Movements And Hunting Activity of House Cats (Felis catus) Living Around Travis Wetland, Christchurch, New Zealand

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Frontispiece. Cat hunting at Travis Wetland

ABSTRACT

The Christchurch City Council is typical of local authorities in New Zealand concerned about the potential impact of house cat populations on conservation areas in urban environments. This thesis estimated the house cat population around Travis Wetland by a door knock survey in January–Feburary 2000. Prey selection of 88 of these cats was then assessed by having owners record the prey their cats retrieved over a 12-month period during November 1999-March 2001. The movements of 21 of the cats was monitored by radio telemetry from May 2000-March 2001.

The estimated population of house cats in a 196ha area of suburban housing around Travis Wetland was 494 cats, of which 170-260 may be visiting the wetland. Of the 21 cats radio tracked from this population, eleven (52%) are known to have visited the wetland. Cats living close to the wetland were more likely to visit the wetland than cats living further away.

Nine hundred and eighty one retrieved prey items were recorded by the cats' owners. These comprised 38% rodents, 19% exotic birds, 18% native skinks, 16% native insects, 6% exotic insects, 1% native birds and 2% other species such as frogs, goldfish and stoats. Predation appeared to be opportunistic and seasonal, with cats switching prey when availability changed. The mean number of prey items retrieved per cat per year was 11.5 ± 3.0 (SE). The number and type of prey retrieved was not significantly influenced by whether a cat was wearing a collar with a bell, cat gender, cat breed nor the number of times a cat was fed a day. Hunting activity was significantly affected by the age a cat was desexed, cat age and type of food fed to the cat. Cats that lived closer, traveled further and spent more time in the wetland were found to retrieve a greater diversity and number of prey, suggesting that the proximity of natural habitat had a significant influence on the hunting behaviour of these cats.

Home range sizes of the radio tracked cats (12 male, 9 female, all desexed) varied from 0.1ha-10.1ha. The maximum distance the cats moved from their homes varied from 29m-276m. Home ranges of cats living adjacent to the wetland tended to be skewed towards the wetland, which suggests that they were being attracted to it by prey availability. Cats mainly used the periphery of the wetland with the largest recorded movement into the wetland being 198m. Cat age, weather, distance of the cat's home to the wetland periphery and time of the day all influenced the movement of these cats.

In comparison with a similar Australian study where the density of the surrounding house cat population was nearly three times less, the home ranges and movements of house cats in this study were small, which supports the theory that cats living in high density populations tend to restrict their movements.

Further research is required to accurately quantify the impact of house cat predation and the maximum distance that house cats will travel from suburbs to natural adjacent habitat in New Zealand.

KEYWORDS: Conservation area, home range size, hunting behaviour, house cat, population density, predation, prey availability, prey selection, radio telemetry, wetlands.

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Chapter 1 Introduction

1.1 House Cats In New Zealand

House cats are the only felids found in the wild in New Zealand, having been introduced from 1769 onwards by early European explorers who kept cats on their ships to control rats (King 1990). They are not thought to have become feral in New Zealand until the early 1800s. In the late 1800s their feral distribution widened as they were released onto farmlands to help control rabbits. Feral cats now inhabit most of New Zealand and have proven able to colonise a range of habitats from mountains to sea level and urban to rural environments.

Due to its isolation, New Zealand has produced a high level of specially adapted, endemic flora and fauna. In the absence of mammalian predators many New Zealand birds evolved as ground dwelling or flightless with no defensive mechanisms against predators such as cats. Since human colonisation, extensive forest clearance and introduction of predators, New Zealand has suffered two waves of extinction (Diamond 1990 in Towns et al 1990). The first following Maori occupation where at least 32 species of large birds became totally extinct (King 1984), and the second, still occuring after European arrival (Diamond 1990 in Towns et al 1990). During early European colonisation seven species or subspecies of mainland birds suffered extinction or irreversible declines and from (1884-1984) 13 species or subspecies of birds are now rare, endangered or extinct (King 1984). Professor Diamond, a world-renowned ornithologist once stated "New Zealand no longer has a bird fauna - just the wreckage of one". On the main islands of New Zealand, the threats from introduced predators to the native avifauna are much less obvious and urgent now than they were 50-100 years ago, because most of the bird species vulnerable to predation have become extinct or confined to predator-free offshore islands (King 1984). Kakapo, black stilt, New Zealand dotterel, short-tailed and long-tailed bats, North Island brown kiwi and Otago skinks are all mainland threatened or vulnerable species still at risk from cat predation in New Zealand (King 1986) (Gillies 1998).

Until recently the focus of predator ecology and conservation in New Zealand has been almost exclusively on rural areas and predator-free offshore islands. Many species vulnerable to cat predation in New Zealand have already been translocated to offshore islands, but conservation managers in New Zealand still face the issue of protecting mainland biodiversity and species. Most studies investigating the ecology and impacts of cats in New Zealand (Fitzgerald & Karl 1979, Karl & Best 1982, Fitzgerald 1986, Fitzgerald 1988, Langham 1990, Fizgerald et al. 1991, Alterio & Moller 1998) and overseas (Mirmovith 1991, Page *et. al.* 1992, Tidemann *et. al.* 1994, Dickman 1996) have been on feral cats in rural areas. Only one previous study (Gillies 1988) has been undertaken in New Zealand on the ecological impacts of house cats near urban conservation areas.

Gilles concluded that domestic cats are indeed a significant conservation threat. He suggested it is important that where urban development encroaches on habitat containing native sensitive to cat predation householders should be encouraged not to own cats or at least informed of the threat their cats could pose to these species. Research conducted in Australia by David Barratt (1998) on domestic house cats in urban Canberra concluded that the ecological impacts of house cat predation will potentially be greatest in remnant habitat adjacent to housing development. He stated that new residential developments in particular could have an impact, as not only will new development influence the number of animals able to invade these habitats, but domestic house cats could contribute to the decline of populations already present.

As the results and implications of research overseas and in New Zealand on urban house cats living near conservation areas become understood, conservation organisations and wildlife managers in New Zealand are becoming more aware that domestic cats may be a management issue. Local authorities, ecologists, cat welfare groups, conservation organisations and some of the public in New Zealand have voiced a need for information on the predation impacts of domestic house cats and guidelines on how to manage urban cat populations. An area of particular concern in New Zealand is the building of new housing subdivisions next to ecological sensitive areas. The Thames-Coromandel District Council has been a leader among New Zealand local authorities for gaining successful consent of predator free subdivisions and the provision of "wildlife friendly" subdivisions in their district plan. Developers wanting to subdivide next to habitat supporting endangered and vulnerable species are encouraged to create cat or predator free subdivisions. (See Appendix 1.1 for cat and predator free subdivisions in New Zealand).

1.2 STUDY AREA

Travis Wetland in Burwood, Christchurch is one of many habitats in New Zealand that have been reduced to remnants by the encroachment of development (Plate 1.1). Travis Wetland is the largest (119ha) freshwater wetland remnant of its type left on the Canterbury Plains and one of only two freshwater urban wetlands left in New Zealand. It supports over 76% of all native wetland bird species that occur in lowland Canterbury and provides a refuge for over half of the total Christchurch pukeko population (Crossland 1996). Travis Wetland also provides occasional habitat for globally endangered birds such as the Australian bittern (*Botarus poiciloptilus*) and black stilt (*Himantopus novaezelandiae*) and contains rare and vulnerable plant species (Travis Wetland Landscape Development Plan 1998).

