BEHAVIOURAL RESPONSES OF DINGOES TO TOURISTS ON FRASER ISLAND

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By Kate Lawrance and Karen Higginbottom

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EXECUTIVE SUMMARY

Aims

This study investigates some of the ways in which dingoes are affected by tourists on Fraser Island, with a view to providing recommendations that may help reduce the threat of attacks on tourists by dingoes. It was carried out during the year 2000, just prior to the first fatal attack by a dingo on a human at Fraser Island. In recent years management concerns have arisen due to apparent habituation of the dingo population to humans and human food sources, reflected in a number of attacks on visitors. The aims of this study were to (a) determine the effects of the intensity of human use of an area on dingo behaviour; (b) determine whether certain human behaviours are triggers of aggressive and other dingo behaviours; (c) determine whether certain characteristics of individual dingoes and humans are associated with the likelihood of aggressive interactions with humans; (d) make recommendations for the modification of tourist education programs in order to reduce the incidence of aggressive interactions between dingoes and tourists.

Key Issues

Effects of intensity of human use of an area on dingo behaviour

In order to determine the effects of the intensity of human use of an area, dingo behaviour was described and compared between areas of low and high levels of human use. The observation sites were standardised as all being along the eastern beach of the Island, with those classified as being of high use being the areas around key tourism attractions or accommodation areas. A pilot study was conducted to develop a behavioural repertoire. The amount of time spent in various activities (moving, standing still, sitting down, lying down), and the rate at which certain behaviours (sniff ground, sniff food, eat, look at person, look at vehicle, sudden turn, interaction with another dingo) were recorded. Paired observations of eight individual dingoes were made in areas of low and high levels of use, during the middle of the day.

In the areas of low human use, dingoes spent almost half their time moving and about a quarter of the time lying down. They ate natural

food items about 29 times per hour. In areas with high levels of human use, dingoes more frequently sniffed the ground, looked at people, and made sudden turns than when in areas with low levels of use. This seemed to reflect a greater propensity to actively search for food in such areas and to be disturbed by human behaviour. There were no significant differences in proportions of time spent in the various activities between high and low use areas. However, on average, dingoes spent about 13 per cent less time lying down, 10 per cent more time standing still, and 8 per cent more time moving while in the high use areas. The lack of statistical significance may reflect the low level of power due to the small sample size. These results indicate that the natural behaviour of dingoes may be disrupted through exposure to human food sources and disturbances relating to human activity. The consequences of such disruptions are unknown.

Effect of human behaviour on dingo behaviour

In order to determine whether certain human behaviours are triggers of aggressive and other dingo behaviours, an experimental approach was used. Six human behaviours were defined (stimuli), representing the major categories of behaviour showed by tourists towards dingoes. These were running towards, running away, walking towards, walking away, submission and aggression. A total of 63 individual dingoes were sampled, during three different times of the year. This required individual identification of dingoes to avoid pseudo-replication. For each dingo, each of the six human behaviours was delivered in a standardised manner, using a randomly varying sequence. Dingo responses were recorded in detail and later categorised as Walk towards, Trot towards, Run towards, Aggression, Walk away, Trot away, Run away, Submission, Still and Neutral movement. In order to provide adequate sample sizes for analysis, some of these categories were then pooled, and sequence analysis was carried out.

There was a significant relationship between the human stimulus behaviour and the dingo response. Dingoes were most likely to move towards the person or act aggressively in response to the person moving away from them. The dingo responses of moving away or submission were most likely to occur after the human had moved towards the dingo or displayed aggression. The human stimulus of Submission appeared to prompt a neutral or submissive response

from the dingo. The nature of these relationships did not differ between times of the year. They were, however, affected by the gender of the dingo in one of these periods. In July-August, female dingoes were more likely than males to respond aggressively when the human moved towards them, and less likely to do so when the human moved away from them. This is the time of the year when pups are born. At other times of year, no difference was observed between the responses of male and female dingoes. During April-May (the mating season), adult dingoes were more likely to respond aggressively than were sub-adult dingoes.

Effects of dingo and human characteristics on aggressive incidents

In order to determine what dingo characteristics and other factors are associated with the likelihood and severity of an aggressive incident, a dingo incident survey was designed, in consultation with QPWS staff. The plan was that this be completed by rangers throughout Fraser Island whenever a report of an aggressive incident occurred. The survey included questions about the severity of the incident and various characteristics of the people and dingoes involved in incidents. These data could be analysed to determine the relationship between likelihood or severity of incidents and these characteristics. The incident report form was approved by rangers at three of the four ranger stations on the island, and expected to be implemented. However, despite this support, no incident surveys had been completed by the end of this study.

Conclusions

The high level of tourist activity on Fraser Island has influenced the behaviour of dingoes. Dingoes behave differently in areas with high levels of human activity than they do "naturally", although the significance of this is unknown. The way in which they respond to people is affected by the way that people behave towards them, and this knowledge can be used to educate people about how to minimise the danger of being attacked. Dingoes seem to be equally likely to display aggressive behaviour to humans at different times of the year, although adult dingoes may be most dangerous during the mating season, and female dingoes most dangerous during the pupping season. Habituation of dingoes to people and human food

sources appears to be the underlying cause of the observed changes to dingo behaviour, and may also be resulting in the aggressive responses of dingoes to certain human behaviours.

Recommendations

Management

- Managers should attempt to monitor what unnatural food sources are available to dingoes in the townships and resorts, so that action may be taken to remove them.

- A dingo incident survey such as the one developed through this study should be implemented, in order to determine what associations there are between aggressive incidents and dingo characteristics, and to monitor the timing, location and frequency of aggressive incidents.

- Education campaigns should continue to highlight the dangers of feeding dingoes, both directly by handouts and indirectly by not storing food and garbage appropriately.

- Interpretive material provided to visitors of Fraser Island should advise that people do not turn and walk or run away from dingoes, as this may trigger an aggressive or excited response.

Research

- Identify the impacts of the behavioural changes associated with human presence. These might include changes to social interactions and impacts on dingo health and the health of prey populations.

- Develop a more comprehensive description of dingo behaviour. Future behavioural research should be carried out with a larger and more representative sample size and observations should be made at all times of the day, and in a variety of environments on the island.

- Examine the responses of dingoes to human behaviours in further detail.

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ABSTRACT

This study investigates some of the ways in which dingoes are affected by tourists on Fraser Island, with a view to providing recommendations that may help reduce the threat of attacks on tourists by dingoes. Firstly, dingo behaviour was described and compared between areas of differing levels of human use. The findings provided some evidence that the natural behaviour of dingoes is disrupted in the vicinity of humans. Secondly, responses of dingoes to experimentally varied modes of human behaviour were compared. The dingo response differed according to human behaviour, with dingoes being most likely to approach or act aggressively if the human moved away from them. Thirdly, a survey was designed to determine what factors are associated with aggressive incidents, but insufficient data were obtained for analysis. Recommendations are provided for incorporating these findings into management.

PREFACE

The research presented in this report formed the basis of an honours thesis submitted by Kate Lawrance to Griffith University in March 2001. The data collection was carried out during April–December 2000, just prior to a (the first) fatal attack on a human by dingoes on Fraser Island. It therefore does not include discussion of the management issues that subsequently arose.

1. INTRODUCTION

The purpose of this study was to examine how dingo behaviour is affected by tourism on Fraser Island, Queensland. In order to provide context, Section 1.1 discusses the broad impacts of wildlife tourism, followed in Section 1.2 by an examination of the impacts and management of wildlife feeding and habituation. Finally, the behaviour of dingoes will be discussed in Section 1.3, within the context of habituation, aggression and responses to tourists. This leads into the research questions proposed in Section 1.5, relating to the effects of tourist presence and tourist behaviour on dingo behaviour, and the factors associated with dingo aggression.

1.1 Impacts of Wildlife Tourism

A growing awareness of environmental issues is currently contributing to an increasing demand for wildlife and nature-based tourism (Weaver 1999). Tourism in natural areas can contribute to conservation by creating funds and awareness, or by replacing less sustainable land-use practices (Weaver 1998). Conversely, nature-based tourism, of which wildlife tourism is a sub-sector, can potentially have a number of serious negative impacts. These differ depending on the environments and animals involved, and the form of tourism.

Nature-based tourism has been associated with a number of physical impacts on the environment, including changes to vegetation structure and communities, soil compaction and erosion, water pollution and noise pollution (Liddle 1997). In addition, wildlife tourism may also have specific impacts on animal populations. These may include interruption of behaviour due to the presence of tourists, habitat changes, or direct disturbance due to harassment by or interaction with tourists (Liddle 1997).

Interruptions to behaviour may include disruption of foraging or resting behaviour, disturbance to parental behaviour or the avoidance of trails and areas used by tourists (Green and Higginbottom 2001, Burger and Gochfeld 1993). Behavioural changes may also result from

habituation of animals to tourists and human food sources (Mace and Waller 1996, Seideman 1997, Corbett 1998a).

Animals with diurnal hunting and feeding behaviour, such as lions and cheetahs, are often the focus of wildlife tourism in Kenya. Tourist disturbance can prevent these animals from making a kill (Green and Higginbottom 2001). Cheetahs are known to abandon kills, cease hunting and even abandon cubs when tourist vehicles are present (Mather 1989).

Walking tours through Galapagos National Park, which have rapidly increased in popularity in recent years, have been found to affect the behaviour of masked, red-footed and blue-footed boobies (Burger and Gochfeld 1993). Along tourist trails, mating and parental behaviour has been found to differ, and birds appear to avoid building nests on or near the trails.

A detailed study of a royal albatross population at Taiaroa Head, New Zealand, found that tourism was influencing nesting distribution, chick survival and the timing of chick departure from nests (Higham 1998).

Habituation to tourists, and the associated behavioural changes are prevalent concerns for managers of many Australian national parks (Burger 1997). Wildlife feeding is believed to be a major cause of habituation of wild animals to tourists. As animals become habituated, it is common for them to harass and even attack visitors, when seeking handouts of food.

1.2 Habituation - Impacts and Management

Throughout evolution, most wild animals have developed a natural, instinctive wariness of humans. However, many animals are also capable of learning, and in certain situations, can learn through experience not to fear people (Herrero 1985). This is usually a result of repeated contact with people, which has no negative consequence (QPWS 1999). Further to this, animals may learn that food can be gained from people and human areas. People may feed animals either

indirectly with discarded food scraps or accessible food stores, or directly with handouts.

Wildlife feeding provides benefits for tourists due to the close contact it enables with the animals, and has hence been a popular activity for some time (Orams 1997). However, both feeding and habituation have been found to have negative impacts on the animals' health and behaviour (Skira and Smith 1991). Wildlife feeding can lead to health problems for the animals due to inappropriate diets, and habituation can lead to changes in social and other behaviours. Wild animals known to be habituated to people and human food sources have exhibited behaviours such as stealing food, damaging property, even attacking and injuring people. Wildlife feeding whether direct or indirect can also lead to unnatural population growth and depletion of natural resources and prey populations.

Examples of situations where wild populations have become habituated to humans are given in sections 1.2.1 to 1.2.5. Several different approaches to the management of this issue will be illustrated by these examples.

1.2.1 Bears of the Yellowstone Region, US

A well-known and well documented case of wildlife habituation associated with tourism is the brown and grizzly bears of North America. During the 1950's and 60's, it became a popular tourist activity to watch habituated bears beg for food on roadsides and angrily search through bins near campgrounds (Titlow and Titlow 1981). In Yellowstone National Park, this problem was perpetuated by grizzly and black bear 'feeding shows' and open-pit garbage dumps (Herrero 1985).

Herrero (1985) draws a distinction between those bears accustomed to human presence, habituated bears, and those bears, which eat human food and garbage, 'food conditioned' bears. Bears that are both habituated and food conditioned have been associated with a large number of injuries. In addition to having no fear of people, food conditioned bears deliberately enter human areas, and at times are believed to treat people themselves as prey (Herrero 1985).

Habituation and food conditioning of bears eventually became a serious management problem for several national parks in the Yellowstone region. Food conditioned bears were suffering from a significantly higher mortality than average, and dangerous conflicts between bears and people were rapidly increasing (Titlow and Titlow 1981; Creachbaum, Johnson & Schmidt 1998; Knight, Mattson, Blanchard & Eberhardt 1988). During the 1950's, bears injured an average of fifty-six people every year in Yellowstone National Park alone (Titlow and Titlow 1981). Many fatal conflicts were also recorded (Herrero 1985).

In 1967 as the problem continued to worsen, land managers implemented a plan in Yellowstone National Park aimed at reducing encounters between bears and people, and preventing habituation. The plan involved the closure of rubbish dump sites, enforcing regulations against feeding, installing 'bear-proof' bins and regulating the use of walking tracks in areas of high bear usage. Bears that entered roadsides or developed areas were relocated and problem animals were destroyed. The plan was successful in reducing the number of injuries to an average of just two per year. With little encouragement for bears to enter campsites and human areas, and with the removal of already habituated or food conditioned bears, unnatural behaviours associated with habituation were rarely observed. The distribution and size of the bear population also returned to its pre-tourism levels (Titlow and Titlow 1981).

Similar problems have arisen in many National Parks, with continuing research and experience leading to more comprehensive management programs and, as in the following example, some preventative measures.

Planning of recreation developments within Shoshone National Forest, an important grizzly bear habitat, began with identifying local bear use patterns and the primary causes of bear-human conflict. Campgrounds were zoned and positioned accordingly, with tent sites located furthest from food preparation areas and bear travel corridors. Where possible, campsites were developed outside of those areas used frequently by bears. In some cases, fences were used to direct bears around campsites located along bear travel paths. As most bear attacks were found to be associated with surprise

encounters, trails were designed to have a maximum sight distance. All elements of the campground that could potentially attract bears, such as food and bins, were made inaccessible to them. Finally, interpretative signs were created, aimed at delivering information about bear safety and conservation in an entertaining fashion (Creachbaum *et al*. 1998).

In a similar situation, the majority of trails in the Jewel Basin Hiking Area, Montana, are located in forested, rather than open habitat areas. With the open habitat containing more of the preferred forage of grizzly bears, bear-human conflicts are avoided. Management programs in the Jewel Basin Hiking Area also discourage habituation, encourage public education and only allow low human use levels. In a study carried out in the area between 1987 and 1994, no human-bear conflicts were observed or found recorded historically (Mace and Waller 1996).

In addition to management at a park or regional level, Herrero (1985) has suggested that there are a number of ways in which an individual can reduce their chances of a bear attack or reduce the intensity of an attack. When camping, these include locating the cooking area at least 100m downwind of the tent, camping where trees allow for safe storage of food, camping near a possible escape tree and leaving packs outside and open. All of these actions serve to reduce a bear's interest in a campsite.

It is also important that an individual know how to behave in the event of an encounter with a bear. For example, in many cases it is best to 'play dead' so that the bear loses interest. Despite this, there have been examples where this has not been the appropriate action to take and attacks have been fatal. For example, if the bear has entered a campsite in search of food, and may decide that the people themselves are food, it is best to flee or fight the bear (Herrero 1985).

The problem of habituated and food conditioned bears is a serious issue, having been associated with injuries and even deaths of national park visitors. The previous examples have shown that by removing access to human food sources and reducing encounters between bears and humans, habituation and food conditioning can be prevented and attacks reduced. Individuals entering bear habitats

must also be aware of the risks involved and of how best to avoid or cope with bear encounters.

1.2.2 Hand-fed Dolphins, Australia

The hand-feeding of wild dolphins occurs under supervision at a number of Australian resorts (Orams 1997). At Tangalooma Wild Dolphin Resort, Queensland, up to nine bottlenose dolphins are fed nightly by resort guests and staff. This program began in 1992, and today, between 60 and 80 guests are allowed to feed the dolphins each day. The behaviour of the dolphins was monitored between September 1993 and September 1994 (Orams 1996). During that time, the dolphins began to develop 'pushy' and aggressive behaviours, nudging and shoving people in order to be fed. In some cases, guests fingers and knees were bitten, and in one case, a dolphin was observed following a guest as they walked away, through the water, and biting them on the calf.

In order to prevent these incidents from occurring, a set of appropriate feeding techniques was developed, and guests are now informed of these prior to all feeding sessions. To ensure that guests comply with these techniques, one resort staff member is allocated to every two to three guests. The appropriate feeding techniques involve:

- Feeding at an appropriate water level, as dolphins are found to be more aggressive at certain water depths
- Ignoring 'pushy' animals, and deliberately rewarding passive animals with food, therefore training the dolphins not to behave aggressively
- Guests enter and leave the water as a group
- Guests spread out in a long continuous line, reducing the chance of dolphins rushing from guest to guest (Orams 1994)

Since the implementation of this new education and supervision program in 1995, the resort has observed no aggressive behaviour, and no injuries have been incurred during the feeding sessions. In

most cases, guests have been willing to comply with any rules regarding the feeding of the dolphins.
The success of this program reveals that animal behaviour can be manipulated in order to prevent conflicts with tourists. In order to do this, both managers and tourists must learn how to behave in their presence.

1.2.3 Samango Monkeys, South Africa

Samango monkeys (*Cercopithecus mitis erytharchus*) generally confine themselves to the forest, feeding on fruits in the treetops. Within the Cape Vidal Recreation Reserve, these monkeys have become accustomed to stealing food from tourists, campsites and picnic grounds. This harassment became a serious problem for many visitors to the region, and the shooting of problem animals was employed as a method of reducing human-monkey conflicts. This technique was neither favourable in tourists eyes, or for the conservation of the monkeys, which are classed as a rare species. A number of alternative solutions were trialed (Chapman *et al*. 1998).

The alternative techniques included a variety of chemical deterrents being placed in rubbish bins in problem areas. Mace-like deterrent sprays were also used. The different chemicals were found to have varying effects on the feeding habits of the monkeys. None were found to effectively deter the monkeys from feeding in human-use areas. A survey of visitors to the reserve identified guest education as the most favourable method of controlling the problem. Other favourable methods identified were 'monkey-proof' bins and food storage containers. Little public support existed for chemical control or shooting of problem monkeys (Chapman *et al*. 1998).

