experiments were carried out suggesting that seals at Ohau Point and Tonga Island are in good condition, although, pup numbers are increasing at Ohau Point and decreasing at Tonga Island. Two seasons of mark-recapture data is not enough to detect if tourism is actually impacting upon the seals' reproductive ability, therefore, long-term monitoring of pup production and condition are recommended along with other possible future studies. At the moment, tourism is impacting the short-term behaviour of the seals, causing them to change behaviour in response to the stimulus. Tourism has also caused seals at various sites to habituate to specific stimuli. Because there is little information on the long-term implications of habituation future work investigating the process and its implications in natural populations would prove interesting. For fur seal tourism to be sustainable, it needs to be managed appropriately, considering both the long and short-term impacts on the target species, and how to lessen this impact.

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Table A: Raw data of tourist approaches to seals by air, land and sea.

Whakamoa Season 1

Subsite	private/tourist	response	# of seals	Total seals	% Response
Island Bay	air	N	20	20	100.0%
Island Bay	boat	C	12	30	40.0%
Island Bay	boat	N	18	30	60.0%
Whakamoa	air	N	10	10	100.0%
Whakamoa	boat	A	2	10	20.0%
Whakamoa	boat	C	3	10	30.0%
Whakamoa	boat	N	5	10	50.0%
Whakamoa	land	A	9	11	81.8%
Whakamoa	land	C	2	11	18.2%

Whakamoa Season 2

no traffic

Kaikoura Season 1

Subsite	private/tourist	response	# of seals	Total seals	% Response
Barney's Rock	air	N	40	40	100.0%
Barney's Rock	boat	N	16	16	100.0%
Barney's Rock	land	A	11	165	6.7%
Barney's Rock	land	C	16	165	9.7%
Barney's Rock	land	N	138	165	83.6%
Barney's Rock	vehicle	C	4	66	6.1%
Barney's Rock	vehicle	N	62	66	93.9%
Ohau Point	air	C	4	295	1.4%
Ohau Point	air	N	291	295	98.6%
Ohau Point	boat	N	110	110	100.0%
Ohau Point	land	A	37	185	20.0%
Ohau Point	land	C	40	185	21.6%
Ohau Point	land	N	108	185	58.4%
Ohau Point	vehicle	C	7	760	0.9%
Ohau Point	vehicle	N	753	760	99.1%
Peninsula	air	N	184	189	97.4%
Peninsula	land	A	43	268	16.0%
Peninsula	land	C	113	268	42.2%
Peninsula	land	N	112	268	41.8%
Peninsula	swim	A	31	438	7.1%
Peninsula	swim	C	56	438	12.8%
Peninsula	swim	I	3	438	0.7%
Peninsula	swim	N	348	438	79.5%

Kaikoura Season 2

Subsite	private/tourist	response	# of seals	Total seals	% Response
Barney's Rock	boat	N	1	1	100.0%
Barney's Rock	land	A	2	15	13.3%
Barney's Rock	land	C	4	15	26.7%
Barney's Rock	land	N	9	15	60.0%
Barney's Rock	vehicle	N	15	15	100.0%
Ohau Point	air	N	60	60	100.0%
Ohau Point	boat	A	1	193	0.5%
Ohau Point	boat	C	144	193	74.6%
Ohau Point	boat	N	48	193	24.9%
Ohau Point	horn	C	9	141	6.4%
Ohau Point	horn	N	132	141	93.6%
Ohau Point	land	A	38	291	13.1%
Ohau Point	land	C	46	291	15.8%
Ohau Point	land	I	5	291	1.7%
Ohau Point	land	N	202	291	69.4%
Ohau Point	train whistle	N	248	248	100.0%
Ohau Point	vehicle	C	17	270	6.3%
Ohau Point	vehicle	N	253	270	93.7%
Peninsula	air	C	5	54	9.3%
Peninsula	air	N	49	54	90.7%
Peninsula	boat	A	11	166	6.6%
Peninsula	boat	C	21	166	12.7%
Peninsula	boat	N	134	166	80.7%
Peninsula	kayaks	A	3	32	9.4%
Peninsula	kayaks	C	8	32	25.0%
Peninsula	kayaks	I	2	32	6.3%
Peninsula	kayaks	N	19	32	59.4%
Peninsula	land	A	33	221	14.9%
Peninsula	land	C	58	221	26.2%
Peninsula	land	N	130	221	58.8%
Peninsula	swim	A	60	941	6.4%
Peninsula	swim	C	230	941	24.4%
Peninsula	swim	I	4	941	0.4%
Peninsula	swim	N	647	941	68.8%
Peninsula	vehicle	N	2	2	100.0%
Peninsula	walk	A	25	279	9.0%
Peninsula	walk	C	72	279	25.8%
Peninsula	walk	I	1	279	0.4%
Peninsula	walk	N	179	279	64.2%

Tonga Island Season 1

Subsite	private/tourist	response	# of seals	Total seals	% Response
cove	land	A	1	1	100.0%
East	air	N	12	12	100.0%
East	jet ski	C	1	10	10.0%
East	jet ski	N	9	10	90.0%
East	kayaks	C	7	404	1.7%
West	boats	A	13	316	4.1%
West	boats	C	10	316	3.2%
West	boats	N	286	316	90.5%
West	boats & k	C	3	10	30.0%
West	boats & k	N	7	10	70.0%
West	kayaks	A	69	404	17.1%
West	kayaks	I	1	404	0.2%
West	kayaks	N	327	404	80.9%
West	swim	A	11	62	17.7%
West	swim	C	6	62	9.7%
West	swim	I	1	62	1.6%
West	swim	N	44	62	71.0%

Tonga Island Season 2

Subsite	private/tourist	response	# of seals	Total seals	% Resp
Tonga Island	boats	I	2	963	0.2%
Tonga Island	boats	A	42	963	4.4%
Tonga Island	boats	C	115	963	11.9%
Tonga Island	boats	N	780	963	81.0%
Tonga Island	jet ski	C	1	3	33.3%
Tonga Island	jet ski	N	2	3	66.7%
Tonga Island	kayaks	A	47	443	10.6%
Tonga Island	kayaks	C	100	443	22.6%
Tonga Island	kayaks	I	2	443	0.5%
Tonga Island	kayaks	N	294	443	66.4%
Tonga Island	swim	A	38	121	31.4%
Tonga Island	swim	C	36	121	29.8%
Tonga Island	swim	I	3	121	2.5%
Tonga Island	swim	N	44	121	36.4%

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Dedication

In the beginning of all things wisdom and knowledge were with the animals, for Tirawa, the One Above, did not speak directly to man. He sent certain animals to tell men that he showed himself through the beasts, and that from them, and from the stars and the sun and the moon should man learn.... all things tell of Tirawa.
- Eagle Chief (Letakots-Lesa) Pawnee

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-Chief Luther Standing Bear