Plate 1.1. Encroachment of housing development on Travis Wetland.

1.3 RESEARCH OBJECTIVES

The general aim of this study was to determine the movement patterns and hunting activities of domestic cats at Travis Wetland.

There were 3 specific objectives in this study, and a chapter is devoted to each:

- To estimate the population of domestic cats living within foraging distance of Travis Wetland

- To measure the home range size of such cats and identify any seasonal and nocturnal/diurnal differences in home range size and wetland use

- To identify on a seasonal basis the chief prey items of domestic cats living adjacent to Travis Wetland

Chapter 2 Literature Review

2.1 Impacts And Benefits Of House Cats

Domestic cats are known to have caused bird extinctions world-wide (King 1986), but little quantitative information exists on their impacts on wildlife populations. As Fitzgerald (1984) suggests, it is relatively simple to identify the foods taken by cats, but much more difficult to tell if this predation is actually affecting prey populations. This is particularly so on continents, where the cat is usually just one of many predators. On islands there are fewer factors that might mask the role of the predators (Fitzgerald 1984). For example on the Galapagos Islands Konecny (1987) found feral cats to be the only predator present, eliminating any potential effects of competition on food choice.

The literature provides many contrasting results and opinions as to the impact domestic cats have on wildlife populations, suggesting both negative and positive impacts. The effect of house cats is thought to be particularly severe because house cat numbers are often kept artificially high by supplementary feeding (Coleman & Temple 1993) so that these cats can continue to exert heavy predation pressure until prey reach extremely low densities (Fitzgerald 1988). Unlike feral cats, house cats are often protected from disease and competition. Rapid reproduction of cats in urban areas contributes to the large number of stray cats put down every year in New Zealand and Australia. In Southern Illinois, house cats predate voles and other small mammals to such an extent they may leave insufficient prey for wintering hawks and falcons (George 1974). Cats contribute to the endangerment of bird populations such as least terns, piping plovers and loggerhead shrikes in America. In Florida, house cats have brought several unique species of mice and wood rats close to extinction and are threatening marsh rabbit populations (Coleman & Temple 2000).

Two studies of urban house cats in Australia have produced conflicting ideas. In Victoria Australia, on an average hectare of urban land there are two cats that will each eat eight birds a year. In most suburban areas only 20 birds hatch per hectare per year so it is likely that cats take most of the population (Paton 1991 in Dickman 1993). Yet Barratt (1998) in Canberra Australia suggests that house cat predation may not be a threat to wildlife populations in established urban areas as these species have already been able to persist through disturbance, adapted to coexisting with cats, and have access to supplemented food. Using the same mail survey method as Paton (1991 in Dickman 1993), Barratt (1998) found house cats in Canberra caught 23 mean prey items per year (compared with Paton's estimate of 31 prey items per year in Victoria). Barratt suggests it is likely that cats in his study had available only a fraction of the abundance and diversity of mammalian prey suggested to have been caught by cats in Paton's study (1991 in Dickman 1993). However Barratt also states that although most of the cats in his study caught relatively few prey, the impact of one or a small number of aggressive cats in an urban environment could mean the temporary exclusion of the breeding population of some species on a local scale. Both Paton (1991 in Dickman 1993) and Barratt (1997b) suggest that Australian wildlife may be especially susceptible to cats because many of the native mammals are nocturnal and cats are most active at dusk and dawn.

In Britain, Churcher & Lawton (1987) reported that house cats in the English village of Bedfordshire are responsible for somewhere between a third and a half of all sparrow deaths. From the mean annual catch of the village cats to the estimated total population of house cats in Britain, Churcher & Lawton (1987) estimated that around 70 million animals are killed by house cats a year in Britain and 30-50% may be birds.

Fitzgerald (1988), Barratt (1998), Gillies (1998) and others argue that interpreting predation levels by extrapolating data from small study areas as did Churcher & Lawton (1987) is likely to be unrepresentative of predation through the wider house cat population due to variations in habitat. For example, Fitzgerald (1988) found cats living in cities catch fewer animals and a lower range of prey than cats living on the outskirts of cities.

Cats also have indirect impacts on wildlife populations. A reduction in bird populations by cats could mean a reduction in pollination of plants and an increase in garden pests such as caterpillars and aphids (Stewart 1997). Barratt (1998) suggests that if house cats were able to control populations of introduced birds species such as starlings, less-aggressive native species would benefit, but notes that such effects of house cats on interspecific competition have been largely ignored.

Cats carry a number of diseases including - ringworm, hookworms and toxoplasmosis that can infect other cats, wild animals and humans (Proulx 1988). Approximately 4,500 human babies are born annually in the United States with congenital toxoplasmosis, which can cause lesions, visual, auditory, neurological, and intellectual impairment (Warefield & Gay 1986 in Proulx 1988). In New Zealand, cats are vectors of toxoplasmosis and *Sarcocystis* spp. Feral cats carrying toxoplasmosis have been known to cause abortion in sheep (Collins & Charleston 1979 in Fitzgerald *et al.* 1984) and *Sarcocystis* spp is a parasite of economic importance in New Zealand as it produces visible sarcocysts in the muscles of sheep that can mean the condemnation of the carcase at the abattoir (Kim Morgan pers. comm.). Cats are also a factor in the spread of asthma in humans; a protein called Fel d 1 is produced in the cat's skin and even brief exposure to this allergen can trigger an acute asthma attack in some individuals (Custovic 1998).

To help negate the impacts and problems of house cats, local bodies in parts of Australia and the USA have begun to impose controls on such cats. Cities such as Melbourne have imposed bylaws to confine cats at night (Richards 1994). These bylaws also require cats to be desexed and identified by a collar, microchip or tattoo. In Hawaii, leglisation exists making animal abandonment a crime, and neutering and identification compulsory. San Mateo County, California, runs a cat education campaign, provides low cost neutering, and has legislation requiring compulsory licensing, neutering of outdoor cats and rabies inoculation. In New Zealand the Royal Forest & Bird Protection Society have recently drafted New Zealand's first cat management policy (Appendix 2.1) and are encouraging housing subdivisions next to ecologically sensitive areas in New Zealand to be cat free. Other organisations in New Zealand, such as the Hokitika SPCA, advocate more intensive control of cats (Karli Thomas pers. comm.).

Cat predation of pest species is encouraged by humans. Cats can help suppress populations of other damaging predators such as rats and thus allow denser populations of birds than would exist without them (Fitzgerald 1988). In a study of the diet of cats on Christmas Island in the Indian Ocean, researchers concluded that cats were beneficial in stablising the numbers of (*Rattus rattus*), which were serious predators of ground nesting birds on the island (Tidemann et al. 1994). Elton (1953) showed that, if existing infestations of Norway Rats (*Rattus norvegicus*) in farm buildings were exterminated, domestic cats could prevent reinfestation of the buildings (Fitzgerald 1988). Consequenlty there has been concern in New Zealand that if cats are removed wildlife may not benefit and may even suffer. Veitch (1997) has argued that if cats are removed then this results in more rats preying on remaining birds, more rats and mice as food for stoats and more rabbits as food for ferrets. These predators will then continue to eat birds whenever the opportunity occurs. When cats were removed in the Orongorongo Valley, Wellington rat numbers increased (Fitzgerald & Karl 1979).