In areas of high tourism visitation where wildlife conflicts occur, guest satisfaction with management programs must be considered along with safety and conservation issues. Chemical control methods such as baiting are commonly proposed as solutions to habituated wildlife. Despite these methods being able to be employed without mortality of the animals, they are not often favourable solutions in public opinion as they raise certain moral concerns.

1.2.4 Within Australian National Parks

Despite general 'no-feeding' policies within most Australian national parks (Burger 1997, Skira and Smith 1991), visitors appear to be confused by the conflicting messages they receive from many private operators (Skira and Smith 1991). Guests of many resorts and private parks, such as Queensland's Tangalooma Wild Dolphin Resort, O'Reilly's Guesthouse and Currumbin Bird Sanctuary are actively encouraged to feed wild animals (Burger 1997). In many national parks, feeding of wildlife occurs not only without encouragement, but also in spite of strict regulations (Skira and Smith 1991). In a number of Tasmanian national parks, feeding was believed to be causing serious health problems for wallabies (Skira and Smith 1991). Wallabies were found to be dependent on human feeding and to have unusually high local population densities. In some cases, habituation had led to increased mortality due to road accidents. Problems for visitors in the form of harassment for food by wallabies, and by currawongs swooping to steal food directly from people have also arisen. In more extreme cases, emus were reported aggressively stealing food and raiding campsites. In one incident, a Tasmanian devil attacked a visitor in their campsite (Skira and Smith 1991).

In order to manage the problem of wildlife feeding in reserves and national parks throughout Australia, land managers have implemented discouraging fines, signs and other educational materials (Burger 1997, Skira and Smith 1991). Tasmanian land managers also recognise that in some heavily visited areas, with current availability of staff, it is not possible to prevent feeding. In these areas, attempts have been made to educate visitors on how best to approach animals, and what is appropriate to feed them (Skira and Smith 1991).

The Tasmanian example highlights the difficulty in managing tourist behaviour and hence the problem of wildlife habituation. In certain situations it may be necessary for land managers to accept a certain level of wildlife feeding and habituation, and to attempt to reduce its impacts.

1.2.5 Dingoes on Fraser Island

The focus of this study will be the dingo (*Canis lupus dingo*) population on Fraser Island, Australia. As tourism on Fraser Island has increased, dingoes have slowly become habituated to human presence and have also learned to rely on human food sources such as rubbish and handouts from tourists and residents. Currently this is a serious management issue as habituated and food conditioned dingoes are harassing and attacking visitors to the island. In 1998, an estimated 300 attacks on visitors to Fraser Island were reported (pers.comm. Haste 2000). No fatalities have resulted from these attacks, although many serious wounds have been incurred.

The population of dingoes inhabiting Fraser Island is of increasing conservation significance as interbreeding with domestic dogs threatens populations elsewhere. Due to the geographical separation of the island, the dingoes on Fraser are thought to be amongst the most pure living in the wild. The dingo was introduced to Australia approximately 3000 years ago (Corbett 1995b) and has since carved a place for itself within many Australian ecosystems and is classed as a native species (Chipp 1983).

Although Fraser Island's dingoes are free of the threat posed by hybridisation, tourism is now presenting the next potential threat. Despite the no-feeding policy adopted by land managers, dingoes appear to be following a somewhat similar pattern of events to the bears of the Yellowstone region during the 50's and 60's. The altered behaviours displayed by a number of Fraser Island dingoes are thought to be a result of the presence of tourists and human food sources (Corbett 1998a).

It has become a common event to witness dingoes begging for handouts in popular tourist sites on Fraser Island, or scavenging around campsites for food. As dingoes have come to rely on these food sources, and have lost their natural fear of people, an increasing number of attacks on people and property are being reported. Not only is this a danger to human visitors to Fraser Island, it is a threat to the dingoes themselves, as often the only solution to a problem dingo is destruction. Dingoes are territorial, and hence relocation is rarely successful (British Columbia Ministry of Environment 1993, Corbett

1998a) as they are likely to either return, be killed by resident dingoes, or displace resident dingoes.

Tourism on Fraser Island has grown rapidly over the past decade, with 300 000 people now visiting the island each year (QPWS 1999). As tourism has grown, so too has the incidence of attacks reported on tourists, with the majority of attacks occurring during times of peak visitation to the island (pers. comm. Fullarton 1999). It is now estimated that as many as 300 attacks occur each year (QPWS 1999).

At present, an education strategy is underway on Fraser Island, focussing on discouraging direct and indirect feeding of dingoes, and encouraging appropriate behaviour when dingoes are present. In addition to this, open rubbish tips have been closed, and all rubbish is now transported off the island. Dingo proof bins have been installed and lockable food storage containers have been provided to campers.

Aversive conditioning using chemical baits have previously been trialled on Fraser Island with limited success, although recommendations have been made for trials to continue (Tauchmann 1998). As with the situation of Samango monkeys in South Africa, such techniques may not be favourable in public or tourists' opinion.

During the 12 to 18 months leading up to the beginning of this study, national park managers on Fraser Island witnessed a reduction in the number of incidents with dingoes and people, though the reasons for this are unclear (pers. comm. Haste 2000). Many dingoes are still believed to be both habituated to people and food conditioned.

1.2.6 Application of examples to Fraser Island dingo situation

It is clear that there are a number of similarities between the current situation on Fraser Island, and those situations discussed in the previous sections. To provide a basis for what approach research and management should follow, it is important to consider what has been learnt in these similar situations.

To follow the example of bears in North America, an eventual solution to the 'food conditioned' bears was found through the use of a variety of management techniques, centring around visitor and public

education, and campsite and recreation area design. Although both situations are unique, many comparisons can be drawn, and it is likely that an eventual solution to the problem of food conditioned dingoes and dingo attacks will have to involve a number of different management techniques, with visitor education playing a key role. Visitor education campaigns were designed using knowledge of bears' feeding behaviours and movement patterns. So far, little is known about dingo behaviour. Current visitor education programs on Fraser Island have been designed using knowledge of dingo behaviour based on the experience of national park rangers.

It was shown on Moreton Island that aggressive behaviour of bottlenose dolphins could be managed through an understanding of dolphin behaviour and how to control it. Again, it was important that what was learnt about the animals' behaviour was used to educate visitors. For this approach to be taken on Fraser Island, a greater understanding of dingo behaviour would first be necessary.

Commonly, what seems to separate the Fraser Island dingo issue from the examples cited above is the relative lack of understanding of dingo behaviour. For education campaigns to be successful and to ensure that the appropriate management techniques are implemented, a greater understanding of dingo behaviour, and how it is influenced by human presence is required. An understanding of dingo behaviour will also help to determine the impact of tourists and tourism on the dingo population of Fraser Island.

1.3 Dingo Behaviour

Although little is known of dingo behaviour on Fraser Island, knowledge of dingo behaviour elsewhere and behaviour of closely related species is important in understanding the Fraser dingoes. The knowledge of long term residents and staff of the island must also be considered.

1.3.1 Packs and territories

Several factors indicate that the dingo population of Fraser Island is saturated, i.e. there may be more dingo territories than the island can sustainably support. Firstly, there is a high level of infanticide.

Following the winter births, the dominant dingoes are likely to kill the pups of subordinate females if competition for food is high (Corbett 1998b). Therefore, the more dingoes there are, the greater the competition and the higher the level of infanticide. Also, there have been significant reductions in dingo prey populations in recent years (Corbett 1998a).

Fraser Island dingoes live in packs of between two and nine animals, within defined territories, although territories appear to overlap. These packs consist of adults and younger animals of both sexes and are maintained throughout the year (Corbett 1998a). Females often remain with the pack throughout their lives, whilst males may disperse in order to establish their own territories or join with other packs. A social hierarchy exists in each pack, usually with a dominant adult male and female, and subordinate animals. Corbett (1998a) estimates that there are around 26 dingo territories on Fraser Island and around 200 individuals (including pups) immediately following the breeding season, which is reduced to around 100 dingoes before the beginning of the next breeding season. No quantitative measure of dingo numbers on Fraser Island exists, though Corbett's (1998a) estimate is supported by rangers' reports and is consistent with populations in similar habitats on the mainland.

1.3.2 Aggression, dominance and submission

Unlike many Australian animals, aggression is an important behaviour within dingo society, used to define social ranking and to defend territories. Aggression is displayed in varying degrees by different behavioural acts, including an upright stance, a raised tail, stiff legs, staring, snarling, lunging and snapping (Corbett 1995a). Biting does occur but only in extreme circumstances. Dingoes of a high social ranking may exhibit these behaviours in order to display dominance. In response, less dominant dingoes will respond with a set of submissive behaviours, in order to avoid actual conflicts (Corbett 1995a). Submissive behaviours include a 'grin' whereby teeth are not bared, but the mouth is open, and the tongue often protrudes. The avoidance of eye contact by turning or lowering the head is also a submissive act. Dingoes will sometimes participate in active submission, which occurs without any prior aggressive or threatening displays (Corbett 1995a).

There are several periods throughout the year when aggression will occur for different reasons amongst dingoes. Between March and May is the breeding season, when there is active competition for mates, territories and dominance (QPWS 1998a). During this time, dingoes will actively defend their territories with vocalisations, dominance displays, and by snarling or nipping at intruders (QPWS 1998a). Births occur once per year, from about June to August. During this time, adult dingoes will often keep to themselves, though parents may be protective of their young and aggressive towards intruders (QPWS 1998a). As the pups born in winter begin to grow, they will learn and practice dominance behaviours and may be aggressive between September and March.

1.3.3 Dingoes and people

The consistent and abundant food sources (eg. handouts, campsites, rubbish bins) available as a result of increasing human presence have apparently encouraged dingoes to lose their instinctive wariness of people (Corbett 1998a). As well as the attacks and displays of aggression which appear to result from this situation, it is possible that other dingo behaviours may be affected, for example, the loss of hunting skills, or changes to social structures (Masterson 1994). For example, it appears that there are two types of dingo territories on Fraser Island (pers. comm Haste 2000, Corbett 1998a), those that exist in inland, bush areas or beaches where the main food source is natural, and those that are centred around areas of high human use, where much of the food intake is scavenged from human sources. Territories centred around human use areas tend to cover smaller areas, yet contain relatively high numbers of dingoes, due to the availability of an abundant, localised food source (scraps, hand-outs etc.).

Although it is recognised that habituation may be the underlying cause of dingo attacks and threats towards people, reasons for and triggers of attacks remain unclear. It is possible that some attacks occur between September and March as a result of pups, which are learning dominance and aggressive behaviours, 'playing' with people, especially young children. Attacks may also result from people responding incorrectly to threats and displays of dominance by adult dingoes. Understanding these social interactions, and the nature of

dominance behaviour amongst dingoes, may help people to anticipate when an attack is likely to occur.

Dingoes are territorial animals, commonly having well-defined home ranges of varying size (Breckvoldt 1998). Particularly during the mating season (March-May), dingoes will actively defend their territories (QPWS 1998a). It is thought that some dingoes may have come to view human food sources such as scraps, bins, and handouts as part of their territory. Hence, the motivation behind some attacks may be the protection of these foods from people, whom they view as competitors (Corbett 1998a). Again, if these behaviours could be better understood, people may be able to predict when an attack is more likely, and how to avoid it.

Similar to bears (Herrero 1985), it has been suggested that dingoes that are habituated may also view people as prey. This is another possible reason for dingoes to attack. Dingoes are believed to cooperatively hunt wild horses on Fraser Island (pers.comm. Ford 2000), making an animal the size of a human conceivable prey.

Several national park rangers have had many years experience with dingoes, and have extensive knowledge of interactions between dingoes and people. Some of this knowledge has been drawn together as part of a visitor education campaign (QPWS 1998b). The 'Be Dingo Smart' brochure (QPWS 1998b) suggests that people should not make too much noise, run, encourage or otherwise excite dingoes. It is believed that loud noises or fast movements may excite dingoes, prompting them to respond by attacking, threatening or fleeing. The brochure also suggests that people in groups are less likely to be the victim of an attack than a lone person. Children, who are likely to run and make loud noises, are also believed to be more likely victims of attack. Records of previous incidents with dingoes and people also indicate a possible association between people being in water, and the chance of an attack.

Ranger observations and two studies of dingo-human interactions (pers. comm. Haste 2000; Corbett 1998a) indicate that there is a peak period of interactions between people and dingoes on Fraser Island, occurring between about November and March. This corresponds with the end of the young dingoes' weaning period and the period of

highest visitation to the island. Other peak periods of interaction occur during most Australian school holidays (pers. comm. Fullarton 1999).

At present no ongoing monitoring of aggressive incidents between dingoes and people is conducted on Fraser Island. Records of incidents are kept in some cases, though reporting systems are inadequate for allowing information to be collated in an island wide database (QPWS 1999). The QPWS aims to implement a monitoring program in order to determine the level of dingo activity and incidents between dingoes and people, in each management area.

1.3.4 Aggressive behaviour of animals related to the dingo

Dingoes (*Canis lupus dingo*) are a very close relative of the domestic dog (*Canis lupus*), being a sub-species of *Canis lupus* (Corbett 1995b; Breckwoldt 1998). Both dingoes and domestic dogs are descendants of wolves, also close relatives within the genus Canis. As little is known of dingo behaviour, some possible explanations for some aspects of it may be found through comparison to domestic dog and wolf behaviour.

In a study of aggression in various breeds of domestic dogs (Sherman *et al.* 1996), it was found that attacks on dogs from other households were most often initiated by males. Fights and attacks were initiated in most cases by younger dogs, with excitement being the most important trigger of fighting. These results were compared to wolf behaviour and were found to be similar to dominance conflicts and territorial defence. Excitement may therefore be a possible cause of dingo attack, as speculated in QPWS literature (QPWS 1998b). The results of this study of domestic dogs might also be comparable to the previous description of dingo behaviour, with males and excitable juveniles initiating most attacks. In the opinion of a long-serving park ranger on Fraser Island, female dingoes are rarely aggressive towards people (pers. comm. Ford 2000). This is yet to be scientifically tested however.

A serious problem in three forests of Bihar State, India, is the taking and killing of children from nearby villages by wolves. The majority of victims in these cases are females aged between 3 and 11 years

(Rajpurohit 1999). There are only two reported cases of dingoes in Australia taking children, both involving female babies (Anon. 1998). QPWS (1998b) literature also agrees that dingo attacks may be more frequently directed at young children. It is the opinion of several parks rangers on Fraser Island that females, in particular menstruating females, have a higher than average chance of a dingo attack (pers comm Ford 2000). This is also thought to be the case with bear attacks (pers comm Ford 2000). Again, these are speculations and require scientific testing.

1.3.5 Information needs for management

So far, most existing knowledge of dingo behaviour under Fraser Island's unusual circumstances has been formed on the basis of casual observations and opinions. In order to be able to properly educate visitors and prevent dingo attacks, there is a need for scientific study of dingo behaviour and what specific factors influence it. This study will provide a quantitative description of dingo behaviour and attempt to identify what events and behaviours may lead to aggressive encounters between dingoes and people. There appears to be a complicated set of instinctive behaviours and learned reactions combining to influence how dingoes respond to people. A quantitative description of dingo behaviour will have broad benefits for management, providing information on how dingoes allocate their time to different activities, and how frequently they participate in certain behaviours, given different situations. Information gained throughout this study may be incorporated into education programs helping people to avoid dingo attacks, and to avoid disrupting dingo behaviour.

In order to gain a more complete understanding of the situation on Fraser Island, the objectives of this study will focus not only on aggression or attacks, but will have a broader focus on general dingo behaviour, and how it may be influenced by visitors.

1.4 Aims

1. To determine whether certain characteristics of individual dingoes and humans are associated with the likelihood of aggressive interactions with humans
2. To determine whether the pattern of dingo behaviour differs according to the level of human use

3. To determine whether certain human behaviours are triggers of aggressive and other dingo behaviours

4. To make recommendations for the modification of existing tourism education programs, in order to reduce the incidence of aggressive interactions between dingoes and tourists

1.5 Research Questions and Hypotheses

There are three main approaches taken in this study. All three are aimed at determining how tourism affects dingo behaviour on Fraser Island, and what factors are associated with aggressive behaviour of dingoes. The first approach, relating to the first aim of this study (Section 1.4) involves examining actual aggressive incidents between dingoes and people, in order to determine what dingo characteristics and other factors influence the likelihood of such an incident. Secondly and following from the second aim of this study (Section 1.4), dingo behaviour will be quantitatively described, and the presence of humans on the pattern of dingo behaviour will be determined. Finally, in order to determine how human behaviour influences dingo behaviour, as per aim three of this study (Section 1.4), interactions between dingoes and people will be studied, with a focus on how dingoes respond to certain human behaviours. These three approaches will aim to answer the following research questions and specific hypotheses.

Question 1: What dingo and human characteristics influence aggressive incidents?

H_0 1: The likelihood of involvement in an aggressive incident is independent of dingo gender.
H_0 2: The likelihood of involvement in an aggressive incident is independent of dingo age class.
H_0 3: Occurrence of aggressive incidents is independent of human group size.

Question 2: What is the effect of human presence on dingo behaviour?

H_0 5: The amount of time spent moving is independent of human use level.
H_0 6: The amount of time spent lying down is independent of human use level.
H_0 7: The frequency of the act of 'sniffing the ground' is independent of human use level.
H_0 8: The frequency of the act of a 'sudden turn' is independent of human use level.
H_0 9: The frequency of the act 'looking at people' is independent of human use level.
H_0 10: The frequency of the act eating is independent of human use level.

Question 3: Does human behaviour affect dingo behaviour?

H_0 4: Dingo response is independent of preceding human act.