Cats provide other benefits by bringing pleasure, company and comfort to humans. Cats are company for many older people and are New Zealand's most popular companion animal (SPCA 2000). Cats also provide human health benefits; research in the School of Social Medicine at the University of Birmingham, England has demonstrated that stroking a purring cat reduces their owner's blood pressure (Jarvis 1990). The Burwood hospital spinal unit in Christchurch, New Zealand keeps a cat as therapy for it patients (Plate 2.1). Australian 'national people and pets' survey in 1994 found that dog and cat owners make fewer visits to the doctor and keep better health than non pet owners (Humphries 2001). These social aspects of cats are rarely mentioned in ecological research on house cats.

Plate 2.1. 'Alfy' the Burwood hospital spinal unit cat comforts a patient.

2.2 METHODOLOGIES FOR INVESTIGATING CAT IMPACTS

Mounting concern about the impacts house cats may be having on native wildlife has prompted research to provide more information on the general ecology and hunting behaviour of house cats. Without knowing about the natural mortality and breeding success of prey populations it is hard to quantify the effects of cat predation (Gillies 1998). Fitzgerald (1984) states research done so far in New Zealand usually only provides a partial answer; in most cases we do not know how general the finding is, and if it applies to other localities or habitats. Nevertheless Gillies (1998) suggests surveys of the prey brought home by urban house cats will help in illustrating the potential amount of prey house cats can take in New Zealand.

Surveys of cat owners have been conducted in Australia (Paton 1991 in Dickman 1993, Reark Research 1994, Reid & Speare 1995, Barratt 1998), America (Coleman & Temple 1993), United Kingdom (Churcher & Lawton 1987, Woods 2001) and in New Zealand (Gillies 1998) to assess the numbers and types of prey caught by cats, and owners attitudes towards their cat and cat management practices.

Different methods used to survey cat owners have been by mail (Paton 1991 in Dickman 1993, Coleman & Temple 1993), doorknock (Churcher & Lawton 1987), doorknock and mail (Barratt 1998, Gillies 1998, Reid & Speare 1995) and telephone (Reark Research 1994). Each method has associated error and bias that needs to be considered when regarding the results and conclusions of these authors, which is often something the media and readers overlook.

Paton (1991 in Dickman 1993) surveyed school students and members of bird watching clubs by mail in Adelaide, Australia and concluded that 31 animals were being killed per cat per year in Adelaide and around 60 million vertebrates annually in New South Wales. It has been argued by Newby (1997) that Paton's findings are over-estimated and biased. Newby (1997) suggests respondents from bird watching clubs are likely to be biased and live in areas where there are a disproportionately high numbers of birds. This bias may also be evident in the study by Barratt (1998) who also surveyed people from bird watching, wildlife and environmental groups to assess the prey brought home by their cats.

Coleman & Temple (1993) also used a mail questionnaire to survey rural residents living in Wisconsin, America, to determine their attitudes toward their cat(s), the number of cats on their properties and factors that may affect cat density. Farm residents were found to have a greater number of cats on their properties and were more likely to keep cats for pest control than were non- farm rural residents. When residents were asked whether they would be willing to reduce the number of cats on their property to benefit wildlife, 38% of farmers and 59 % of non-farmers said yes, yet only 12% of farmers and 22% of non-farmers in the survey had their cats desexed. Coleman & Temple (1993) suggested the attitude of farmers and other rural residents toward cats could affect wildlife populations, as large populations of rural cats could pose a threat to some wildlife populations. The conclusions and estimates made by Coleman & Temple (1993) may be more accurate than other house cats surveys as bias was minimised through efforts to reduce the non-response rate.

Several studies have surveyed cat owners to determine the prey taken by their cats and whether they would participate in recording the prey brought home by their cats. These authors assume that the prey brought home by cats is actually representative of the prey these cats take. It has been suggested by George (1974) that house cats bring home only 50% of what they actually catch, meaning predation figures quoted by Churcher & Lawton (1987), Barratt (1998) and Gillies (1998) may underestimate the actual catch of these cats. There is also the assumption that cat owners are equally interested, observant and accurate at recording the prey brought home by their cats. Barratt (1998) found that some participants in his study were not good at determining the amount of prey their cats actually caught. The amount of prey that owners estimated their cats caught prior to commencement of the study was more than double the amount of prey actually caught during the study period. Under-or-over reporting could also be a problem in telephone surveys of cat owners (Reark Research 1994). Unlike a mail survey, people are required to answer quickly during a door knock or telephone survey. Given more time to think people may answer a question more accurately. Hand-delivering a return-by-post questionnaire (Gillies 1998) and surveying face to face (Churcher & Lawton 1987; Barratt (1998) may achieve a more accurate and greater response rate. Contacting cat owners and asking them to record the prey brought home by their cats may have the advantage of reducing the error of owners responding in an untruthful way. Getting people to collect and identify prey eliminates the error of people incorrectly recalling how much prey their cat brings home.

Gillies (1998) and Barratt (1998) both extrapolated from their survey data to make predation estimates for a wider city. Gillies (1998) estimated that house cats in Auckland per year take 170,663 sparrows, 83,025 waxeyes, 2306 kereru and 4613 tui, 1,199,250 rodents and 9225 stoats. Barratt (1998) estimated that between 380,000 and 630,000 animals are taken per year by cats in Canberra. As Fitzgerald (1990), Jarvis (1990), Churcher & Lawton (1987) Barratt (1998) and Gillies (1998) state, caution should be taken when extrapolating predation estimates from survey data in this way. Extrapolating data does not account for differences in seasonal variation in prey, prey type and abundance, climatic conditions, habitat type, cat densities, and differences in cat management (Barratt 1998). Although predation estimates are subject to error, Gillies (1998) argues they are nevertheless useful in assessing the potential number of prey taken by house cats in a local area.

Although authors have used different methods to survey cat owners about the hunting habits of their cats, there are some consistent results. Barratt's (1998) survey in Canberra, and a telephone survey conducted of urban house cats in several Australian cities (Reark Research 1994), both found that there were a high proportion of cats desexed. Barratt (1998) found 98% of cats in his study were desexed and Reark Research (1984) found that 88% of cats were desexed. Both studies also found that cats confined to the house at night caught less prey. The amount of prey caught by cats was not significantly reduced by wearing a collar with a bell (Paton 1991 in Dickman 1993, Reark Research 1994, Reid & Speare 1995, Barratt 1998 and Gillies 1998) and that in some cases hunting tended to be higher among cats that wore bells. Cat age (Churcher & Lawton 1987, Barratt 1998, Gillies 1998), position of the cat's home in the study area (Churcher & Lawton 1987, Barratt 1998) and cat density (Churcher & Lawton 1987, Barratt 1998) were all found by the authors to significantly affect hunting.

Surveys of cat owners have also been used to determine the level of public support for cat management plans. Reid & Speare (1995) conducted a questionnaire survey of residents on Magnetic Island, Townsville, Australia, to determine their support for such a plan. Residents were mostly in favor of a cat management plan although cat owners were less in favor. The most common reason residents gave for their support was to protect wildlife on the island. The majority of residents (60%) said they had noticed no decline in wildlife while 40% thought there had been a decline in at least one species and 85% felt their cats had no impact on the natural environment. The least support given by residents was to confining cats on the owner's property at night and not feeding stray cats. Over half of the cats (54%) were recorded as having caught something in the month prior to the survey, although only 31% considered their cats as hunters. This could be another source of error in the survey, as a lack of will by owners to consider their cats as hunters may mean they ignore or are less observant to the prey brought home by their cats and therefore may not record a correct estimate on the questionnaire.