2. METHODS

2.1 Overview

Three separate techniques were employed in order to answer the different research questions outlined in Section 1.5. Firstly, a survey was implemented in order to answer questions about how characteristics of dingoes and other factors relate to aggressive incidents between dingoes and people. The survey was to be completed by rangers on Fraser Island whenever an aggressive incident with a dingo was reported. Actual interactions between dingoes and visitors could not be studied in sufficient numbers due to their infrequent and spatially dispersed occurrence. Secondly, in order to answer questions relating to effect of human presence on the pattern of dingo behaviour, observations were made of dingo behaviour in areas with high and low levels of human use. Thirdly, to determine if certain human behaviours are likely to affect dingo behaviour, behavioural sequence sampling was used.

2.2 The Study Site

2.2.1 Fraser Island

All sampling was carried out on Fraser Island, off the Queensland coast, Australia (see Figure 1). At approximately 123km long, Fraser is the world's largest sand island. Due to a number of unique geological and biological features, Fraser Island is World Heritage listed and most of the island is part of the Great Sandy National Park, managed by the Queensland Parks and Wildlife Service (QPWS).

The dingo population on Fraser Island is believed to be the purest stain remaining on Australia's eastern seaboard, due to their isolation from domestic dogs (QPWS 1999). For this reason the dingoes of Fraser Island are of national conservation significance and of particular interest to this study.

Although Fraser Island is a sand island, it supports a variety of vegetation types, from coastal dune vegetation, to heath land and rainforest. The eastern beach of the island is an exposed sandy beach,

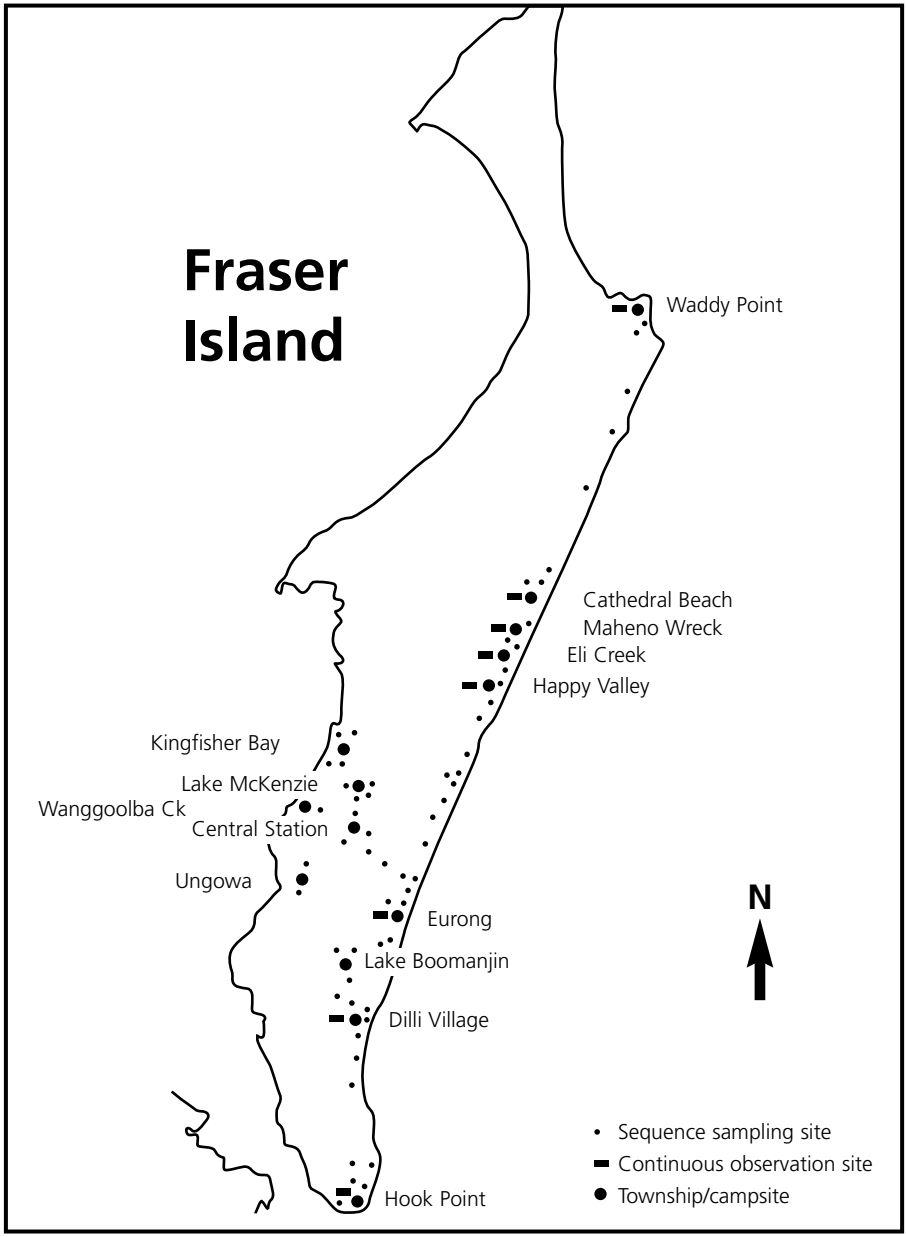
which has in the past been subjected to sand mining. Little development has occurred along the eastern beach, with vegetation covering most of the dune system. The dunes are regularly used for camping and recreation, and the beach is used as a 4WD road, with a constant stream of traffic travelling at around 60-70 km/hr.

During the previous 10 to 15 years, tourism visitation to Fraser Island has increased rapidly. Figures released in 1998 stated that approximately 300 000 tourists visit the island each year (QPWS 1999). Travel around the island is by 4WD vehicles only, which can access most of the island via a series of inland tracks and along the eastern beach.

2.2.2 Dingo observation sites

Sites used for observations of dingo behaviour undertaken in order to compare between areas of high and low levels of human use were located along the eastern beach of the island. These included Hook Point, Dilli Village, Eurong, Eli Creek, the wreck of the Maheno, Cathedral Beach Resort and Waddy Point (see Figure 1). These sites are all areas of a similar environment, i.e. the eastern beach, and have a relatively high level of human use due to the provision of accommodation, or being major tourist attractions.

Figure 1: Map of Fraser Island showing study sites



Hook Point is a major access point for Fraser Island, located at the southern tip of the island. A large area of the beach is used for cars coming from Rainbow Beach, to embark and disembark the two barges, which service the area.

Eurong, further north along Fraser's eastern beach, is the island's largest township, consisting of a large resort and a residential area. Dilli Village is a QPWS owned and managed camping site on the eastern beach of the island, north of Hook Pt and south of Eurong. Moving further north, Cathedral Beach resort is a privately owned camping and accommodation facility. Towards the very north of Fraser Island's eastern beach is Waddy Point, another QPWS managed campground with a ranger station and information centre.

The mouth of the freshwater Eli Creek is a popular tourist attraction on the eastern beach of Fraser Island. Also a popular attraction on the eastern beach, is the wreck of the Maheno, lying 3.5km north of Eli Creek.

Dingo responses to human behaviours were observed at and around Kingfisher Bay Resort Village, Central Station, Wanggoolba Creek barge landing, Lake McKenzie, Lake Boomanjin, Ungowa, and along the eastern beach of the island, from Hook Point to Waddy Point (see Figure 1). Sites along the eastern beach used for making continuous observations, described above, were also used for these observations. These sites were chosen as they cover the majority of Fraser Island, and due the high likelihood of observing dingoes at them.

The Wanggoolba Creek barge landing is another access point for Fraser Island, used regularly by visitors and tour operators. The site is at the mouth of the Wanggoolba Creek, on the western side of the island, south of Kingfisher Bay Resort Village.

Kingfisher Bay Resort Village is located on the sheltered western side of the island. The low-rise development is Fraser Island's largest resort by land area.

Central station is located approximately 10km inland of Eurong. It is an area of cleared rainforest, consisting of a ranger station/information centre, ranger accommodation and QPWS

managed camping facilities. South of the Wanggoolba Creek barge landing on the western side of the island, is Ungowa. Ungowa is a small camping area managed by QPWS, with access by road or boat.

Lake McKenzie is one of the islands most popular attractions, being a large perched lake approximately 5km north of Central Station. The QPWS manage a small camping area and day use facilities. Lake Boomanjin is another perched lake, located approximately 10km south of Central Station. A small camping area and toilet block are managed by the QPWS at the lake.

2.3 Dingo Incident Report Survey

Currently, the method by which the details of aggressive incidents involving dingoes and people are recorded varies between different ranger stations, and between different staff members. The information contained within them, including descriptions of the dingoes, locations, dates and the nature of the incident is not shared or used for management purposes.

A new incident report form (Appendix A) was designed for the purposes of this study, and for further use by QPWS staff. The form was used to gather data relating to the nature of aggressive incidents, the characteristics of the dingoes involved, and the people involved. The use of the survey form was intended to continue beyond the duration of this study in order to standardise the reporting system on the island and allow for information to be more easily shared.

2.3.1 Survey design

The incident survey was designed primarily to determine if different characteristics of dingoes (age, gender) or people (group size) are associated with the chance, or severity, of an aggressive incident (see Section 1.4, Aim 1). The survey was also designed to help determine if certain human behaviours and activities are associated with the chance or severity, of an incident.

A survey was the chosen method for answering the above questions, due to the likelihood of it yielding a larger sample size than field research in the available time period. The survey was implemented in

all ranger stations on Fraser Island, therefore being capable of including all incidents on the island, whereas field observations are limited to a small area at any one time.

When designing a survey, the most important consideration in order to get results, is motivating people to respond (Salant and Dillman 1994). It therefore must not be too long or too complicated. In designing a survey to be completed by busy QPWS staff, these factors were very important. In order to minimise the time taken to complete the survey, open-ended questions were kept to a minimum. The simplest questions were asked first, in order to encourage their completion. All rangers on the island were presented with drafts of the survey form, in order to ensure its length and format were suitable.

Most questions used in the survey were partially closed-ended, meaning that although answer choices were provided, the opportunity was also provided for respondents to create their own answer (Salant and Dillman 1994). Answer categories provided were discrete and in most cases, unordered. This type of question, although more difficult to answer than one providing ordered categories, provides the maximum amount of information, without the laborious data entry and response time required with open-ended questions (Salant and Dillman 1994). The opportunity for respondents to create their own answer was provided so as not to force answers into inappropriate boxes, and to allow for new information to be provided.

Firstly the survey form requested information, which was required for record keeping purposes of QPWS. This included the location, date and time of the incident. This information may also be useful for examining patterns in the timing and location of incidents.

Question 1 asked about the severity of the incident, ranging from the dingo following the person, the dingo taking or damaging property through to the dingo biting and tearing the skin of the person. The levels of severity were created using information provided by past records of incidents with dingoes. This information was used to analyse relationships between the severity of an incident and certain dingo characteristics and other factors, as explained in subsequent questions.

The primary aim of this survey was to determine whether certain dingo and human characteristics are associated with the likelihood or severity of an incident. Questions 12 and 13 asked the age category and gender of the dingoes involved in the incident. In many cases, it was expected that the person involved in the incident would be the only witness. As visitors could not be expected to be experienced in identifying dingoes and their characteristics, only two categories of dingo age were used.

Questions 10 and 11 asked about the number of dingoes actually involved in the incident and the number of dingoes present during the incident. Questions 8 and 9 asked how many people were present prior to the incident, and how many people were involved in the incident. As the relationship between these factors and the likelihood and severity of an incident is unknown, categories were not created, leaving the questions open-ended.

Questions 2, 3 and 4 related to the activity and behaviour of the people involved in the incident. Question 2 asked what activity the people were engaged in, prior to the incident. Categories of activity were developed using suggestions by QPWS (1998,b) as to what behaviours may be associated with the chance of a dingo attack (see Section 1.3.3). Question 3 asked what type of environment the people involved in the incident were in, prior to its occurrence. The different categories of environment were developed using records of the location of previous incidents (see Section 1.3.3). Question 4 related to the noise level of the people involved in the incident, prior to the incident. Categories of noise level related to the voices of the people involved, according to information provided by QPWS (1998,b) as to how this influences the chance of a dingo attack (see Section 1.3.3).

In addition to the factors considered by the above questions, it is likely that both the people involved, and the ranger reporting the incident would have further information and opinions as to what caused the incident. For example, the ranger may be familiar with the individual dingo involved or be aware of certain external factors that may have influenced the dingo's behaviour. To allow for this, two open-ended questions (Questions 5 and 6) asked for any further information or

opinions as to the cause of the incident, from both the people involved and the reporting ranger.

In order to determine if any human behaviours are associated with an aggressive incident involving a dingo ending, or the dingo leaving, Question 7 asked what human actions preceded the end of the incident.

Following comments from several QPWS staff and modifications to the survey, the forms were distributed to all ranger stations on Fraser Island. For the purpose of this study, the form was made available for use in the period from November 2000 to January 2001, although its use is intended to continue. Assistance with completing the form was made available via telephone throughout the period of the study. The time period of the survey's implementation included the historical peak of human-dingo interactions, which is between December and January (pers. comm. Max Haste).

2.3.2 Data analysis

By the end of this study, insufficient data had been collected by a QPWS staff for analysis. Had enough surveys been completed however, data relating to the gender and age of the dingoes involved, as well as the number of people involved in the incident (questions 1, 2 and 3, Section 1.4) would have been analysed to determine if these factors influenced the number of incidents, or the severity of the incident. The frequency of reported incidents would have been compiled in two-way contingency tables with the age of the dingo involved (adult or sub-adult/juvenile), the gender of the dingo involved, and the number of people involved (1 person, or >1 person). Chi-square tests would have been used to determine if the proportion of incidents of different levels of severity were significantly different for different dingo ages, dingo genders or number of people involved.

2.4 Continuous Observations of Dingo Behaviour

Continuous observations were used in order to describe dingo behaviour in its natural state, and to compare this with dingo behaviour when in environments of high levels of human use.

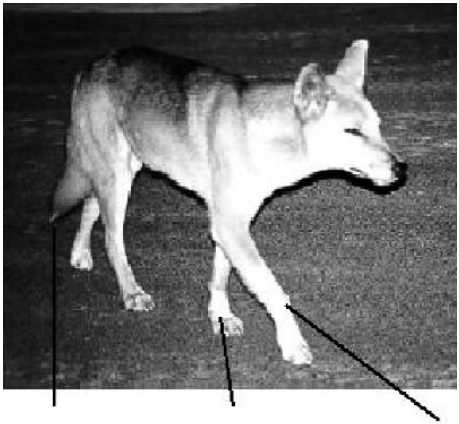
2.4.1 Observation of dingoes in the field

Dingoes are large and conspicuous mammals, making it possible to observe their behaviour from some distance away. As dingoes are often moving at a pace faster than can be followed on foot, most observations were made from a vehicle, which followed the dingoes at a distance of approximately 50-100m away. When observations were being made outside of the vehicle, the observer sat or crouched on the ground, and remained partly hidden from the dingo by objects such as trees, bushes and cars. Hand-held binoculars were used for most observations.

In order to record the detail required for continuous observations, records were made directly onto a tape recorder, and later transferred to data sheets. Observations were recorded by one person only throughout the study, though an additional person was required to drive the vehicle during the observations. The length of observations was timed, using a stopwatch operated by the driver of the vehicle. During preliminary observations, it was established that the presence of the vehicle did not alter the behaviour of the dingoes.

Individual dingoes were identified by a combination of several characteristics, including gender, age group, distinctive markings and colouration, in particular the amount of white colouration on the feet (known as 'socks') and the presence/absence of white colour on the tip of the tail. Using the combination of these colourations and characteristics, as well as particular scars and individual markings, identification was considered to be quite accurate, considering that within each dingo territory, there are an estimated maximum of nine dingoes (Corbett 1998a; QPWS 1999). All of these features were identified by rangers on Fraser Island (pers. comm. Bakhach 2000; pers. comm. Haste 2000) or by staff of the Kingfisher Bay Resort Village (pers. comm. Sinclair 2000) as useful for identification, though at present no system exists to record them in full. The complete records for all dingoes identified throughout the study are displayed in Appendix B. Colour photographs of these individual dingoes are available from the author on request. Figure 2 shows how dingoes were identified and provides an example of sock markings and body colouration.

Figure 2: Example of markings and characteristics used for dingo identification



Name: Socks

Site: Eurong

Sex: Male

Age: Sub-Adult

White Tail Tip: Yes (Very Small)

Conditions: Good, ribs just showing, some scarring, solid frame.

Socks: Front left is medium-long, front right is long, no clear socks on hind legs.

Other: Black colour on shoulders, spine and along tail, body colour is quite dark, yellow-orange, scar on right hind leg.

2.4.2 Introduction to the technique of continuous observation

Continuous observation involves recording all observed behaviours from predefined repertoires of states and events, for specified periods of time. A state is 'the behaviour an individual, or group, is engaged in; an ongoing behaviour' (Lehner 1996). Examples of behavioural states may be 'feeding' or 'resting', where the behaviour will occur over prolonged time periods. An animal may be involved in other behaviours within a state, for example, it may pause to look at another animal whilst feeding, but the general category of behaviour, or state, is still feeding. Defined repertoires of states are comprehensive, meaning that together, they account for 100 per cent of an animal's time, and are usually discreet. An event however, 'approaches an instantaneous occurrence that happens so fast that you just count its occurrence; a momentary behaviour' (Lehner 1996). States can be used to describe how an animal divides its time between behaviours, and events are used to describe the frequency of certain behavioural acts.

Using this method, and focusing on one individual animal, it is possible to accurately measure the frequency and duration of several behaviours during the one observation (Lehner 1996). It is therefore a useful technique when an overall description of the behaviour of that animal is required.

2.4.3 Procedure

Continuous observations were used to compare dingo behaviour between environments with high and low levels of use by humans. High use environments were defined as sites with frequent and concentrated human use as well as some modification of the environment (eg. from car parking, informal roads, houses). Low use environments were defined as those outside of the high use areas. The purpose of these observations was to describe the natural behavioural repertoire of dingoes and also to determine how dingo behaviour varies as a result of being in an environment with a high level of human use.

Sites for continuous observation sampling were all located on the eastern beach of Fraser Island, from the ocean, up to the edge of tree cover in the dunes. The eastern beach was the only area on Fraser Island with very few obstructions to vision, so that dingoes could be observed from a distance. Most other parts of the island are heavily vegetated, making observations difficult from more than 20m away from the dingo. Being able to make observations from 50-100m away prevented the presence of the observer from influencing the behaviour of the dingo. The high use environment sites used for observation were Eli Creek, The Maheno Wreck, Cathedral Beach Resort, Hook Point barge landing, Dilli Village and Eurong township (see Fig. 1). The low use areas, similar to the high use areas in all aspects excluding human presence, were located adjacent to the high use areas.

In order to create a repertoire of states and events of dingo behaviour to be used for continuous observations, pilot observations were made of dingoes in high and low human use environments. States were defined on the basis of posture and movement (eg. lying down, moving) of the dingo, rather than the function (eg. resting, playing) of the behaviour. Knowledge of dingo behaviour was not adequate to

make assumptions about the function of dingo behaviours. Events were chosen which were expected to vary as a result of human presence, and which occurred frequently enough to provide a reliable measure of the difference in occurrence between high and low human use environments. The time spent in each state was recorded by noting when that behaviour began and ended. The frequency of each event was recorded by noting each time the event occurred.

Sampling was carried out during one 14-day period, from 27 November to 10 December. Although it was originally planned to record in multiple seasons, observations made in other seasons did not return sufficient sample sizes for analysis. Sample sizes were limited by a number of unforeseen constraints to collecting continuous observation data. With the site for observations being restricted to the eastern beach of the island, large amounts of time were often spent locating dingoes, or waiting for dingoes to move to the eastern beach. Also, with the area of the low human use part of the eastern beach being quite large, there was a low chance of observing a dingo in both environment types during the one session. Also, many observations could not be completed when the focal dingo moved away from the beach and into the dune vegetation. Therefore a number of days were spent making observations, which could not be used for analysis.

Paired observations of high and low human use environments, for each dingo, were used to increase the power of the study to detect an effect of the level of human use. Given the small sample size available, this was considered necessary in order draw reliable conclusions. Each of eight individual dingoes was observed for a period of 30-minutes in one environment type before being observed immediately after in the other environment type, for the same duration. Only those observations that continued from one environment type to the other were included in the analysis.

Observations were only made between 10am and 2pm, as dingo behaviour was expected to differ throughout the day, and the sample size was not large enough to consider this source of variation. Four of the eight dingoes were first observed in a high human use site, then immediately after in a low human use area. The remaining four dingoes were observed first in a low use area and then immediately

after in a high use area. This was to control for the effect of the environment type and the time on the dingoes' future behaviour, and was achieved by locating the dingoes in the desired environment type. Additionally, observations for individual dingoes were made continuously, with no break between the two environment types.

Observations were recorded continuously on to a tape recorder, and then transferred to data sheets using a stopwatch. Low tide provided the only time when the eastern beach sites could be accessed, so all observations were made on or within 2hrs either side of low tide. For varied periods of time during sampling, dingoes moved into heavily vegetated areas and could not be observed. Sampling ceased during this time and continued if and when the dingo returned to view. It was assumed that dingo behaviour during this time did not differ from behaviour when in view.

2.4.4 Data Analysis

For each dingo, in each environment type, the time spent in each state was calculated and converted into a percentage of the total duration of the observation period. Similarly, for each dingo in each environment type, the number of times each event occurred was calculated and converted to a frequency per hour.

Exploratory data analysis of these dependent variables was undertaken using plots of the mean +/- standard error for all combinations of environment type and state, and plots of the mean +/- standard error for all combinations of environment type and event. Log transformations were then performed on the events data, due a substantial heterogeneity of the variances displayed in these plots. The data for both percentage time spent in each state, in each environment type, and the frequency of each event, in each environment type, were then analysed using two separate two-way factorial analyses of variance. For the states data, Environment type (2 levels) and State (4 levels) were the fixed factors in the analysis. For the events data, Environment type (2 levels) and Event (6 levels) were the fixed factors. The variation due to individual dingoes was treated as a block in both of these analyses. The alpha level was set at 0.05. Post hoc (Tukey's HSD) tests were then used to make pair-wise comparisons within significant factors and their interactions.

2.5 Sequence Sampling

Sequence sampling was used to examine the relationship between human behaviours and dingo responses, in order to determine if dingo behaviour is affected by human behaviour.

2.5.1 Introduction to the technique of sequence sampling

Sequence sampling involves recording a series of consecutive behaviours, called a sequence. Sequences may be performed by individual animals, or may alternate between two or more individuals (Lehner 1996). A sequence involving two animals may describe, for example, a mating ritual, where the behaviour of one animal is often followed by a certain behaviour of the other. The order in which the behaviour of both animals occurs would be recorded. Recorded sequences are used to determine how likely it is that a particular behavioural act will be preceded by another (or the same) particular behavioural act. Results are interpreted as implying that there is a relationship between the two acts. For example, when one person smiles in the direction of another person, that other person will usually smile at the first person. This would support the hypothesis that the human act of smiling triggers the act of smiling in the responding person.

2.5.2 Procedure

Given that the available sample size was limited by the number of individual dingoes, which could be located, a controlled experiment was designed in order to record dingo responses to certain human behaviours, rather than observing actual dingo-visitor interactions. This approach also enabled the control of a number of extraneous variables. The experiment involved recording the responses of dingoes to a set of particular human behaviours, which were performed by one person, in the presence of each dingo. Using this approach, variables not able to be measured, such as the smell of the person, could be controlled. Categories of 'typical' tourist behaviours (in relation to dingoes) were described, using casual observations of visitors to the island, and interviews with QPWS staff and tour guides. A repertoire of six human behavioural acts was defined.

A total of 63 individual dingoes were located and identified, so that sequences could be recorded. The number of dingoes observed was limited by much of Fraser Island being inaccessible, and the tendency of dingoes to travel long distances within a day. With an estimated population of between 100 and 200 dingoes on the island (Corbett 1998a), 63 dingoes represented at minimum, approximately 30 per cent of all dingoes on Fraser Island. Following the technique for describing dingo characteristics and colourations as described in Section 2.4.1, dingoes were identified carefully in order to ensure that each dingo was sampled once only. A response to each human behaviour was recorded once only for each dingo. With a sequence being defined as one human act and one dingo response, 6 sequences were therefore recorded with each dingo.

With each dingo being considered one replicate, a design was initially planned whereby each dingo would be sampled once in each season. This was not possible for biological reasons relating to the mating and breeding seasons. Many of the adult dingoes sampled in April-May were not seen again in July-August as this was the breeding season, when mating pairs tend to be more elusive. Therefore rather than repeating the sampling on each dingo in each season, and in order to gain independence, a separate set of dingoes was sampled in each season. A total of 63 individual dingoes were sampled, 21 in season 1, 20 in season 2, and 22 in season 3. In some cases sessions were unable to be completed due to the dingo moving out of sight. Those sequences already recorded with that dingo were kept and included in analysis.

In order to remove the influence of different human characteristics on dingo behaviour, the same person performed all sequences. The person was a 23 year old, 170cm tall male of medium build. Care was taken to keep the colour of clothing and the smell of perfumes, soaps and suncream constant throughout all sequences. This was achieved through the use of the same amount of the same products prior to every sampling period.

Table 1 describes the six human behaviours, representing typical tourist behaviours, which were performed in the presence of dingoes.

Table 1: Operational definitions of all human stimulus behaviours performed in the presence of dingoes

HUMAN STIMULUS BEHAVIOUR	OPERATIONAL DEFINITION
Running towards	Person runs from 20m away to between 3m and 5m away from the dingo, at a pace of approximately 2.5m/sec.
Running away	Person runs from within 3-5m from the dingo to approximately 20m away, at a pace of approximately 2.5m/sec.
Walking towards	Person walks from 20m away to between 3m and 5m away from the dingo, at a pace of approximately 1m/sec.
Walking away	Person walks from within 3-5m from the dingo to approximately 20m away, at a pace of approximately 1m/sec.
Submission	Person stands still, between 3 and 5 metres from the dingo, with head and eyes lowered, shoulders leaning forward and down, for a period of approximately 10 seconds.
Aggression	Person waves arms, shouts, stamps feet, for a period of approximately 10 seconds. Person is standing between 3 and 5 metres from the dingo.

Behavioural categories Submission and Aggression were determined using known categories of dingo behaviour (Corbett 1995a) and other behaviours identified by the QPWS on Fraser Island as being able to reduce or promote excitement and aggression in dingo responses. This is further detailed in section 1.3.3 of this report. Submission represents a potential strategy for avoiding a dingo attack, whereas Aggression has been suggested to trigger aggression in dingoes.

Preliminary observations determined that if dingoes were going to respond to human acts, they would do so within a period of 10

seconds, and for this reason, each human act was carried out for a period of 10 seconds. The timing of the human acts was monitored with a stopwatch. The human acts involving walking and running occurred from 3m to 20m away from the dingo. Those acts in which the human was to remain in the one location were performed between 3 and 5m away from the dingo. This distance was set so as to be close enough for the dingo to be aware of the person, and not so close as to jeopardise the safety of the person, should the dingo become aggressive.

Dingo responses were recorded in detail on to audiotape as they occurred and later categorised for the purpose of statistical analysis. In order to achieve a sufficiently large sample size, observations were made at all times of the day, but not during the night as lack of visibility made this impossible. Although it is known that dingo behaviour differs throughout the day, it was assumed on the basis of preliminary observations that responses to the experimental acts would not change. Sequences were not recorded with dingoes, which were sleeping, eating or interacting with other dingoes, as these factors were expected to influence the responses of the dingoes to the human acts.

For each dingo, a total of six sequences were recorded, one for each human behaviour category. For the purposes of this study, a sequence was defined as one preceding human act and one dingo response. Due to the possibility that previous human acts may have altered how the dingo responded to later human acts, the order in which the human acts were carried out was randomised. A gap of five seconds was left following the ten-second execution of each human act. This allowed time for the dingo to stop responding to the previous human act. No greater gap was necessary, as the dingo response was usually immediate and stopped when or shortly after the human act was completed. If at any stage during the session the dingo moved out of sight, the session was either completed as soon as the dingo could be located, or the partial results were recorded and kept.

Interactions were recorded at a number of sites around the island, chosen on the basis of a high likelihood that dingoes would be present, and according to accessibility. These sites were at and around, Lake McKenzie, Lake Boomanjin, Central Station, the

Wanggoolba Creek barge landing, Waddy Pt, along the eastern beach between Hook Point and Waddy Point, and at Kingfisher Bay Resort Village (see Fig 1). It was assumed that the site of the interaction did not affect the dingoes' responses.

2.5.3 Data analysis

Testing of preliminary data found that there was no significant difference between the responses of individual dingoes. Therefore there was no need to remove the effect of variation due to individual dingoes and data analysis could be simplified by treating multiple responses from each dingo as independent replicates.

Though dingo response is considered as the dependent variable in this analysis, there was not sufficient information available for it to be measured continuously. Dingo response was therefore defined as a multinomial variable, and was included as a factor in the hierarchical log linear analysis (explained below), which does not treat any factors as dependent variables. As Dingo response was considered to be dependent, only those interactions involving the Dingo response variable were considered in the following analysis.

Data gathered during sequence sampling were analysed using hierarchical log linear analysis. Log linear analysis uses models incorporating various factors, and their generalised interactions, to determine how well these factors explain the observed data. For example, a saturated model, which includes all factors and their interactions, must by definition explain all of the variation in the data set and will be a perfect fit for the observed data. The aim of log linear analysis is to determine the simplest model which best explains the data set.

The process used began by firstly incorporating only the main effects in the model (independent model), followed by adding two-way interactions one by one, followed by three-way interactions and so on, until the model was saturated. For each of these models, a X^2 value to test goodness-of-fit was calculated. The differences between the X^2 values of successive models were then calculated (X^2diff), in order to determine if there was a significant difference between the successive models. Alpha was set at 0.05. Using this process, it could

be shown which individual factors and interactions were having a significant effect on explaining the pattern in the data. Factors used in the analysis were season (three levels), dingo response (three levels) and human stimulus behaviour (four levels). In order to provide a large enough sample size for analysis, human stimulus behaviours walk towards and run towards were pooled, as were human stimulus behaviours walk away and run away. The four levels of human stimulus behaviour analysed were therefore move towards, move away, submission and aggression.

A similar analysis was performed on data within each season, in order to include the variables of dingo age (three levels) and dingo gender (two levels) in addition to human stimulus behaviour and dingo response. The variables of dingo age and dingo gender could not be included in the above analysis due to a number of zeros in the data for certain levels of each, and as the sample size was inadequate for testing so many variables. Therefore each season was treated independently, in order to determine the effect of these two factors.

In order to explain how the factors of dingo response and human stimulus behaviour were interacting, individual comparisons were made using tests of proportions. Tests of proportions were used to compare the proportion of one level of dingo response, between two different human stimulus behaviours. Alpha was set at 0.05.

3. RESULTS

3.1 Dingo Incident Survey

The dingo incident survey was implemented by the senior ranger of Fraser Island, at all ranger stations on the island, between the months of December 2000 and January 2001. The incident report form was approved by rangers at three of four ranger stations on the island, with no reply received from the fourth due to staff turnover. Despite this support, no incident surveys were completed and returned in the duration of this study. For this reason, no results can be displayed or analysed.

3.2 Effect of Level of Human Use on Dingo Behaviour

3.2.1 Categories of dingo behaviour

A repertoire of four mutually exclusive states was defined: moving, standing still, sitting down and lying down (see Table 2). The times spent in each of the four states summed to 100 per cent for each dingo. As mentioned in Section 2.4.3, without adequate knowledge of dingo behaviour, assumptions could not be made about the function of dingo behaviours. Therefore the recorded states were those that could be defined objectively, without making assumptions.

Table 2: Repertoire of states recorded during continuous observations

STATE	OPERATIONAL DEFINITION
Standing	Body upright, not in motion
Lying	Body in horizontal position on ground, hind limbs to side of body, forelimbs either out in front of body or to side of body, head either on ground, on forelimbs or upright
Sitting	Hind legs folded under body on ground, forelimbs straight and vertical, head upright
Moving	Body upright, legs moving (either one at a time: walking, left and right legs moving in unison: trotting, or front and hind legs in unison: running)

The repertoire of defined behavioural events was sniffing the ground, sniffing food, eating, looking at people and vehicles, sudden turns and interactions with other dingoes (see Table 3). Frequencies of these events reflect how often dingoes search for food, find food and how often their behaviour is disrupted.

Behavioural events occurred for short durations only, often lasting for no longer than one or two seconds, and usually not longer than 5 seconds. Events often occurred in bouts, however, for example a dingo might sniff the ground repeatedly in one area for several minutes. In some cases, events were associated with a change in state. For example, a dingo might look at a person or vehicle, and also respond by standing up and moving away. A dingo might also sniff the ground whilst trotting, then stop moving in order to sniff the ground again.

Table 3: Repertoire of events recorded during continuous observations

EVENT	OPERATIONAL DEFINITION
Sniffs Ground	Head down, snout touching or within 10cm of ground
Sniffs Food	Head down, snout touching or within 10cm of food object (human or other)
Eats	Jaws around food object
Looks at Person	Head up and turned towards person, ears pointed up and towards person, eyes open and looking towards person
Looks at Vehicle	Head up and turned towards vehicle, ears pointed up and towards vehicle, eyes open and looking towards vehicle
Sudden Turn	Body upright, direction of movement changes by more than 900, in a single movement. Direction of movement is away from a person, animal or object making a loud noise or fast movement.
Interaction with other dingo	Change in behaviour or direction of movement in response to presence of other dingo, within 10m of other dingo

3.2.2 Description of dingo behaviour

Observations of dingo behaviour made in areas with low levels of human use are expected to represent the natural pattern of dingo behaviour, during the middle of the day. Dingoes spent approximately half of the observed time moving (45.2%), whether it be walking, trotting or running. Similarly, incidental observations of around 70 dingoes throughout the study found that dingoes spent a large amount of time moving, usually either trotting in a particular direction, or walking whilst frequently sniffing the ground. In recorded observations, dingoes also sniffed the ground much more frequently than they displayed any other event behaviour, on average 94 times per hour.

On average dingoes spent 26.3 per cent of the time lying down. Again, incidental observations of dingoes also found that they were often lying down during the middle of the day, resting or grooming, but not sleeping.

Dingoes ate frequently during the observations, approximately 29 times per hour. In most cases they ate small amounts of food scavenged from the beach. Dingoes were observed eating jellyfish, shellfish, fish carcasses, bird carcasses, coconut husks and berries. Interactions with other dingoes were also quite frequent, occurring approximately 10 times per hour.

The remainder of the dingoes' time was spent either standing still or sitting down. Approximately 18 per cent of time was spent standing still. During this time, dingoes would often sniff the ground, sniff food items and eat, relatively frequently. Only a small amount of time was spent sitting down (10%).

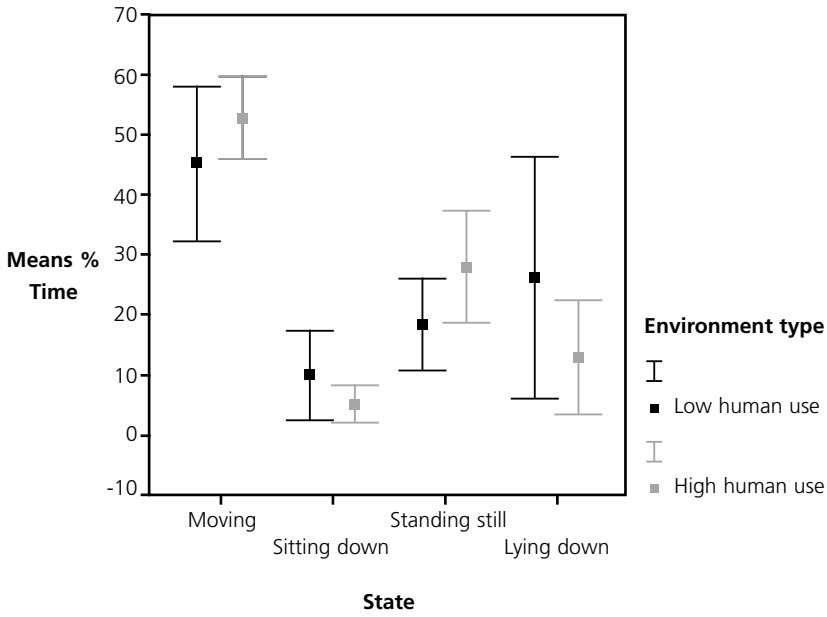
Further incidental observations of dingo behaviour were recorded by the observers and are displayed in Appendix C.