Kennedy (2000) surveyed 61 households in urban Christchurch, New Zealand, to determine whether having an awareness of house cat impacts on urban wildlife influences whether cat owners comply with cat controls. Findings from the survey supported Kennedy's (2000) hypothesis that people with a higher awareness of domestic cat impacts on wildlife are more likely to comply with a hypothetical cat control by-law in Christchurch. Kennedy (2000) suggests increasing public awareness of cat impacts would be expected to improve public sympathy and compliance with legal cat control measures.

2.3 CAT HUNTING BEHAVIOUR

The house cat *Felis catus* (Linnaeus 1758) is a carnivorous mammal belonging to the family Felidae. Despite being domesticated and kept as pets, house cats are often opportunistic hunters and scavengers outside of the home. House cats have sensitive hearing and specialised sight allowing them to become successful predators. Cats can hear sounds vibrating up to 100,000 cycles per second (cps) while humans can only hear sounds vibrating up to 20,000 cps (Fogle 1991). Their night and binocular vision are excellent giving them the ability to focus on prey in reduced light and see even the slightest movements.

Most domestic cats fed by humans have a dependable food supply, but this feeding does not suppress the desire to hunt and kill live prey (Leyhausen 1979, Liberg 1984). Leyhausen found prey killing and consumption to be relatively independent of hunger. These cats evolved as opportunistic hunters of small rodents and are adapted to hunting frequently for small meals (Turner & Meister 1988). Consequently, house cats can be observed hunting even after a full meal of meat. Supplementary feeding of a house cat is thought to reduce the motivation and time spent hunting but does not eliminate it.

House cats are thought to be able to hunt just as effectively as feral cats (Coleman & Temple 1993). Both in Southern Sweden (Liberg 1984) and in New Zealand (Gillies 1998) the diets of domestic and feral cats were found to be very similar. Fitzgerald (1988) in a review of the quantitative studies of house and feral cats concluded they are both generalist predators, exploiting a wide range of prey and able to switch readily from one prey to another.

House cats are obligate carnivores, with each individual requiring a minimum of 100-150g of protein each day, more if a female is nursing a litter (Australian Department of Conservation and Natural Resources 1992). Research worldwide suggests house cats show a preference for small mammals but will become generalist predators if other prey are available (Fitzgerald 1988, Turner & Meister 1988, Gillies 1998). Consequently, both domestic and feral cats are a potential threat to native wildlife populations.

There have been very few studies of the hunting activities and prey of urban house cats worldwide and only one published study in New Zealand (Gillies 1998) (See Table 2.1). Churcher & Lawton (1989) commented that the lack of studies on urban house cats is not surprising given that the most common method of examining a cats diet has been through droppings or gut contents which requires dead cats. The few recent studies of urban house cats (e.g. Barratt 1998 and Gillies 1998) used similar methods to Churcher & Lawton (1987) who recruited cat owners into the study to record the prey their cats brought home. One of the main findings from this work has been that the amount of prey caught by house cats is significantly less than that of feral cats (Liberg 1984, Churcher & Lawton 1987, Fitzgerald 1988, Barratt 1998, Gillies 1998). Turner & Meister (1988) suggested supplementary feeding of a house cat reduces its motivation to hunt, as house cats usually hunt for no more than a quarter of each day whereas a feral cat will spend 12 out of 24 hours hunting. Well-fed cats may hunt less seriously, resulting in fewer kills, or might kill as frequently but consume little or none of its prey (Bradshaw 1992).

An important point that came out of a 7-year study of 30 house cats (Leyhausen 1979), was that hungry cats displayed the same catching, killing and play behaviours as well fed. The desire to kill by these cats always outweighed their hunger. The same has been found by Adamec (1976) and Kuo (1931) in Leyhausen (1979). Although Leyhausen (1979) found hunger does not appear to influence predatory behaviour Adamec (1976) found some evidence to suggest appetite does. When highly palatable food (salmon) was offered to cats, hunting was sometimes inhibited (Adamec 1976). Biben (1979) found that while cats will engage in predatory behaviour whether hungry or not, the tendency to kill does increase with hunger. It may be that well-fed cats still hunt due to a desire for variety in their diet (Bradshaw 1992, Fogle 1991), or that some kills are for play and practice (Neville 1992). Neville (1992) suggests the instinctive drives that have evolved in the cat's development as a predator are so specialised that, even though they are no longer used for the original function of enabling the cat to survive, they are still used. Predatory aggression, grasping and killing prey are all instinctive behaviours. If a certain part of the brain, the naterolateral part of the hypothalmaus is electrically stimulated, cats perform the death bite on whatever is available (Fogle 1991). Nevertheless research with kittens found that play involving predatory motor patterns, the bringing of live prey back to the nest by the mother, and observation of the mothers predatory behaviour all influenced how effective a predator the kitten will become (Bradshaw 1992).

Although house cats take fewer prey than feral cats, Liberg (1984) and Gillies (1998) found their diets to be similar. The diet of house and feral cats on farmland in Southern Sweden were broadly similar, although house cats ate more household food and less rabbits (Liberg 1984). Gillies (1998) found waxeyes were an important prey species for urban house cats in Auckland and also for feral cats in the Orongorongo Valley, Hawkes Bay, Herekopare Island and Stewart Island in New Zealand. Gillies (1998) concluded that house cats are not substantially different from their feral counterparts in the prey they take, the main difference being that domestic cats do not need to hunt to survive.

Table 2.1. Previous studies of prey selection of house cats in different environments.

Author (s)	Date	Locality	Subject	Method
Ebernard	1954	Suburban/rural Pennsylvania	Food habits of house cats	Gut and scat collection
George	1974	Rural Illinois	Domestic cats as predators of raptors	Prey collection
Liberg	1984	Rural Sweden	Food habits and prey impact by feral and house cats	Scat collection
Childs	1986	Suburban Baltimore	Size dependant predation on rats	Prey collection
Churcher & Lawton	1987	Suburban England	Predation by domestic cats	Prey collection
Trueman	1990	Hobart, Tasmania	Impact of domestic cats on wildlife	Prey collection
Paton	1991	Suburban/rural Adelaide	Loss of wildlife to domestic cats	Mail survey
Carss	1995	Rural Scotland	Prey of two domestic cats	Prey collection
Barratt	1995	Suburban Canberra	Predation by house cats	Prey collection
Gillies	1998	Suburban Auckland	Prey species of house cats	Prey collection
Woods et al.	2001	Suburban/rural Great Britain	Predation of wildlife by domestic cats	Prey recording

Both house and feral cats are generally considered to be successful hunters (Fogle 1991). In a review of studies of the hunting behaviour of domestic cats (Turner & Meister 1988) found that one out of every two to four pounces made by a house cat captures prey and that between 40% and 65% of feral cats have identifiable prey in their stomachs. The hunting success of a domestic cat depends on the predator defense mechanisms of its prey (Turner & Meister 1988), the size and difficulty of its prey (Biben 1979, Childs 1986) and prey availability (Liberg 1984). When rodents were at high densities in autumn in Sweden cats took an average 40 minutes for a successful capture; at low density in summer they took 70 minutes. Some cats are better hunters than others. Baerends-Van Roon & Baerends (1979) found most cats to be capable of catching mice, although some caught more than others. They suggested there were motivational differences between individuals or classes rather than differences in ability.