3.2.3 Time spent in states in areas of high and low levels of human use

In both environment types, dingoes spent approximately half of their time moving (see Figure 3). In the low human use areas, dingoes

spent 26 per cent of time lying down, 18 per cent of time standing still, and 10 per cent of time sitting down. On average, dingoes spent approximately 8 per cent more time moving and 10 per cent more time standing still in the high human use environments than the low human use environments. Dingoes spent approximately 13 per cent more time lying down and 5 per cent more time sitting down in the low human use environments than the high.

Figure 3: Comparisons of per cent time spent in each state between 'low human use' and 'high human use' environments, showing means and standard errors of the means



A two-factor univariate ANOVA, with individual dingoes as blocks found no significant effect of environment type on the proportion of time spent by dingoes in different states, though there was a significant difference in time spent in each state (see Table 4). There was no significant effect of individual dingo on the time spent in different states.

Table 4: Univariate ANOVA, with individual dingoes as blocks, testing for effect of environment type on time spent in each state, and for difference in time spent between states

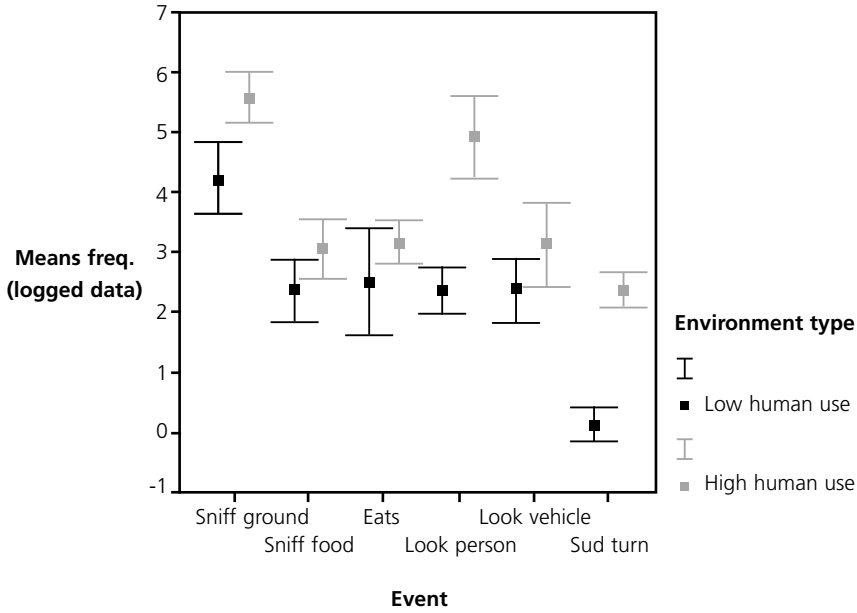
SOURCE	df	MEAN Sq.	F	p
Dingo	7	0.336	.001	1.000
Error	49	260.670		
Environment	1	0.360	.001	.971
Error	49	260.670		
State	3	4850.700	18.600	.000
Error	49	260.670		
State*Environment	3	457.580	1.755	.168
Error	49	260.670		

3.2.4 Frequency of events in areas of high and low levels of human use

Most recorded events appeared to occur more frequently in the environments with high levels of human use (see Figure 4). The most frequent event was 'sniffs ground', which occurred more frequently in high (282 times per/hr) than low (94 times per/hr) human use environments. In the areas of low human use, dingoes looked at people relatively infrequently (11 times per/hr), whereas in the high human use environments, dingoes looked at people, on average 179 times per hour. The event 'sudden turn' did not occur in the low human use environments, but occurred 11 times per hour in the high human use environments. Conversely, the event 'interaction' did not occur in the high human use environments, but occurred 10 times per hour in the low human use environments. However, the event 'Interaction' did not occur in six of the eight dingoes and was not included in the statistical analysis.

As Figure 4 shows, events 'sniffs ground', 'sniffs food', 'looks at person', 'looks at vehicle' and 'sudden turn' all appear to occur more frequently in human use environments.

Figure 4: Comparison of frequencies of each event in environments with high and low levels of human use, showing means and standard errors of the means (of logged data)



A two-factor univariate ANOVA, with individual dingoes as blocks, found a significant effect of the environment type on the frequency of events and a significant interaction between event and environment type (see Table 5).

Table 5: Univariate ANOVA, with individual dingoes as blocks, testing for effect of environment type on the frequencies of events

SOURCE	MEAN Sq.	df	F	p
Dingo	0.64	7.0	1.108	.367
Error	0.70	6.5		
Environment	45.10	1.0	77.425	.000
Error	0.62	7.0		
State	23.50	5.0	40.470	.000
Error	0.61	35.0		
Event*Environment	2.85	5.0	4.891	.001
Error	0.54	35.0		

The interaction effect was further examined using Tukey tests, which found a significant difference between environment types in the frequencies of events: Sniffs Ground, Looks at Person and Sudden Turn (see Table 6). All three of these events occurred more frequently in human use environments.

Table 6: Results of Tukey tests for testing for significant differences between environment types in the frequencies of each event

EVENT	MEAN DIFF.	SE	Sig.
Sniffs Ground	-1.34	0.38	0.033
Sniffs Food	-0.68	0.38	0.815
Eats	-0.63	0.38	0.877
Looks at Person	-2.55	0.38	0.000
Looks at Vehicle	-0.75	0.38	0.705
Sudden Turn	-2.25	0.38	0.000

3.3 Effects of Human Behaviour on Dingo Behaviour

In total, responses of 63 different individual dingoes were observed, recording six behavioural sequences with each. The full repertoire of behavioural responses of dingoes to the human behavioural stimuli as observed during these sequences is shown in Table 7.

The responses of dingoes to human stimulus behaviours consisted of either movement towards or away from the human, or one or more of a number of behavioural acts previously described in literature (Corbett 1995a) as being either aggressive or submissive. Those behavioural responses interpreted as aggressive were pooled into the one category, Aggression. As described in Section 1.3.2, this included baring teeth, snarling, growling, raising of the tail, straightening of back and legs, lunging towards the person, nipping or biting the person (Corbett 1995a). Those behavioural responses interpreted as being submissive were pooled into one category, Submission, which included crouching and averting the eyes by lowering or turning the head (see Section 1.3.2) (Corbett 1995a).

So that sample sizes would be large enough for log linear analysis, dingo response categories had to be pooled. Before response categories were pooled, assumptions were made as to the nature of the response. The new dingo response category Advance/Threat was defined to include walk towards, trot towards, run towards and aggression, pooled on the basis of these behaviours being considered at least mildly threatening. Movement of a dingo towards a person is considered to be slightly aggressive or threatening, as it shows no fear or submission, and as attacks and threats have been observed to be preceded by movement towards the person. Similarly, the new dingo response category Retreat/Submission was defined as including walk away, trot away, run away and submission, which are all at least somewhat submissive. New dingo response category Still/Neutral includes response categories 'still' and 'neutral movement', which are neither aggressive nor submissive. Human behavioural acts were grouped into four categories: Towards, Away, Submission and Aggression.

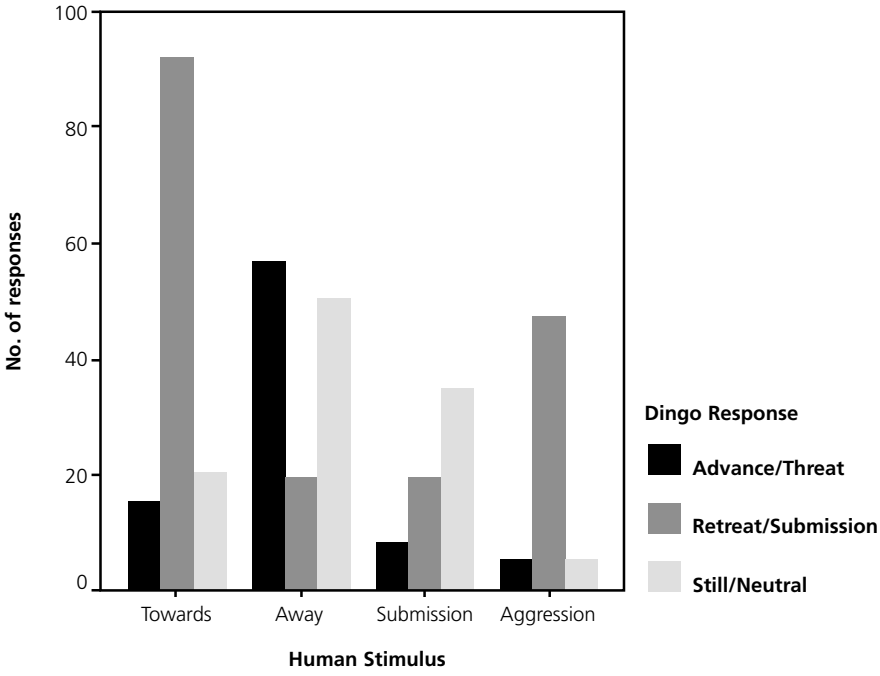
Table 7: Repertoire of recorded behavioural responses of dingoes to human behavioural stimuli

BEHAVIOURAL ACT	OPERATIONAL DEFINITION
Walk towards	Dingo moves towards person, with only one foot lifted from the ground at a time. Direction of movement is within 45° of directly towards the person. Does not display acts interpreted as aggression.
Trot towards	Dingo moves towards person, with feet moving in diagonal pairs (i.e. Front left and hind right foot move together). Direction of movement is within 45° of directly towards the person. Speed is approximately double that of walking. Does not display acts interpreted as aggression.
Run towards	Dingo moves towards person, with hind feet and front feet moving in pairs. Direction of movement is within 45° of directly towards the person. Speed is approximately double that of trotting. Does not display acts interpreted as aggression.
Aggression	While stationary or moving towards the person, dingo bares teeth, snarls, growls, raises tail, straightens back and legs, lunges towards person, nips or bites person.
Walk away	Dingo moves away from person, with only one foot lifted from the ground at a time. Direction of movement is within 45° of directly away from the person.
Trot away	Dingo moves away from person, with feet moving in diagonal pairs (i.e. Front left and hind right foot move together). Direction of movement is within 45° of directly away from the person. Speed is approximately double that of walking.
Run away	Dingo moves away from person, with feet moving in pairs of the front and hind two. Direction of movement is within 45° of directly away from the person. Speed is approximately double that of trotting.
Submission	Dingo does not move, and participates in any of: crouching (front legs are stretched out in front, hind legs are upright, chest and head are lowered towards the ground), lowering or turning the head.

Still	Dingo is standing, sitting or lying down, and does not change posture in response to the human behavioural stimuli. Does not display acts interpreted as aggression.
Neutral movement	Dingo walks, trots or runs (see above definitions) in a direction that is neither towards nor away from the person (see definitions above). Does not display acts interpreted as aggression.

As Figure 5 illustrates, some trends in dingo responses to human stimuli were observed in the raw data. In particular, dingoes appeared to respond more aggressively to 'move away' and more submissively to 'move towards' and 'aggression'. Human stimulus 'submission' appeared to prompt a neutral or submissive response.

Figure 5: Frequency of each dingo response within each level of human stimulus behaviour, for all seasons



The variables of Human stimulus, Dingo response and Season were included in a hierarchical log linear analysis (Table 8). The only parameter, which added significantly to the goodness-of-fit of the model, was the interaction between human stimulus and dingo response. Thus the type of dingo response is related to the type of human stimulus, and was not influenced by the season.

Table 8: Goodness of fit tests for successive hierarchical log linear analyses, involving the relationship between dingo response (D), human stimulus behaviour (H) and season (S)

VARIABLES IN MODEL	X^2(model)	df (model)	X^2 (diff)	df (diff)	Significance of X^2 (diff)
(D) (H) (S)	138.7	28			
(S) **(D x H)**	18.93	22	119.77	6	< 0.001
(D x H) **(D x S)**	15.88	18	3.05	4	No
(D x H x S)	0	0	15.29	12	No

(A maximum of three-way interactions were included in the model. The X^2 (diff) is a test of how the effect or interaction being added into the model, adds to the goodness-of-fit of the model. As Dingo response (D) is considered as the dependent variable, only those models including the variable Dingo response are displayed)

In order to determine which dingo responses were different for which human stimuli, tests for proportions were used. Each test was used to show if a particular dingo response occurred significantly more often, after one type of human stimulus than another. As season was shown to have no effect on dingo response, it was excluded from this analysis.

The dingo response Advance/Threat was found to occur significantly more often following human stimuli move away, than after any other human stimuli ($Z_{(0.05,2)}$=1.96, Z_c=6.15). Moving away from the dingo was therefore the human stimulus most likely to prompt an aggressive response from a dingo. The dingo response of retreat/submission, occurred significantly more often following the human stimuli of aggression and move towards, then after move away or submission ($Z_{(0.05,2)}$=1.96, Z_c=5.72). Dingoes were therefore most likely to retreat or behave submissively when the human either moved towards them, or behaved aggressively towards them.

In order to determine the effect of dingo age and gender on dingo response to the human stimuli, hierarchical log linear analyses were run for data within each season, including the factors dingo age and dingo gender. The factors human stimulus, dingo response, dingo age and dingo gender were included in the analysis.

During April-May, the interaction between human stimulus and dingo response was significant (Table 9). The interaction between dingo response, human behaviour and dingo age was also found to have a significant effect. At $p<0.1$, the interaction between dingo response, human behaviour, dingo age and dingo gender was significant. The relationship between dingo response and human stimulus therefore depended somewhat on dingo age and possibly dingo gender.

Table 9: Goodness of fit tests for successive hierarchical log linear analyses ran on April-May data, involving the relationship between dingo response (D), human stimulus behaviour (H) dingo age (A) and dingo gender (G)

Variables in Model	X^2 (model)	Df (model)	X^2 (diff)	df (diff)	Significance of X^2 (diff)
(D) (H) (A) (G)	110.94	40			
(H) (A) **(D x G)**	109.89	38	1.05	2	No
(A) (D x G) **(D x H)**	35.79	32	74.1	6	<0.001
(D x G) (D x H) **(D x A)**	33.89	30	1.9	2	No
(D x A) (A x H) (G x A) **(D x G x H)**	26.7	17	7.25	6	No
(G x A) (D x G x H) **(D x H x A)**	13.66	11	13.04	6	<0.05
(D x H x A x G)	0	0	13.58	8	<0.1

(A maximum of four-way interactions were included in the model. As Dingo response (D) is considered as the dependent variable, only those models including the variable Dingo response are displayed)

During July-August, the interaction between human stimulus and dingo response was again found to add significantly to fit of the model (Table 10). The interaction between dingo response, human stimulus and dingo gender was also found to be significant at $p<0.1$. In July-August, there was a trend towards a relationship between dingo response, human stimulus and dingo gender. There was no effect found of dingo age.

Table 10: Goodness of fit tests for successive hierarchical log linear analyses for July-August data, involving the relationship between dingo response (D), human stimulus behaviour (H) dingo age (A) and dingo gender (G)

Variables in Model	X^2 (model)	df (model)	X^2 (diff)	df (diff)	Significance of X^2 (diff)
(D) (H) (A) (G)	71.03	40			
(H) (A) **(D x G)**	69.08	38	1.95	2	No
(A) (D x G) **(D x H)**	29.55	32	39.53	6	<0.001
(D x G) (D x H) **(D x A)**	27.76	30	1.79	2	No
(D x A) (A x H) (G x A) **(D x G x H)**	19.35	17	10.38	6	<0.1
(G x A) (D x G x H) **(D x H x A)**	9.62	11	9.73	6	No
(D x H x A x G)	0	0	9.11	8	No

(A maximum of four-way interactions were included in the model. As Dingo response (D) is considered as the dependent variable, only those models including the variable Dingo response are displayed)

During November-December, the interaction between human stimulus and dingo response again added significantly fit of the model (Table 11). No interactions with the variables Dingo age, or Dingo gender were found to be significant.

Table 11: Goodness of fit tests for successive hierarchical log linear analyses for November-December data, involving the relationship between dingo response (D), human stimulus behaviour (H) dingo age (A) and dingo gender (G)

Variables in Model	X^2 (model)	Df (model)	X^2 (diff)	df (diff)	Significance of X^2 (diff)
(D) (H) (A) (G)	99.51	63			
(H) (A) **(D x G)**	99.18	61	0.33	2	No
(A) (D x G) **(D x H)**	51.57	55	47.61	6	<0.001
(D x G) (D x H) **(D x A)**	49.37	51	2.2	4	No
(D x A) (A x H) (G x A) **(D x G x H)**	29.97	34	1.57	6	No
(G x A) (D x G x H) **(D x H x A)**	12.88	22	17.09	12	No
(D x H x A x G)	0	0	12.91	16	No

(A maximum of four-way interactions were included in the model. As Dingo response (D) is considered as the dependent variable, only those models including the variable Dingo response are displayed)

4. DISCUSSION

4.1 Factors Influencing Occurrence and Severity of Aggressive Incidents

Although much cooperation and encouragement was provided from the QPWS staff, and the survey form developed was agreed to be useful, not a single survey form was completed and returned throughout this study. This indicates that despite the desire to manage the issue of human-dingo interactions on Fraser Island, either limited resources or lack of staff commitment do not allow for any substantial effort to be devoted to this cause. Until this situation is reversed or improved significantly, it will remain difficult to implement successful management plans and actions.

The management of human-dingo interactions on Fraser Island is hindered by a lack of information about the nature of these interactions and of dingo behaviour. If implemented by the staff of the Queensland Parks and Wildlife Service on the island, this survey would provide valuable information about how the characteristics of dingoes and other factors relate to the likelihood of an aggressive incident.

Understanding how the age and gender of a dingo influence aggressive behaviour could help people to behave appropriately in the presence of dingoes and avoid an attack. For example, if older, male dingoes were found to be more likely to attack than other dingoes, then people could be instructed to be cautious of adult male dingoes, and avoid encounters with them.

The survey would also provide information on what other factors influence the chance and severity of a dingo attack. This could include factors such as the behaviour of the people, the number of people in a group and the age of the people. Again, this information could be used to reduce the number or severity of attacks on Fraser Island, by educating people as to how to behave in the presence of dingoes and what group size is ideal. There may also be people of certain characteristics (age, gender, height) who should be particularly

cautious, and perhaps avoid behaving in ways that might be interpreted by dingoes as aggressive.

The incident survey would also serve as an effective means of monitoring attacks and incidents on the island by providing information on the locations, dates, times and severity of attacks. If patterns or trends were identified, than this information could help land managers to significantly reduce the number of attacks and incidents. For example, if the majority of attacks occur during the middle of the day, then mangers could instruct visitors to be especially cautious during this time. Also, if there are particular sites where incidents occur repeatedly, then managers could focus efforts on reducing human-dingo interactions at those sites.

Results from the survey would also increase understanding of dingo behaviour, particularly aggression, in the wild. There is presently very little published information relating to aggression in wild dingo populations. It has been suggested however, that characteristics such as gender and age do influence aggressive behaviour in other animal populations, such as bears (Mace and Waller 1996), dolphins (Orams 1996) and monkeys (Chapman *et al.* 1998), and also in dingoes (Corbett 1998b, Corbett 1995a, pers.comm. Ford 2000).

4.2 General Observations of Dingo Behaviour

What little knowledge there is of dingo behaviour comes from studies of dingoes either in captivity, in various areas throughout mainland Australia, and parts of Asia. This study provides the first quantitative description of dingo behaviour in Australia. Although incidental observations made of dingo behaviour on Fraser Island during this study indicate similarities with studies done elsewhere, the general pattern of dingo behaviour elsewhere has not previously been quantitatively described.

The description of dingo behaviour observed during this study is limited to dingoes on Fraser Island. It is also limited to the middle hours of the day, when dingoes are believed to be more active. All observations were made on the eastern beach of the island, also limiting their application, although the behaviour of dingoes in other

areas of Fraser Island would not be expected to differ greatly from that of dingoes on the eastern beach of the island.

Dingoes observed during this study spent approximately half of their time moving. Studies of dingoes in other areas in Australia have indicated that dingoes will commonly travel long distances during a day. These distances are influenced largely by food availability (Corbett 1995a). Observations also indicated that dingoes spent a large amount of the time whilst they were moving searching for food, given that they sniffed the ground quite frequently. The observed dingoes also spent approximately one quarter of the time lying down. Observations were made on Fraser Island, Queensland, during the middle of the day, in summer, when temperatures are commonly above 30°C. Studies in other parts of Australia have found that climate can play an important role in the daily movement patterns of dingoes (Corbett 1995a). It is likely that the dingoes were actively searching for food during the day, although they also spent a substantial amount of time resting due to the high temperatures.

4.3 Effect of Human Presence on Dingo Behaviour

As mentioned above, this behavioural description is limited by observations being made only during the middle of the day, and only during the months of November and December. The sample size was also limited to eight dingoes for this part of the study, increasing the chance that results may not be representative of dingoes on Fraser Island, and reducing the power of statistical analyses to detect any effect of human presence on dingo behaviour.

No significant difference was found in time spent by dingoes in behavioural states between environments with high and low levels of human use. On average however, dingoes spent more time moving and standing still in areas of high human use than in areas of low human use. Also, they spent more time lying down and sitting down in low human use environments. This indicates that dingoes may spend more time in the active states of moving and standing still, when in environments of high rather than low levels of human use, although this was not statistically significant. This lack of significance may have been associated with the small sample size of eight dingoes. This effect could indicate that the dingoes are more distracted, more

disturbed, and/or spend more time searching for food, when in high human use environments. The presence of people, deliberately interacting with the dingoes, and either directly or indirectly making food available to dingoes, could be causing this effect. In order to determine if this effect on dingo behaviour is occurring, this study would need to be repeated with a larger sample size.

Dingoes also appeared to have different movement patterns when in areas of low and high levels of human use. When in areas of low human use, total distance travelled appeared to be greater then when in areas of high human use, despite the dingoes having spent less time moving in these areas. The sizes of dingo territories are thought to increase according to increases in both pack size and food availability (Corbett 1995a). The differing movement patterns observed between dingoes in areas of low and high levels of human use might have been a result of high food availability in the areas used by large numbers of people.

A significant difference was found in the frequency of certain behavioural events between high and low human use environment types. Dingoes were found to sniff the ground, look at people and make sudden turns significantly more frequently when in high human use environments than when in low human use areas. As the act of sniffing the ground represents that a dingo is searching for food, this is supportive of conclusions made above that dingoes might spend more time moving in high human use environments because they are searching for food. This indicates that the dingoes are 'food conditioned' to human food sources and may enter human use areas in order to find food. On average dingoes also sniffed food more frequently when in human use environments, indicating that there may have been more food available to them, or that they were searching for food more actively.

In human use environments, dingoes more frequently looked at people and made sudden turns. Also on average, dingoes looked at vehicles more frequently, though this difference was not significant. Although it may seem trivial to determine that dingoes look at people and vehicles more often in human use environments, all three of these event categories indicate that the behaviour of the dingo has been disrupted, as it must stop what it is doing to participate in any of

them. A sudden turn is interpreted as a fright response to a noise or movement, as it was recorded when the turn was made in the opposite direction to an object, person or noise. Without a more comprehensive description of dingo behaviour, it is difficult to determine what the effect of this disturbance will be. Further research into this disturbance on dingo behaviour by people, could be used to determine its impacts on foraging or social behaviours.

This is the first time that the relationship between high levels of human presence and behavioural changes in dingoes has been studied. Similarly, little has been published on this relationship in other species. Studies by Herrero (1985) and Mace and Waller (1996) have found that bears, which are normally instinctively wary of and will avoid humans, will not enter areas used frequently by humans unless they are habituated to human presence, and are searching for food. Dingoes also have an instinctive fear of humans (QPWS 1999). This indicates that the behavioural changes identified when dingoes were in areas used by large numbers of people were associated both with habituation to human presence, and with the purpose of them entering that area being to search for food. A study of Samango monkeys in a South African recreation reserve (Chapman *et al.* 1998) found that the monkeys had changed their movement patterns and foraging behaviours in response to human presence and the availability of human food sources. Similarly, dingoes in this study were observed to have different movement patterns and foraging behaviours when in areas of high levels of human use.

Results from this study indicate that dingo behaviour is affected by human presence. Dingoes in areas of high human use were found to have different movement patterns, were found to be searching for food more often, and their behaviour was disrupted more often than dingoes in areas of low human use. This increase in foraging behaviour is likely to be a result of 'food conditioning' to human food sources. This habituation of the dingoes to people and human food sources has most likely been caused by the availability of unnatural food sources in human use areas, and could possibly be affecting other dingo behaviours such as social interactions and hunting behaviours. The increase in disturbance to dingo behaviour observed in areas of high human use are likely to be caused by interactions with

people, and may also be impacting on other dingo behaviours such as feeding, resting and social interactions.

4.4 Effects of Human Behaviour on Dingo Behaviour

Responses of dingoes were clearly affected by the human behaviours performed in their presence. The pattern observed indicated that dingo behaviour differs with respect to human behaviour, and also that individual dingoes respond in similar ways. The similar behaviour of individual dingoes may indicate that dingo behaviour is determined largely by instinct and learning from parents and social/family groups. Being pack animals, this is not altogether surprising.

No difference was found between the three seasons in dingo responses to the human stimuli. These results do not necessarily indicate that dingo behaviour does not change throughout the year, but simply that the response to certain behavioural stimuli did not change. Dingoes did not respond more or less aggressively in any of the sampling seasons, which were the mating and breeding seasons, and the time when young dingoes were becoming independent. This indicates that these factors do not explain aggressive interactions between dingoes and people, as suggested by QPWS (1998a), and that these factors may not be the cause of the apparent peak of aggressive interactions during November-December (pers. comm. Haste 2000). Alternatively, the increase in aggressive incidents during this time may be a result of there being more tourists on the island at that time, and so increasing the likelihood of a dingo-human encounter. This was found in a study in the Jewel Basin Hiking Area, Montana (Mace and Waller 1996) where the number of bear-human interactions was directly related to the number of visitors to the area.

When a human moved towards a dingo or behaved aggressively in the presence of a dingo, the response of the dingo was usually to retreat or display submission. These two human behaviours may therefore reduce the likelihood of an aggressive dingo-human interaction, by causing the dingo to retreat. In most cases, the response of the dingo appeared to be a fright reaction, where it ran away immediately. Remaining still and quiet in the presence of a dingo was also found to reduce the likelihood of an aggressive response. Dingoes usually either did not respond to this human

behaviour, or moved away. Contrary to these findings, QPWS (1998b) literature advises that making fast movements and loud noises in the presence of a dingo may excite the dingo and hence lead to an attack. However, results are also supportive of QPWS (1998b) literature, which suggests that remaining still and quiet in the presence of a dingo may help to avoid an aggressive encounter. Without having measured variables such as human age, height and gender, it cannot be said whether dingoes would respond aggressively to the above human behaviours, given different human characteristics. This is a possible cause of discrepancy between results from this study, and QPWS literature.

When a person moved away from a dingo, there was a very good chance that the dingo would either become aggressive, or follow that person. Although a dingo moving towards a person cannot necessarily be interpreted as an aggressive act, the movement towards shows that the dingo is either excited or interested in that person. This is believed to precede most aggressive interactions between dingoes and humans on the island (QPWS 1998b). Therefore the trigger for a dingo to behave aggressively may not be movement, as suggested by QPWS (1998b) but more specifically, movement away from the dingo.

All human movements away from the dingo were performed whilst the human was also facing away from the dingo. In dingo-dingo interactions, staring is an aggressive act, often used to assert dominance. Subordinate dingoes will avoid making eye contact with dominant dingoes (Corbett 1995a). The reaction of the dingo to the human moving away may have been a response to the lack of eye contact, rather than the moving away. Further research into human-dingo interactions could be used to determine the response of dingoes to humans moving away whilst facing and not facing the dingo.

During April-May, adult dingoes were more likely to respond aggressively than were sub-adult dingoes. April-May is during the mating season, a time when adult dingoes are likely to be more defensive of their territories. As territories are defended with aggressive behaviour, adult dingoes would therefore be more likely

than sub-adult dingoes to respond aggressively to human behaviours at this time.

During July-August, female dingoes were less likely than males to respond aggressively when the human moved away from them, and more likely than males to respond aggressively when the human moved towards them. Pups are born in July-August, a time when adult females are thought to be more aggressive when threatened. At this time, female dingoes have been observed behaving more aggressively towards other dingoes, even dominant male dingoes (Corbett 1995a). This reflects in the fact that the female dingoes responded more aggressively than the males, only when the person moved towards them. The aggressive behaviour was likely to be a defensive response, used to protect pups.

Although dingoes most often retreated or behaved submissively when the person moved towards them or behaved aggressively, there were two cases (out of 63 dingoes) when the response was aggressive. The two dingoes that responded aggressively were adults (one male, one female) and most likely the dominant pair in their pack, evidenced by their stance, tail position and interactions with other dingoes. When threatened by other dingoes, dominant dingoes respond with aggression. These dominance and threat behaviours are used to maintain the social hierarchy within a pack. A returned threat often precedes serious fighting and wounding (Corbett 1995a). Therefore the dingoes that responded aggressively to the human moving towards them or behaving aggressively, were most likely asserting their dominance by returning the threat behaviour. This type of response could potentially lead to a serious attack by the dingo, as often occurs when threat behaviours are returned between dingoes. For this reason, it would be irresponsible to recommend that people always chase dingoes away, as certain dingoes may return the threat behaviour or even attack.

Unfortunately there is no absolutely correct way to behave in the presence of a dingo, as they are all individuals, and it is impossible to predict how each one will respond to each individual person. Although dingoes most often remained still or retreated when the human behaviour 'submission' was performed, situations have been recorded when the dingoes responded aggressively to this. Therefore

it is important that visitors to Fraser Island be taught to recognise dingo characteristics and behaviours, such as dominance and threat behaviours, which may increase the chance of an attack. This would enable visitors to make the best judgements as to how to behave in each situation.

The responses of each dingo were limited to one person only, who was an adult male. It has been suggested by rangers on Fraser Island (pers. comm. Ford 2000) that dingoes respond differently to individual people, and can be more confident with females and younger people. Therefore it cannot be assumed that the results of this study may be applied to all visitors to Fraser Island, though it may be a useful guide.

In a study of the behavioural responses of bears to humans, bears were found to flee during most encounters (Mace and Waller 1996), indicating some instinctive fear of people. This is similar to results from this study, in which dingoes were likely to retreat in most encounters. In the absence of habituation and food conditioning, dingoes are thought to be naturally wary of humans (Corbett 1998a). As mentioned in section 1.2.1, Herrero (1985) has identified a number of human behaviours that may decrease the chance of an attack by a bear. The most strongly recommended was 'playing dead' by remaining still and quiet, so that the bear would lose interest and move away. Similarly, dingoes were found to lose interest (moving away or not responding) when the human remained still and quiet in its presence. Herrero (1985) also suggested that running from a bear would usually increase the chance of a serious attack. Results from this study also indicate that a person should not run from a dingo, as the response of the dingo will most likely be to follow the person or to become aggressive.

Herrero (1985) also notes that human aggression directed at black bears is an effective means of causing bears to retreat. Running towards bears, as well as yelling and clapping the hands were all found to be effective methods of chasing away bears. This is again similar to the above results, where dingoes tended to either retreat or behave submissively when the human moved towards them or behaved aggressively.

The similarities found between the responses of bears and dingoes to humans may be related to the predatory nature of the two species. Though both species were found to flee most often when confronted by humans, they were also more likely to chase or attack a human running away from them, and were likely to lose interest in a person 'playing dead'.

5. CONCLUSIONS

The pattern of dingo behaviour on Fraser Island was found to be affected by human presence. Dingoes in areas with high levels of human use more actively searched for food and their behaviour was disturbed by people and vehicles. They appeared to have different movement patterns to dingoes in low human use environments, with less time spent resting. This differing pattern of behaviour represents that the dingoes are habituated to humans, and conditioned to human food sources.

Dingo behaviour was affected by human behaviour, with dingoes responding in predictable ways to certain human behaviours. Turning and moving away from a dingo was a trigger for an aggressive response by the dingo. Moving towards a dingo and making loud noises and fast movements preceded the dingo response of retreating or behaving submissively. A person remaining still and quiet in the presence of a dingo prompted the dingo to lose interest and/or move away. This knowledge could be used to educate visitors to Fraser Island on how to behave in the presence of dingoes.

Habituation of dingoes to people and human food sources appears to be the underlying cause of the observed changes to dingo behaviour, and may also be resulting in the aggressive responses of dingoes to certain human behaviours.

This is the first study to have quantitatively described dingo behaviour, and to have examined the effect of human presence and behaviour on dingo behaviour. If incorporated into education programs, information learned about human-dingo interactions could have the benefit of reducing the severity and number of dingo attacks on visitors to Fraser Island. This study will also contribute to knowledge of dingo behaviour, and how to observe and identify dingoes. A greater knowledge of dingo behaviour will enable more successful management of the dingo population on Fraser Island, and may contribute to the conservation of the species.

6. RECOMMENDATIONS

Dingo-human interactions have been a cause for concern for land managers on Fraser Island for a number of years. This study indicates that dingoes are habituated to human food sources, and are entering human areas in order to search for food. A number of locals in three townships on the island also indicated that the dingoes were viewed somewhat as pets, and it is likely that they are being fed. Current efforts to manage this issue include: visitor education, the removal of problem dingoes and attempts to keep human food sources out of reach of dingoes.

Managers should attempt to monitor what unnatural food sources are available to dingoes in the townships and resorts, so that action may be taken to remove it. This may include enforcing regulations regarding the direct and indirect feeding of dingoes on the island. Management should also focus on implementing the dingo incident survey on Fraser Island, in order to determine what associations there are between aggressive incidents and dingo characteristics. The survey should also be used to monitor the timing, location and frequency of aggressive incidents. With this information, visitors to Fraser Island could be educated as to what characteristics and factors to be aware of when encountering dingoes, in order to behave appropriately and reduce the likelihood or severity of an incident. Managers could also focus attention on particular sites and times when aggressive incidents frequently occur.

Education campaigns should continue to highlight the dangers of feeding dingoes, both directly by handouts and indirectly by not storing food and garbage appropriately. This should be directed at both locals and visitors to the island. Education programs should incorporate what has been learned in this study regarding the responses of dingoes to human behaviours. Visitors should be informed that moving towards a dingo, making loud aggressive noises, or remaining still and quiet in the presence of a dingo might help to avoid an aggressive interaction. Most importantly, literature provided to visitors of Fraser Island should advise that people do not turn and walk or run away from dingoes, as this may trigger an aggressive or excited response.