In a review of quantitative studies of feral and house cat diets, Fitzgerald (1988) concluded that mammals are the prey found most often (in 50 to 90 % of gut and scat analyses). Mammals are clearly the most important prey of feral cats in New Zealand (Fitzgerald & Karl 1979, Karl & Best 1982, Fitzgerald 1988, Fitzgerald *et al.* 1991, King *et al.* 1996, Alterio & Moller 1997). On continental land areas, birds are less important prey than mammals (birds occur in 21% of guts and scats while mammals occur in 68%) whereas on islands birds are more important (occuring in 51% of guts; Fitzgerald 1988). On continents, passerine birds were the most commonly taken bird group and on smaller oceanic islands seabirds were most commonly taken. Passerine birds are the most commonly taken bird group by cats in New Zealand studies (Fitzgerald & Karl 1979, Langham 1990, Fitzgerald *et al.* 1991, King *et al.* 1996, Gillies 1998). Reptiles are also major prey of cats both on continents and on islands (Fitzgerald 1988). In cat populations at latitudes below 35° reptiles are usually found in more than 20% of guts, whereas above 40° reptiles are found in no more than 10% of guts. Fitzgerald states there is not enough information to determine whether this reflects a difference in the cats' behaviour or merely a difference in reptile abundance between continents. Frogs, fish and invertebrates are also recorded in cat dietary studies (invertebrates frequently and frogs and fish rarely).

Barratt's (1997a) study of urban house cats in Canberra, Australia, found rats (*Rattus rattus*) and mice (*Mus domesticus*) were the most commonly caught prey species. In Auckland New Zealand, rats (*Rattus spp*) and mice (*Mus musculus*) and invertebrates were the most commonly caught prey (Gillies 1998). Sparrows (*Passer domesticus*) and waxeyes (*Zosterops lateralis*) were the most common bird species taken in both studies. Crickets (*Teleogryllus commodus*) lepidopterans and cicadas (Cicadidae) were the most common invertebrate prey caught by house cats in Auckland (Gillies 1998). Skinks were the most common of the reptile species caught in Canberra. Reptiles comprised 7% and amphibians 1% of the total prey taken by house cats in Canberra. Other species caught by house cats in Canberra were bats (*Petarus fuscipes*) and brushtail possums (*Trichosurus vulpecula*). In Auckland the most common lizards caught were skinks. Amphibian species were recorded in the Auckland survey (*Litoria* spp). Reptiles comprised 8% of the total prey taken by house cats in Auckland and amphibians 0.1%. Other species taken by cats in Auckland were stoats (*Mustela erminea*), rabbits (*Oryctolagus cuniculus*) and hedgehogs (*Erinaceus europaeus*).

2.4 CAT MOVEMENTS

While much literature exists on the spatial behaviour of semi-feral and feral cats worldwide, little is published on the movements of urban house cats. In Australia over the last 10 years there has been growing concern over the movement of urban house cats into ecologically sensitive areas. Barratt (1997b) provides the best study on this issue, with insight into the movements and habitat use of urban house cats living adjacent to a remnant woodland/forest habitat in Canberra, Australia.

Barratt found 60% of the house cats he studied moved from their homes into surrounding woodland/forest habitat. Home range size and movements of these cats were highly variable. This is consistent with research on house cats in rural Sweden (Liberg 1980) and urban England (Bradshaw 1992); semi-feral cats in Switzerland (Turner & Mertens 1986); and feral cats worldwide (Izawa *et al.*1992, Fitzgerald & Karl 1996, Page *et al.* 1992, Gillies 1998, Alterio & Moller 1999).

Liberg & Sandell (1988), in a review of studies on the spatial organisation of domestic cats, suggest population density is a factor affecting the way in which domestic cats space themselves. Domestic cats, like all species of wild felids, decrease their home range size with increasing population density (Bradshaw 1992; See Figure 1). For example the home ranges of a dense population of female feral cats in urban Japan were small (0.1-1.8 ha; Izawa et al.1982), while on New Zealand farmland where the density of cats was low home ranges were larger (154 ha; Langham & Porter 1991).

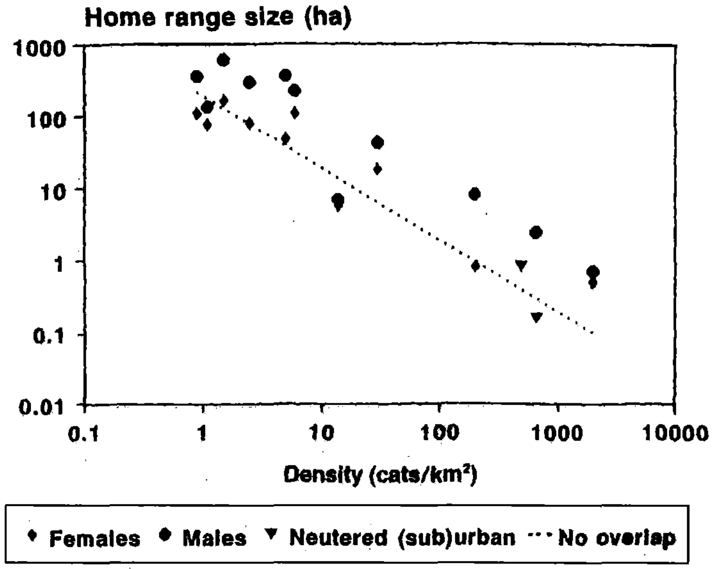


Figure 2.1. The relationship between home range size and cat density, for entire males, females and neuters. (from Bradshaw 1992).

Barratt found no statistically significant effect of gender on home range size although range size tended to be larger for males than females. This statistically non-significant trend was also found by Turner & Mertens (1986), Konecny (1987), Izawa *et al.* (1982), Fitzgerald & Karl (1986), Langham & Porter (1991), Langham (1992), Dowding (1997) and Gilles (1998). As males compete for access to females, the main factor determining male range size is female density and distribution, therefore male ranges generally will be larger than female ranges (Liberg & Sandell 1988). The main factors affecting female range size are food abundance and distribution (Turner & Mertens 1986, Bradshaw 1992). Liberg & Sandell (1988) have concluded that the smallest female ranges are found in urban feral populations that subsist on rich clumped food resources, intermediate ranges in farm cats and the largest ranges by feral cats living on dispersed natural prey.

House cats in Barratt's study had larger nocturnal home ranges and movements than diurnal. Mean nocturnal home range size for the cats was 7.89ha while mean diurnal range size was only 2.73ha. Several other studies of feral cat movements (Izawa et al. 1992, Langham & Porter 1991, Page *et al.* 1992, Alterio & Moller 1997) also report greater nocturnal activity and movement than diurnal. However some research (Langham 1992, Alterio & Moller 1997) on feral cats in New Zealand and overseas (George 1974) has found some individuals to be more active during the day than at night. Alterio & Moller (1997) found cats in New Zealand coastal grassland were moderately active in autumn and spring during the day. Langham (1992) found females denning in barns on New Zealand farmland to be more active during the day in spring and summer when rearing kittens and that cats denning in swamp and willows were active over an entire 24hr period during autumn to winter. Semi-dependant farm cats in Illinois, were found to hunt more around midday in winter (George 1974). Turner & Meister (1988) believe there has been an increase in the diurnal activity of house cats due to domestication and the provision of food by people.