Future research should be used to identify the impacts of the observed changes to dingo behaviour, caused by human presence. The impacts on dingoes of changes to foraging behaviours and movement patterns should be examined. These might include changes to social interactions and impacts on dingo health and the health of prey populations. Further research should also aim to identify the impacts of the disturbance to dingo behaviour observed in areas of high human use. This disturbance may impact on other dingo behaviours, particularly foraging and social interactions. In order to successfully manage human-dingo interactions on Fraser Island, a more comprehensive description of dingo behaviour is required. Future behavioural research should be carried out with a larger and more representative sample size and observations should be made at all times of the day, and in a variety of environments on the island. So that the frequency and severity of aggressive human-dingo incidents on Fraser Island may be reduced, future research should also be used to further examine the responses of dingoes to human behaviours. Particularly, research should aim to determine the response of dingoes to human behaviours, when eye contact is maintained, and when it is not. Also, future research into human-dingo interactions should measure the effect of variables such as the age and gender of the person.

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APPENDIX A: DINGO INCIDENT SURVEY FORM

Dingo Incident Report Form

This form is to be completed by QPWS whenever a negative interaction with one or more dingoes is reported by a visitor or staff member on the island. Results will be used as part of a study on interactions between dingoes and visitors on Fraser Island, what causes them, when they are likely to occur, and how they can be avoided. Please try to fill in the form as accurately and completely as possible, and please request the assistance of the person reporting the incident in doing so.

Date:

Time (of incident):

Location (of incident):

Reporting Officer:

Question 1: What was the most severe action of the dingo/es during the incident? (**A** is the least severe, **C** is the most severe; please circle one letter only)

A. Following or advancing towards the person(s), or taking/damaging food or other objects

B. Baring teeth, snarling or lunging at the person(s)

C. Nipping (dingo's teeth make contact with skin, but skin is not broken) or biting (the skin is broken) the person

Question 2: Immediately prior to the incident, was the person(s) (circle one letter only):

A. Eating?

B. Feeding the dingo?

C. Otherwise trying to attract its attention?

D. Running?

E. Walking?

F. Sitting or standing still?

G. Other

Question 3: Immediately prior to the incident, was the person(s) (please circle one letter only, as above)

A. On land?

B. In water of > 30 cm depth?

C. In water of < 30 cm depth?

Question 4: Prior to the incident, was the person(s) (circle one letter only):

A. Making very little noise, not talking?

B. Talking at normal conversational volume?

C. Talking, yelling, screaming or laughing noisily?

D. Making other noise (please give details)

Question 5: What does the person(s) involved in the incident believe caused/initiated the incident?

_____

_____

_____

_____

_____

_____

Question 6 (QPWS Staff): Do you have any additional information or opinion about what might have caused the incident (please state why)?

_____

_____

_____

_____

_____

_____

Question 7: How or why did the dingo/es leave? (please circle one letter only)

A. Voluntarily, for no apparent reason?

B. When yelled at?

C. When chased away?

D. When yelled at and chased away?

E. When the person(s) stopped moving and making noise?

F. Other

_____

Question 8: How many people were present (within 10 m of the person(s) involved) prior to the incident occurring?

Question 9: How many of the people involved in the incident were:

< 10 yrs

10 yrs or more

Question 10: How many dingoes were present?

Question 11: How many dingoes were involved (actually interacted with or came into contact with any of the people) in the incident? _____

Question 12: How many of the dingoes **involved** in the incident were:
Male

Female

Question 13: How many of the dingoes involved in the incident were:
Adult

Sub-adult/Juvenile

Thank you for your time and assistance.

Please forward any inquiries or comments about this form or this research project to :-

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Thank You!

APPENDIX B: DESCRIPTIONS OF ALL OBSERVED DINGOES

SITE	NAME	SEX	AGE	SOCKS	TAIL TIP	CONDITION	NOTES
Ungowa	Gypsie	F	SA	FL: med-long FR: med HL: short HR:	No	Good, very few scars, shiny coat, ribs showing slightly	Black colour on tail, very playful, not shy of people, walk right into campsites and steals food and other objects. Campers see her about twice per day. **Dates observed:** 21-04, 11.30am., 06-08, 2.10pm **S 1** (April-May) **S 15** (July-August)
Lake Boomanjin Campground	Annie	F	SA	FL: short FR: short-med HL: HR:	No	Ribs are exposed, she looks weary	Was observed alone, has limp on right hind leg, tail held down between legs, black colour on tail **Dates observed:** 22-04, 11.40 am. S 3 (April-May)
Lake Boomanjin Campground	Madonna	F	SA	FL: short FR: short HL: short HR: short (toes only)	Yes	Seems good, but small frame	Black colour on tail and behind shoulders, no white or pale colour on face **Dates observed:** 27-04, 12pm **S 21** (April-May)
Lake Boomanjin Campground	Jane	F	A	FL: FR: HL: HR:		Very good condition, most likely dominant	Tail held up, perpendicular to ground, moved away before any reliable photos could be taken **Dates observed:** 27-04, 12pm **S 22** (April-May)
Lake Boomanjin Campground	Casper	M	A	No clear socks, legs mostly white (up to top joint)		Very good condition, most likely dominant	Tail held up, curled over back, face is white/pale in colour, scar at top of tail, moved away before any reliable photos could be taken **Dates observed:** 27-04, 12pm **S 23** (April-May)

SITE	NAME	SEX	AGE	SOCKS	TAIL TIP	CONDITION	NOTES
Lake Boomanjin Campground	Tina	F	A	FL: short FR: short-med HL: short HR: short-med	Yes (small)	Good condition, ribs just showing	White face, pale body colour, some black on spine and tail. Tail held up, perpendicular to ground, stays around the edge of the campground. **Dates observed:** 29-04, 4.45pm, 07-08, 5pm, 3-12, 4.30pm **S 19** (April-May) **S 13** (July-August), **S 7** (Nov-Dec)
Central Station	Rusty	M	SA	FL: short (toes only) FR: short-med HL: HR: short	Yes	Ribs showing, otherwise good, few scars	Scar on right hind leg, above top joint, dark colour on spine and tail, first seen entering the campsite from the bushes above the ranger barracks, then moved through the campsite towards the information centre. Seen in August moving along road leading from Central Station to barge/Ungowa., is rusty in colour **Dates observed:** 23-04, 8.30am, 04-08, 10.50am **S 2**(April-May), **S 12**(July-August)
Central Station	Jack	M	SA	FL: long FR: med HL: HR:			Black colour on spine and tail, seen on road leading into Central Station **Dates observed:** 23-04, 11am **S 4** (April-May)
Central Station	Mutley	M	SA	FL: short FR: med-long HL: HR:	Yes		Dark colour on spine, seen on Bennetts Rd, walking towards Central Stn, about 4km out. **Dates observed:** 24-04, 1.30pm **S 8** (April-May)

SITE	NAME	SEX	AGE	SOCKS	TAIL TIP	CONDITION	NOTES
Central Station	Jill	F	SA	FL: short-med FR: med HL: HR:	Yes	Ribs showing, small frame	Black colour on tail and shoulders, moving from above barracks, down and through the campsite, seen in August in day-use area, was eating food scraps, is quite timid **Dates observed:** 25-04, 11am, 02-08, 4.45pm **S 12** (April-May), **S 10** (July August)
Central Station	Matty	M	A	FL: short FR: short-med HL: HR:	Yes	Ribs are showing	Some dark on shoulders. Body is a pale sandy colour. Face is white. Tail is curled over back. The socks are not very clear as the legs are pale in colour. Black spot on tail. **Dates observed:** 8-12, 9.40am **S 24** (Nov-Dec)
Central Station	Kelly	F	A	FL: short FR: short HL: HR:	Yes (very small)	Excellent condition. Ribs hardly visible	Face is pale in colour. Body is also pale, sandy colour. Has no fear of people. Tail is curled over back. **Dates observed:** 9.12, 11.05am **S 25** (Nov-Dec)
Lake McKenzie	Ben	M	A	No clear socks, legs pale in colour	Yes (very small)	Good condition, very solid frame, heavily scarred, older looking	Face is very pale in colour, tail is held curled right over back, face is heavily scarred, big scar in right side of snout, seems very confident – probably the dominant male, has been seen by campers twice in the last three days, once in the morning and once in the afternoon, and once with a female. **Dates observed:** 23-04, 10.30am **S 5** (April-May)

SITE	NAME	SEX	AGE	SOCKS	TAIL TIP	CONDITION	NOTES
Lake McKenzie	Missy	F	SA	FL: med FR: short-med HL: HR:	Yes (small)	Ribs are showing	Black colour on tail, pale colour on face and body **Dates observed:** 03-08, 10.45am, 04-08 **S 11** (July-August)
Kingfisher Bay Resort Village	Sandra	F	A	No clear socks, legs pale in colour	Yes (very small)	Good condition	Black colour on tail, seen on road near Sand Bar, walking towards it **Dates observed:** 23-04, 5pm **S 6** (April-May)
Kingfisher Bay Resort Village	Two socks	F	A	FL: long FR: long HL: HR:	Yes (very small)		Face pale in colour, some black on tail and spine, seen on road near shop, walking towards beach **Dates observed:** 24-04, 10.30am **S 7** (April-May)
Kingfisher Bay Resort Village	Sandy	M	A	FL: long FR: long HL: HR:	Yes (very small)	Solid frame, ribs are just showing	Pale, sandy body colour, tail is held curled over back, very little amount of black on shoulders, face is very pale/white. Seen near the Sand Bar and on the beach. Face is heavily scarred. Socks are not very clear as legs are pale. **Dates observed:** 01-08, 2.30pm, 2-12, 3.05pm **S 8** (July-August), **S 5** (Nov-Dec)
Wanggoolba Creek Barge landing site	Heckyl	F	SA	FL: med-long FR: med HL: short HR: med	Yes	Ribs showing, thin looking, not many scars	Black colour on tail and shoulders/spine, body is a rusty colour, scar on front of nose and top inner corner of right eye **Dates observed:** 24-04, 3.30pm, 31-07, 4.45pm **S 9** (April-May), Sequence 6 (July-August)

SITE	NAME	SEX	AGE	SOCKS	TAIL TIP	CONDITION	NOTES
Wanggoolba Creek Barge landing site	Romeo	M	A	No clear socks, legs pale in colour	Yes (very small)	Very good condition, solid frame	This is the dominant male in the pack. He holds his tail up over his back, and is confident to move around and amongst people, although keeps his distance most of the time. Has a scar above left eye, and below right eye. Jagged scars along nose. Some black colour on spine and tail. **Dates observed:** 24-04, 4pm, 31-07, 4.30pm **S 10** (April-May), **S 4** (July-August)
Wanggoolba Creek Barge landing site	Juliet	F	A	No clear socks, legs are pale in colour	No	Good condition, coat looks healthy, body quite solid, but ribs are showing	Scar in front of left ear, and on snout and above left eye. Scar on front right leg above top joint. She is the dominant female. Romeo and Juliet stay close together, they rest together, almost touching, and walk around together. Some black colour on tail. **Dates observed:** 24-04, 4pm, 31-07, 4.30pm **S 11** (April-May), **S 5** (July-August)
Dilli Village	Roger	M	A	No clear socks, pale colour on legs	Yes (very small)	Very good condition	Tail is held curled right over back, scar at top of tail, scar above and below right eye, heavily scarred face, face is white in colour, seen resting off the edge of the campground, and also again at night nearby to people when cooking. **Dates observed:** 28-04, 10am

SITE	NAME	SEX	AGE	SOCKS	TAIL TIP	CONDITION	NOTES
Dilli Village	Val	F	A	No clear socks, pale colour to about middle leg joint – fades to sandy yellow colour	No	Very good condition	Approx. 2cm scar above the inside of left eye, some white colour on face (along snout), black spots on both sides of snout (where the whiskers are), seen resting off the edge of the campground in the bushes, and once walking along the road near the campground. **Dates observed:** 28-04, 10am. 29-04, 7.40am **S 1**6 (April-May)
Dilli Village	Reggie	M	A	FL: short FR: short-med HL: HR:		Good condition, not as big as Roger	Younger looking, some black colour on shoulders and tail, approaches cars and people, but runs away when approached Scar below left eye, black colour on shoulders and tail **Dates observed:** 29-04, 1pm, 29-07, 12.35pm **S 18** (April-May), **S 1** (July-August)
Dilli Village	B1	M	J	FL: short FR: med HL: short HR: short	No	Ribs are showing	Black tail, face, shoulders, spine. Body is dark in colour. **Dates observed:** 27-11, 4pm, 6-12, 5.30pm **Obs 1** (Nov-Dec) **S 6** (Nov-Dec)
Dilli Village	B2	M	J	FL: short FR: short HL: short - med HR: short	Yes	Ribs are showing	Black tail, face shoulders. Body is dark in colour. **Dates observed:** 27-11, 4pm, 6-12, 5.30pm **Obs 7** (Nov-Dec) **S 3** (Nov-Dec)

SITE	NAME	SEX	AGE	SOCKS	TAIL TIP	CONDITION	NOTES
Dilli Village	Dopey	M	J	FL: short FR: short HL: short HR: short	Yes		Black tail, face, shoulders. Body is dark in colour. Sock on front right tapers to a short-medium length on the inside. **Dates observed:** 7-12, 7am **S 17** (Nov-Dec)
Dilli Village	Babe	F	J	FL: short FR: short HL: short HR: short	No		Black tail, face, shoulders. Body is dark in colour. Both front socks taper up on the inside to a short-medium length. **Dates observed:** 7-12, 7am **S 18** (Nov-Dec)
Dilli Village	Mouse	M	J	FL: short FR: short-med HL: HR:	No		Black tail, face, shoulders. Body is dark in colour. **Dates observed:** 7-12, 7am **S 28** (Nov-Dec)
Cathedral Beach Resort	Emma	F	SA	FL: short FR: short HL: HR:	No	Good condition, ribs are showing	Dark colour on tail, tail held between legs, black mark on right side of snout, small scar on right cheek, seen at Cathedral Beach Resort wandering through campsites, was fed by campers, was seen travelling from the Maheno Wreck one hour earlier. **Dates observed:** 25-04, 3.45pm **S 13** (April-May)
Cathedral Beach Resort	Ringo	M	A	FL: short FR: short HL: short HR: short	Yes (very small)	Good condition	Black on shoulders, tail. Some scars on face and nose. Was followed from Maheno wreck to Cathedral Beach. Is well know by managers and campers at Cathedral Beach. Was with Drongo and another female. **Dates observed:** 4-12, 7.15am **S 10** (Nov-Dec) Obs 9 (Nov-Dec)

SITE	NAME	SEX	AGE	SOCKS	TAIL TIP	CONDITION	NOTES
Cathedral Beach Resort	Drongo	M	A	FL: long FR: med-long HL: short HR: short	Yes	Very good condition, few ribs are showing. Large frame	Body is sandy colour. **Dates observed:** 4-12, 7.30am **S 11** (Nov-Dec)
Cathedral Beach Resort	Lili	F	SA	FL: short-med FR: short HL: HR:	Yes (very small)	Good condition, some ribs are showing	Black spot on tail. Body is rusty in colour. **Dates observed:** 7-12, 1.50pm **S 19** (Nov-Dec)
Happy Valley	Janine	F	SA	FL: short - only on toes FR: short HL: short HR: short	No		Black colour on tail and shoulders, body is quite dark in colour, black spot either side of snout (where the whiskers are), approx. 3cm scar above and parallel to right eye, seen moving north along the beach, about 1km north of Happy Valley, 4km south of Eli Creek **Dates observed:** 28-04, 11.25 am. **S 25** (April-May)
Happy Valley	Tess	F	SA	FL: short - only on toes FR: short HL: short HR: short	No		Black colour on tail and shoulders, body is quite dark in colour (as above), black spot either side of snout (where the whiskers are), approx. 3cm scar above and parallel to right eye, seen moving north along the beach, about 1km north of Happy Valley, 4km south of Eli Creek **Dates observed:** 28-04, 11.25 am. **S 25** (April-May)

SITE	NAME	SEX	AGE	SOCKS	TAIL TIP	CONDITION	NOTES
Eli Creek	Bonnie	F	SA	FL: short-med FR: med HL: HR:	Yes (very small)	Good, average sized frame	Black colour on tail, white colour on face, tail held up, perpendicular to ground, and top curled forwards. Seen at Eli Creek, had moved south from the Maheno Wreck. This was a very game animal, was observed chasing children (when they turned to walk or run away from her) and came close to biting a young child before chased away by an adult, would run away when yelled at, stomped at or clapping noise made. **Dates observed:** 28-04, 11.45am **S 26** (April-May)
Eli Creek	Clyde	M	SA	FL: short FR: short HL: short HR: short	Yes	Good condition, no ribs showing	Black colour on tail, shoulders and spine. Face is pale in colour. Small scar on forehead between the eyes. This dingo travelled with the above female, the two were never more than about 5m apart, except amongst all the people, when they became separated (the female ran after a child, the male walked up into the bushes, then they both wandered around separately through the people for about 45 mins). He was also very confident with people, although did not appear to be actively chasing or playing with them as the female was. Seen in July without above female. Was at Eli Ck moving north. **Dates observed:** 28-04, 11.45am., 30-07, 2pm **S 27** (April-May), **S 3** (July-August)

SITE	NAME	SEX	AGE	SOCKS	TAIL TIP	CONDITION	NOTES
Happy Valley	Marge	F	A	FL: long FR: med HL: short (unclear) HR: short (unclear)	Yes (very small)	Good condition	Black colour on shoulders and tail, in August, was bony, ribs showing (had pups), face is pale in colour, seen 500m north of Happy Valley, was eating fish scraps (August) when seen, did not appear to be bothered by people approaching **Dates observed:** 30-04, 10.40am, 11-8, 11.00am, 29-11, 6.35 pm **S 20** (April-May), **S 24** (July-August) **Obs 4** (Nov-Dec)
Happy Valley	Bart	M	SA	FL: short FR: short HL: HR: short	Yes (very small)	Good, solid frame, some scars	Black colour on tail, shoulders and spine, scars on hind part of spine, scar above left eye, tail held horizontal, quite confident, approached to within 1 m of person (when person was standing still) with mouth open and teeth showing, legs and back were held straight and stiff, got very excited when the person ran away, the dingo ran/bounded towards the person, seen moving north about 500m north of Poyungan Rocks, and 5km south of Happy Valley in July, limp on right hind leg in July **Dates observed:** 01-05, 10.40am, 30-07, 11.20am **S 28** (April-May), **S 2** (July-August)