Cats in New Zealand that are diurnally active pose a threat to diurnal native species (Alterio & Moller 1997). Several studies conducted in New Zealand (Langham & Porter 1991, Langham 1992, Alterio & Moller 1997) show that feral cats can be moderately active during the day although are mainly active at night. Species such as skinks may be particularly at risk from predation by such cats due to their high level of diurnal activity. Both Baker (1989) and Middlemiss (1995) (in Alterio & Moller 1997) found cats to be the most important mammalian predators of giant skinks (*Leiolopisma otagense* McCann and *L. grande* Gray). As cats are most active at night in New Zealand, nocturnal insects and lizards are also vulnerable to their predation (Alterio & Moller 1997). House cats may also pose a threat, as domestication has modified the behavioural adaptations, leading to increased diurnal activity coinciding with the daytime provision of food by people (Turner & Meister 1988). Investigating the activity patterns of house cats is thought to be one way of determining their risk on endemic biota (Langham 1992).

Differences in activity patterns appear to depend on the sex of the cat, supplementary feeding, social status and seasons (Liberg & Sandell 1988, Langham 1992, Bradshaw 1992, Barratt 1995a, Alterio & Moller 1997).

Barratt reported large home ranges were not exclusive to non-desexed cats. The nocturnal home range of one intact male was relatively large, but one desexed male and one desexed female had nocturnal home ranges of a similar size. Both Leyhausen (1988) and Page *et al.* (1992) suggest more dominant and aggressive domestic cats will maintain larger ranges than subordinate cats, though subordinate animals may still fiercely defend their territories. Barratt suggested the presence of surrounding habitat with no apparent resident ferals or stray house cats meant dominant and aggressive house cats were able to expand their ranges up to 1km into the adjacent grassland, forest/woodland habitat. No significant difference was found between the home range sizes of desexed males or females. Similarly, Bradshaw (1992) and Chipman in Bradshaw (1992) both report castrated males had ranges only slightly larger than those of females. Apart from inhibition of oestrus and lack of opportunities for maternal interaction, the behaviour of females does not appear to greatly alter after desexing (Bradshaw 1992), whereas fighting, roaming and spraying tend to decline after desexing of males (Fogle 1991).

Home range overlap did not occur between female house cats in Barratt's study, although he mentions that none of their home range areas encompassed properties that had other resident female cats. Liberg & Sandell (1988) suggest that exclusive ranges do occur in females when the food resource is stable and evenly distributed. Contact between house cats, and overlap in home ranges were, not surprisingly, greatest among cats from the same residence in Barratt's study. Overlap in home ranges of males and females from separate residences also occurred. Bradshaw (1992) suggests pet cats generally have less need to defend a territory than do ferals because they have a reliable source of food that is often defendable against other cats. Each sex tends to maintain exclusive territories against members of their own sex but male and female territories and home ranges can overlap completely (Bradshaw 1992).

This is also seen in group-living female ferals that accept strange males into their group but not strange females. It is thought that males pose a lower competitive threat than strange females to group living females (Liberg & Sandell 1988). Bradshaw (1992) states that there may be less competition for food in house cats but that competition for foraging space is observed, as young cats often take long routes in spaces between territories of other cats to reach hunting grounds (Bradshaw 1992, Fogle 1991). This was found in male house cats from separate houses in Barratt's study, which actively avoided each other's core areas (i.e. their house and yard). Cats also appear to avoid one another in a shared territory through spatial detail and timing of their movements (Leyhausen 1988, Bradshaw 1992, and Page et al. 1992).

A number of authors have made similar conclusions about the spatial organisation of house and feral cats. Their findings indicate that home range size and spatial distribution are primarily determined by the density and spatial distribution of other cats (Izawa *et al.*1982, Turner & Mertens 1986, Fitzgerald & Karl 1986, Langham & Porter 1991, Fogle 1991, Bradshaw 1992, Barratt 1997b), and in particular cats utilising separate food resources (Barratt 1997b). Kinship, personality and social dominance of individual cats appear to be important factors (Liberg & Sandell 1988) as well as the location of hunting, resting and sunning sites and barriers such as busy roads for house cats and the availability of shelter for feral cats (Barratt 1997b).

Alterio & Moller (1997) have suggested that the study of cat activity patterns is one way to determine the relative predation risk on endemic biota and therefore useful in conservation management. Barratt recommends that experimental research needs to be conducted on the effect of neutering, nocturnal curfews and roads (as potential barriers to movement) and the movement patterns of house cats living close to different natural habitats. Liberg & Sandell (1988) concluded that there are no great discrepancies between domestic cats and wild felids, so future research on domestic cats has great potential for increasing the understanding of not only domestic cats but the behavioural ecology of felids in general.

2.5 MANAGEMENT OPTIONS

Concern about the impact of house cats on native fauna and the consideration of cats as a community problem has lead some groups to consider cat management options. Richards (1994) produced a 'Cat Kit', which lists the problems house cats can cause in communities as: endangering wildlife, causing a community nuisance through fighting, spraying and digging in gardens, spreading disease, the suffering of neglected/un-owned cats and kittens, financial and emotion burdens on animal welfare agencies, and a threat to agriculture through decreased productivity via toxoplasmosis and sarcosporidiosis.

In Australia there are those who support implementation of controls and those who believe the facts are scarce and that cat control is nothing but "cat bashing". Andersen (1994) states that even though the extent to which the cat threatens Australia's fauna is not yet clear, politicians are still keen to act against cats. Low (1996) believes there is now effectively an "anti cat" campaign in Australia and suggests that comments such as "cats threaten the future survival of most wildlife" in a Victorian Department of Environment leaflet will probably do more harm than good, making cat owners and conservationists enemies instead of allies. To be useful, "anti cat" campaigns should focus on specific situations where cats are a proven problem and something can actually be done (Low 1996). Millwood & Heaton (2000) suggest cat management plans are often hampered by the lack of scientific information quantifying impacts of house cats on wildlife. Non-acceptance of animal management by the community is often due to the failure of authorities to adequately research the issues (Jennens 2000). Kennedy (2000) and Jennens (2000) both suggest that a better-informed community will be more receptive to restrictions on pet ownership. Tidemann (2000) suggests when managing issues where the ecosystem interactions are complex, such as in the case with the domestic cat problem, there needs to be a working hypothesis requiring ongoing evaluation and subsequent modification as further information becomes available.

In Shire Sherbrooke Forest in Victoria, Australia, the Lyrebird (*Menura novaehollandiae)* had declined from 130 birds in 1960s to only 60 in 1990 (Dickman

1993). Due to the decline of the lyrebird and the fact that the Shire of Sherbrooke is surrounded by fragmented native bush exposed to wandering cats and dogs, the Council adopted a by-law in 1991. The by-law requires cats to be confined at night, to be registered and identified by a collar, implanted microchip or tattoo. Richards (1994) believes widespread community debate about this law raised awareness and understanding of responsible pet ownership and since its introduction there have been more lyrebirds and less cat attacks on wild animals. Since the introduction of Sherbrooke by-law the whole state of Victoria now implements cat control under the Domestic (Feral & Nuisance) Animals Act 1996.

In the United States there is estimated to 40-60 million stray or feral cats. One control method that has become popular is TNR (Trap, Neuter, Release), which involves managing colonises of stray cats. TNR is practiced all over America but is controversial, as cat colonies often serve as a dumping ground for unwanted cats and the tinned food attracts more cats and other animals. The National Association of State Public Health Veterinarians in America now opposes TNR because of the health risks associated with cat colonises, such as ringworm, cat scratch fever, toxoplasmosis, and rabies. TNR has become a heated issue in California and Florida, where cat feeders have tried to gain offical approval for TNR in wildlife areas where endangered species are present.