SITE	NAME	SEX	AGE	SOCKS	TAIL TIP	CONDITION	NOTES
Dundubara	Tramp	M	A	FL: short-med FR: short HL: HR:			Heavily scarred on legs and face, some dark colour on legs and tail, scars along nose, above both eyes, and on the inside of the right eye, was quite confident, returning to the person soon after running or walking away, did not run far away, seen moving north, about 100m south of Dundubara **Dates observed**: 01-05, 12 noon **S 29** (April-May)
Happy Valley	James	M	SA	FL: short FR: short HL: HR: short	No	Very solid frame, good condition	Body is dark rusty colour, black colour on tail and shoulders **Dates observed:** 08-08, 10.10am **S 18** (July-August)
Happy Valley	Jodi	F	J	FL: short FR: medium HL: HR:	Yes	Ribs showing	Black on tail, back, shoulders. Body is dark in colour. **Dates observed:** 29-11, 8am **Obs 3** (Nov-Dec)
Happy Valley	Rosy	F	A	FL: short-med FR: medium HL: HR:	No		Black colour on spine, tail. **Dates observed:** 6-12, 8.30am **S 13** (Nov-Dec)
Dundubara	Timmy	M	SA	FL: long FR: med HL: short HR:	Yes	Good condition, ribs are not showing	Black colour on shoulders and tail, body is a dark, rusty colour, was near a group of fishermen, we saw him dig up and eat some fish bones, was seen about 4km south of Dundubara **Dates observed:** 8-8, 5.25pm **S 19** (July-August)

SITE	NAME	SEX	AGE	SOCKS	TAIL TIP	CONDITION	NOTES
Eli Creek	Noodles	M	SA	FL: short FR: short HL: short HR: short-med	Yes	Good condition	Black colour on shoulders, tail and spine, body is dark rusty colour, quite confident and curious, came right up to the car, bark-growled at us, was hanging around near two fishermen, seen 1km south of Eli Creek **Dates observed:** 8-8, 5.40pm **S 20** (July-August)
Eastern Beach (6km north of Eurong)	Selma	F	A	FL: med-long FR: short-med HL: short-med HR: short	Yes (very small)	Ribs are showing, very thin	Black on shoulders and tail. Two scars on top of left ear. **Dates observed:** 30-11, 3.30pm **S 2** (Nov-Dec) **Obs 7** (Nov-Dec)
Eastern Beach (4km north of Eurong)	Simon	M	A	FL: med-long FR: short-med HL: HR:	Yes	Good condition	Black colour on shoulders and tail. Was sitting near fishers and trying to steal their bait. Sam was also with him, the two were seen together on two occasions. **Dates observed:** 1-12, 6.35am **Obs 9** (Nov-Dec) **S 1** (Nov-Dec)
Eastern Beach (north of Eurong)	Sam	M	SA	FL: long FR: med HL: none HR: none	No	Good condition (November)	Black colour on spine and tail, seen on the beach near Eurong. In November was seen with Simon, harassing fishers for bait. **Dates observed:** 09-08, 4.15pm, 30-11, 6pm **S 22** (July-August) **Obs 8** (Nov-Dec)

SITE	NAME	SEX	AGE	SOCKS	TAIL TIP	CONDITION	NOTES
Yidney Rocks	Toby	M	SA	FL: short FR: short HL: short HR:	Yes	Average, some ribs showing	Black colour on tail, shoulders, spine, Was eating fish scraps, appeared curious of the car, but did not approach too close, was seen on the Yidney Rocks Bypass **Dates observed:** 9-8, 1.45pm **S 21** (July-August)
Eurong	Socks	M	SA	FL: med-long FR: long HL: not clear, legs pale HR: not clear, legs pale	Yes	Good condition, ribs just showing, some scarring, solid frame	Black colour on shoulders, spine and along tail, body is quite dark (yellow-orange – rusty colour) in colour, scar on right hind leg, seen moving north along the beach, about 1.5km south of Cornwells Break Rd (north of Eurong). Seen in August on beach near Eurong **Dates observed:** 28-04, 10.50am, 02-08, 3.30pm, 6-12, 4.35pm **S 24** (April-May), **S 9** (July-August), **S 14** (Nov-Dec)
Eurong	Scooby	M	SA	FL: short FR: med HL: short HR:	Yes	Good condition, small frame, ribs not showing	Black colour on spine, tail, seen on the beach near Eurong, and on the inland road near Eurong. **Dates observed:** 30-7, 10.50am, 5-12, 7am **Obs 1** (July-August) **S 12** (Nov-Dec)
Eurong	Monte	M	SA	FL: med FR: long HL: HR:	Yes (very small)	Ribs are showing, poor condition, small frame (better condition in Nov-Dec)	Black colour on tail, spine and shoulders, confident around people, approaches them without caution, seen around the resort area **Dates observed:** 31-7, 5.35pm, 29-11, 6.35pm, 2-12, 9.45am **S 4** (Nov-Dec) **Obs 5** (Nov-Dec)

SITE	NAME	SEX	AGE	SOCKS	TAIL TIP	CONDITION	NOTES
Eurong	Cathy	F	A	FL: med-long FR: short-med HL: HR: short	Yes	Had had pups (July-August), small frame. In November, was in better condition	Was 'begging' for food outside bakery, Black colour on tail, shoulders, we followed her half-way along the road to Central Stn. Seen in November on the Eastern Beach, north of Eurong. Seen with pups on same road in November. Shwo was leading them into Eurong resort. She wasn't watching the pups very closely, and did not appear concerned when one was left behind. She was defensive when we were near the pups – bared teeth, tail curled over back. **Dates observed:** 01-8, 10.30am, 8-12, 6.50pm **S 23** (July-August), **S 21** (Nov-Dec)
Eurong	Ernie	M	SA	FL: short-med FR: med-long HL: HR:	Yes		Black spot on tail, black colour on spine, shoulders, no obvious scars, seen on beach near Eurong, curious of people, approached us. **Dates observed:** 07-08, 8.45am, 08-08, 09-08, 8.40am **S 16** (July-August)
Eurong	Bert	M	A	FL: long FR: med HL: HR:	Yes	Good	Black colour on spine and tail, avoids people, was with above male, they walked around together for the whole time we observed them, seen also the next day together **Dates observed:** 07-08, 9.30am, 08-08, 30-11, 7pm **S 17** (July-August) **Obs 6** (Nov-Dec)

SITE	NAME	SEX	AGE	SOCKS	TAIL TIP	CONDITION	NOTES
Eurong	Anna	F	SA	FL: short FR: short HL: HR:	Yes	Ribs and hips showing, small frame	Black on tail, shoulders and spine. **Dates observed:** 29-11, 6.30am **Obs 2** (Nov-Dec) **S 26** (Nov-Dec)
Eurong	Luke	M	A	FL: short FR: med HL: HR:	Yes	Large frame, good condition	Heavily scarred on face and body. **Dates observed:** 7-12, 10.15am, 7-12, 6pm **S 20** (Nov-Dec)
Eurong	Larry	M	J	FL: short FR: short HL: HR:	Yes		Dark colour, black on tail, face, back. Was with Cathy, who was leading juveniles into Eurong. **Dates observed:** 8-12, 6.50am **S 23** (Nov-Dec)
Eurong	Curly	M	J	FL: short FR: short HL: HR:	Yes		Dark colour, black on tail, face, back. Was with Cathy, who was leading juveniles into Eurong. Very shy. **Dates observed:** 8-12, 6.50am
Eurong	Lucy	F	J	FL: short FR: short HL: short HR: short	Yes		Dark colour, black on tail, face, back. Was with Cathy, who was leading juveniles into Eurong. **Dates observed:** 8-12, 6.50am
Eurong	Moe	M	J	FL: short (toes) FR: short HL: HR:	No		Dark colour, black on tail, face, back. Was with Cathy, who was leading juveniles into Eurong. **Dates observed:** 8-12, 6.50am **S 22** (Nov-Dec)

SITE	NAME	SEX	AGE	SOCKS	TAIL TIP	CONDITION	NOTES
Hook Pt	Vader	M	A	FL: med-long FR: med-long HL: HR:	Yes	Very good condition, solid frame, ribs not showing, heavily scarred though, most likely an older and dominant dingo	Tail is held curled up over back, was seen travelling north, about 3km from the barge landing, on the inland access road, face is pale in colour and is heavily scarred, one scar under left eye stands out. Travelling with Lena. **Dates observed:** 26-04, 10.45am (possibly seen again 05-08, 4.30pm), 3-12, 6.25pm **S 15** (April-May), **S 9** (Nov-Dec)
Hook Pt	Lena	F	SA	FL: med FR: med-long HL: HR: short	Yes	Ribs are showing, smaller frame	Black colour on tail, spine and shoulders, travelling with Vader (both trips), seen in April on access road, in August moving south along the beach, Was very curious of the car, ran from approx. 200m away right up to within 1m of us, walked right up to Justin when he got out of the car, and would not back away no matter what he did, she made him nervous and the sequence could not be completed. In November, was still curious and unweary of people. Becomes excited when people are nearby. Was seen with Vader again. When Vader arrived, she ran over to him, bowed her head, licked his face, then started playing with him (jumping up on him). **Dates observed:** 26-04, 10.45am, 05-08, 4.30pm, 3-12, 6pm **S 14** (April-May), **S 14** (July-August), **S 8** (Nov-Dec) **Obs 8** (Nov-Dec)

SITE	NAME	SEX	AGE	SOCKS	TAIL TIP	CONDITION	NOTES
Hook Pt	Yvonne	F	A	No clear socks, white colour extends to near top of legs (just above highest joints)	Yes (very small)	Very good condition, solid frame. In November was in poorer condition. Heavily scarred	Seen moving south along access road, about 4km from barge, scar below left eye, tail curled right over back, white face **Dates observed:** 29-04, 11.25am, 9-12, 2.20pm **S 17** (April-May), **S 27** (Nov-Dec)
Hook Pt	Tigger	M	J	FL: short FR: short HL: short HR: med	No		Black tail, shoulders, spine. Body dark in colour, brown/sandy. **Dates observed:** 27-11, 3.30pm, 6-12, 5.45pm **S 16** (Nov-Dec)
Waddy Pt	Lady	F	SA	FL: short FR: short No clear socks on hind legs	No	Ribs just showing, appears to be in pretty good condition	Black colour on shoulders and spine, was raining on the day observed, seen in the picnic area and around the campground and rangers quarters **Dates observed:** 01-05, 1.15pm **S 30** (April-May)

APPENDIX C: QUALITATIVE OBSERVATIONS OF DINGO BEHAVIOUR

Territories

Though dingo territories seemed to be fixed, with most individuals being observed in the same area on several occasions, there seemed to be some overlapping between individuals. This was observed most during April-May, a time when dingoes often redefine territories (pers comm Haste 2000). The dominant males of two separate packs were observed in the one location on separate occasions. Dominant dingoes were recognised by their dominance behaviours and postures when interacting with other dingoes. The dominant dingoes were also relatively large and in better condition compared to other dingoes in the pack. The longest distance a dingo was observed to travel was approximately 10km, over a period of three hours, along the eastern beach from the wreck of the Maheno to Cathedral Beach Resort. Another pack, including one adult male, one adult female and two sub-adult females, was followed 8km from the Wanggoolba Creek barge landing to Central Station. An individual female dingo was followed from Eurong, 9.5km to Central Station. Two particular dingoes, with a territory including the Eurong township and resort, did not appear to travel further than 500m beyond the boundaries of the township.

Interactions between dingoes

In approximately 100 sightings of dingoes, around 70 per cent of dingoes were observed alone, though there five pairs and three groups of dingoes repeatedly observed together. Two of these pairs consisted of young male dingoes, and three of the pairs consisted of a male and female. One group consisted of one male and three females, another of one male and two females, while another consisted of two males and one female.

Only one case of apparent aggression between dingoes was observed during the study, which involved two adult males. Though the incident was not clearly observed, the younger of the two dingoes suffered a number of cuts on the face and was displaced from a group

of three females. Two days later the four dingoes were seen together again. This incident occurred during May, the mating season.

On several occasions, younger or subordinate dingoes were observed displaying submission towards dominant dingoes. In two cases, a younger dingo moved towards the dominant male of the pack, before lowering its head and moving their tail from side to side, without raising it. On one occasion, a younger dingo approached a dominant dingo, before lowering their head, and then licking the face of the dominant dingo. In most cases, the dominant dingo appeared not to respond to the submission, except to remain still, with the head and tail held up. On one occasion the dominant dingo responded by moving away.

During November-December, interactions between juvenile dingoes and their mothers were observed. At this stage, the juveniles were approximately 2-3 months old and were becoming independent. When with pups and approached by people, the mother dingoes were defensive and were observed snarling at people on three occasions. When juveniles became separated from their mother, however, they were often left some distance behind.

Frequency, duration and nature of dingo behaviours

During the middle of the day, dingoes spent a large amount of time moving, whether it be walking, trotting or running. Often the movement appeared deliberate, with some destination, as the dingo would trot in the one direction without stopping, apart from for an occasional drink or scratch, for extended periods. It appeared common for dingoes to travel the entire length and width of their territories in a day. In a number of cases, there appeared to be some consistency in daily movements, where the individual dingoes or family groups, were found at the same places at the same times, on several different days.

When observed in areas where human use was concentrated, dingo movement patterns often appeared more random, with changes in direction frequent, and very little total distance travelled (i.e. distance from start to finish). The cause for this random movement appeared to be mostly a result of the dingoes searching for food, and in a

number of cases, reacting to people or vehicles. Dingoes appeared to sniff the ground and sniff food items much more frequently when in areas used by people. Their behaviour was also interrupted more frequently, by people and vehicles.

On very hot days, dingoes were often observed lying down under the shade of trees or bushes. On one rainy day, a dingo was observed lying down under a bush. During the day, particularly in areas where few people were present, dingoes spent a substantial amount of time lying down, often either resting (with eyes closed) or grooming.

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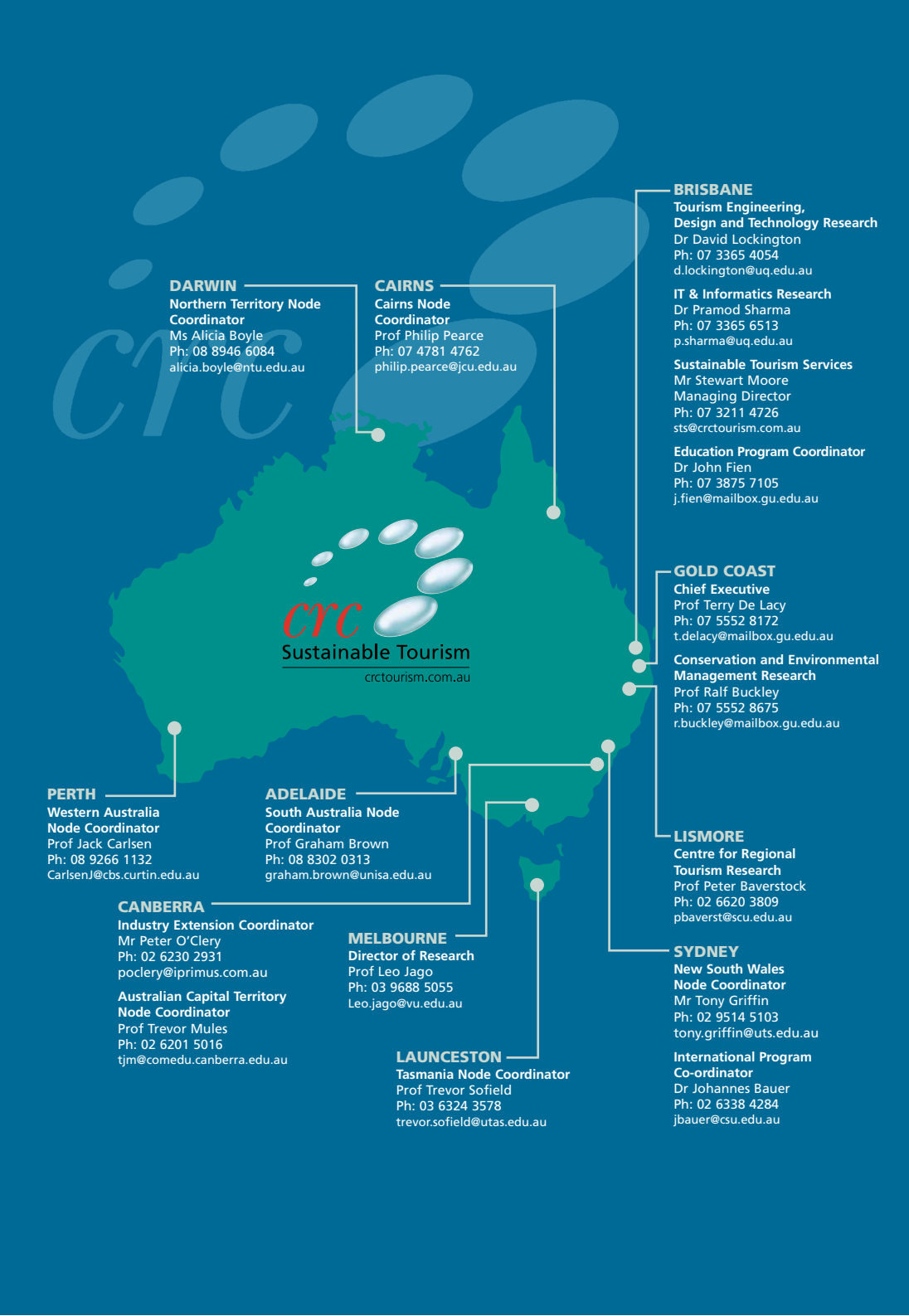

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