In Israel stray cats are desexed and then returned to the people that fed them. In Italy, the Companion Animals and Prevention of Strays Law 281 forbids mistreatment or the euthanase of captured ferals and requires all strays and ferals be desexed and their colonies managed by local councils. In the United Kingdom similar programs are in place run by cat welfare agencies such as the 'Alley Cat Allies' who also promote (TNR).

In New Zealand, the control and management of house cats is a relatively new and controversial idea (Appendix 2.2). Through research on house cats (particularly in Australia), concern by cat welfare groups, a growing awareness of conservation in

New Zealand, and the public's interest in preserving and restoring habitats, the issue of house cats as predators in New Zealand is beginning to be addressed. The RSPCA and other cat welfare groups have been concerned about the number of stray house cats put down every year in New Zealand. The RSPCA euthanasied 16,313 cats in New Zealand in 2000 (Ally Ryan pers. comm.). In a bid to manage cats in New Zealand the Royal Forest and Bird Protection Society has drafted New Zealand's first cat management policy (Appendix 2.1). The policy's goal is to protect native species in New Zealand by limiting the impact of feral and house cats, whilst still recognising that cats are New Zealand's most favoured companion animal. Forest and Bird believe the way to achieve the goal is through responsible cat ownership. Forest and Bird encourage cat free subdivisions next to ecologically sensitive areas (as suggested by Gillies 1998), and have been successful in advocating that the Far North District Council include a policy in their Far North District Plan that excludes dogs, cats and mustelids from known kiwi habitat. To address the issue of predation by house cats, the Wellington Branch of Forest and Bird have trialed 'The Liberator' (an electronic leap-activated alarm on a collar) as a method of managing cat predation. Gilles & Cutler (2000) found the Liberator collar did not reduce predation upon birds, rats, mice or reptiles, although there was some evidence that the level of predation by cats on invertebrates was reduced.

Chapter 3 Reported Cat Abundance And Hunting Activity In The Suburbs Around Travis Wetland

3.1 INTRODUCTION

Determining the potential impact of urban house cats is difficult, as their populations can be large and the methods used to gather information subject to error. The most common method used to gather information on the impact of house cats has been to survey cat owners. Surveys allow information to be gathered on the size and density of house cat populations and how cat owners manage and feel about their cats and cat management practices. Surveying cat owners can also allow their recruitment into studies to record the prey retrieved by their cat, which can help determine the potential number of prey house cats can take.

This chapter details a door knock survey aimed at gaining an estimate of the population of house cats in the Travis Wetland vicinity and acquiring more information on the ecology of house cats in New Zealand.

3.2 METHODS

To estimate the number of domestic cats living on properties adjacent to Travis Wetland and gain information on their ecology, private residences within an 196ha survey area in the suburb around the wetland bounded by the main streets (Figure 3.1) were surveyed by door knock during January and February 2000. Every third house was approached between 7:00pm and 8:30pm. Residents were asked if there were cats living on their property, and if so, were requested to fill out a questionnaire about their cat's characteristics, management, movements and prey capture (Appendix 3.1 and Plate 3.1). Any residents not at home were re-sampled later by a second door knock and, if still not contactable, were sent a mail questionnaire with a freepost reply envelope. Any residents not contacted after those three attempts were recorded as non-respondents. An estimate of the number of private dwellings in the sampled area around the wetland was obtained from Statistics New Zealand (1996). The number of domestic cats living on properties adjacent to Travis Wetland was than estimated by multiplying the number of private dwellings in the area surveyed, by the mean number of cats in dwellings where a response had been obtained in the survey.

To determine any influence of cat physical characteristics, management and lifestyle on reported hunting frequency and maximum distance moved away from home, the survey data were analysed using Spearman's rank correlation, Kruskal-Wallis tests and Mann-Whitney U tests.

Plate 3.1. Travis Wetland resident completing the study survey.

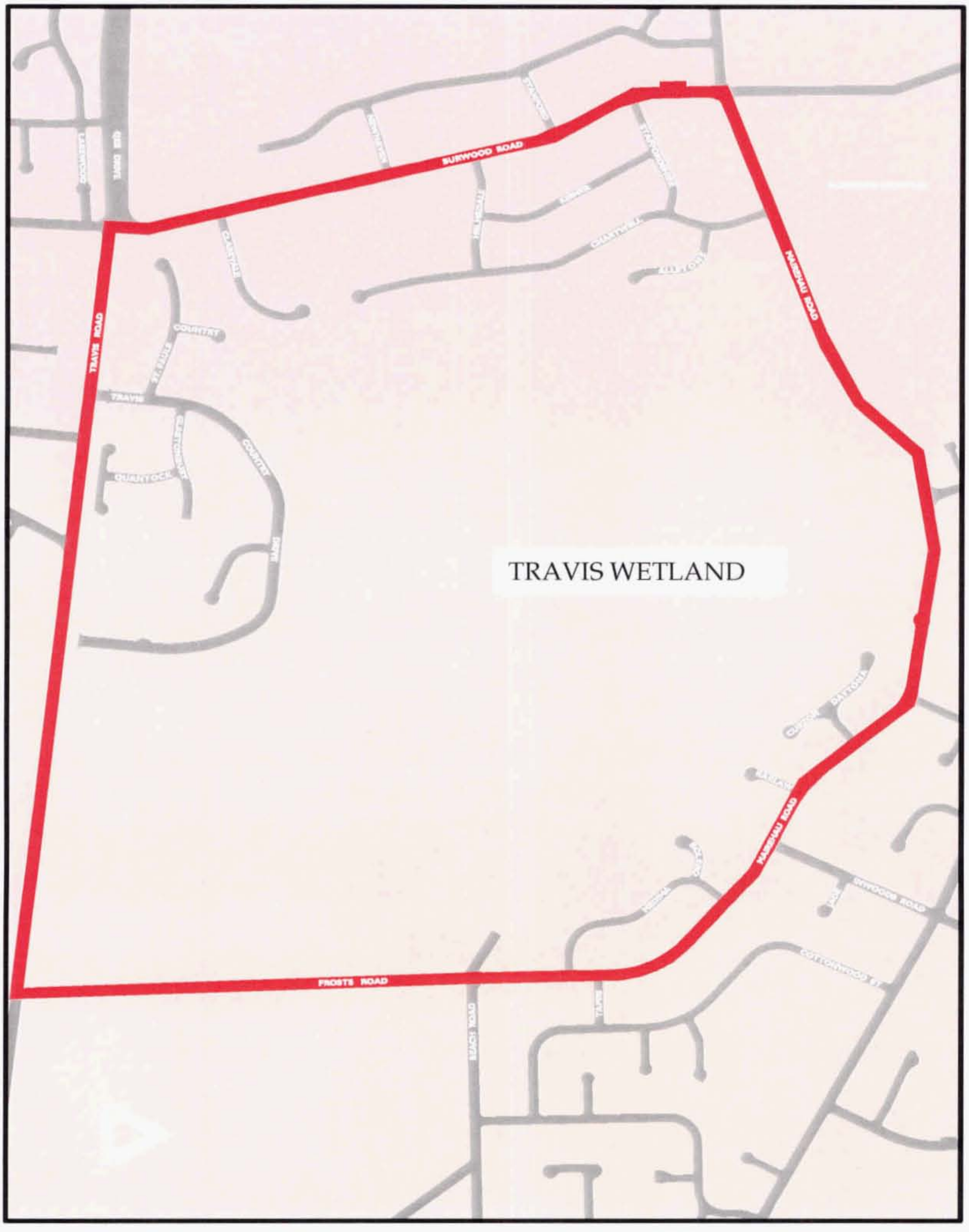


Figure 3.1. Map of the roads surrounding Travis Wetland with the boundary of the door - knock survey area represented by the red line. Only houses encompassed by the red line were surveyed. Scale 1:900. Source City Solutions, Christchurch City Council.

3.3 Results

3.3.1 Cat Population Estimate

The number of households in the area surveyed was 617 (New Zealand Population and Dwelling Census 1996). Approximately every third house (217 houses) was sampled by door knock. A total of 204 residents were contacted and indicated whether or not they had one or more cats (i.e. 94% of houses visited). The reported number of cats is shown in Table 3.1.

Table 3.1. Cat ownership reported by residents living adjacent to Travis Wetland.

No. of cats	No. of households surveyed	% of responses
0	101	50
1	68	33
2	25	12
3	4	2
4	3	1.5
5	1	0.5
6	1	0.5
7	1	0.5
No response	13	-
Total	217	

One third of households had one cat, with the mean number of cats per responding household being 0.8 (i.e., 160 in 204 households[1]).

The average number of cats reported during the first door-knock was 0.80 (126 cats in 158 responses), during the follow up door-knock 0.84 (36 cats in 43 responses), and during the second (mailed) follow up was 0.3 (1 cat in 3 responses). Given the high (94%) overall response rate, non-response bias will be minimal and no attempt has been made to adjust for it.

Assuming the responders were typical of the householders in the area as a whole, the total population of cats in the survey area can be estimated as: 617 households x 0.8 cats per household = 494 cats.

3.3.2 Effect Of Cat Physical Characteristics, Management And Movement On Reported Hunting Activity

Of the 204 households that responded to the survey, 101 had no cats. A total of 160 cats were owned by the remaining 103 households and a separate questionnaire was filled out for each of these cats.

The ratio of male to female cats was 1:1.04. Only a small percentage (5%) of cats were not desexed. Age desexed was unknown by the owners of 60% of the cats. Of the cats whose age at neutering was known, 91% were desexed at 12 months of age or younger. Cat age ranged from 1 month to 16 years, with a mean age of 6 years (± 4 s.d.).

Type of food fed and the number of times a cat was fed each day (Table 3.2) and whether the cat was collared with a bell (18% of cats) were considered in the analysis as possible factors affecting frequency of hunting.

Table 3.2. Number of cats fed different food types as reported by the cat owners of 160 house cats.

Type of food	No. of cats	% of responders
Fresh meat only	5	3%
Canned meat and dried food	44	28%
Dry food only	36	23%
All food types	75	46%
Non responses	0	

Table 3.3. Number of times each cat was fed a day as reported by the owners of 160 house cats.

Number of times fed a day	No. of cats	% of responders
1	15	9%
2	80	50%
3 or more	65	41%
Non response	0	

The frequency of hunting reported the most by cat owners was more than once a year (Figure 3.1). Sex of the cat made no significant difference to the frequency of hunting reported by owners (Mann-Whitney U = 4554, P=0.59). Cat age had a significant affect on hunting frequency (Spearman's rank correlation; r_s = -0.19, P= 0.01). Desexed cats were reported to catch prey more frequently than cats that were not (Mann-Whitney; U = 2340, P=0.011). Cats that had not been desexed were significantly younger than cats that had been desexed (Spearmans's rank correlation; r_s =0.34, P= 0.001) (Figure 2). The age a cat was desexed did not significantly affect hunting (Spearman's rank correlation r_s = 0.16, P=0.52). Neither the number of times a cat was fed a day (Spearman's rank correlation; r_s = 0.09, P= 0.26), nor the type of food fed (Kruskal-Wallis; F =2.11, d.f. = 3,141, P =0.10), nor whether the cat was collared with a bell (Mann-Whitney U; U=1744, P=0.92) had any significant effect on reported hunting frequency.

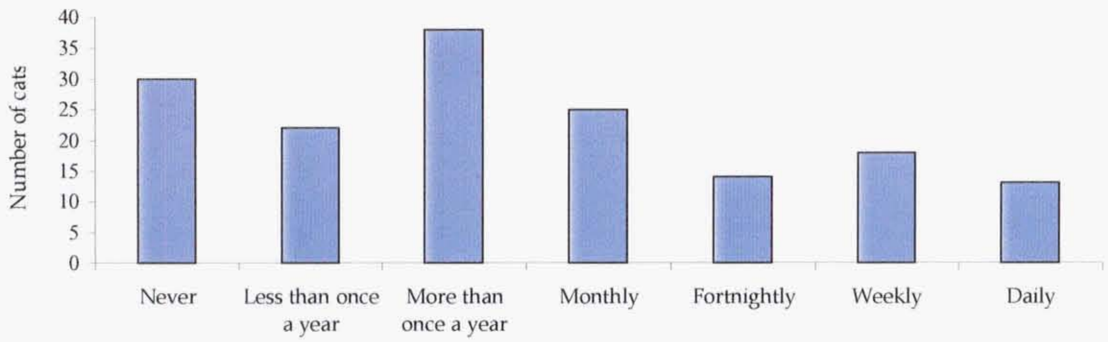


Figure 3.2. Average hunting frequency reported by the owners of 160 domestic cats.

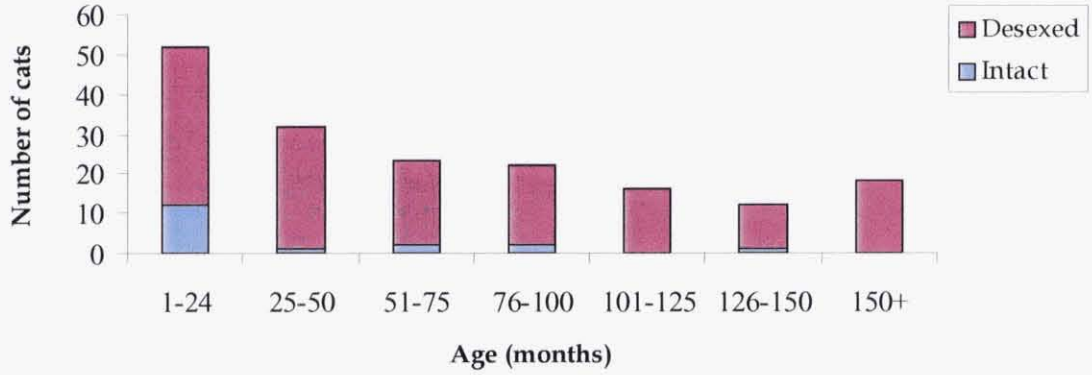


Figure 3.3. Age of cats intact and desexed as reported by cat owners surveyed. N=160.

Similarly, neither the number of cats in the household (Spearman's rank correlation; $r_s = 0.16$, P= 0.11) nor the average number of nights a cat spent outside (Spearman's rank correlation; $r_s = -0.008$, P= 0.92) had any significant influence on hunting. The maximum distances that cats were seen away from home (on a 5-point scale) See Appendix 3.1 was positively correlated with how often cats were reported to hunt (on a 7-point scale; Spearman's rank correlation; $r_s=0.24$, P=0.002) (Figure 3.4).

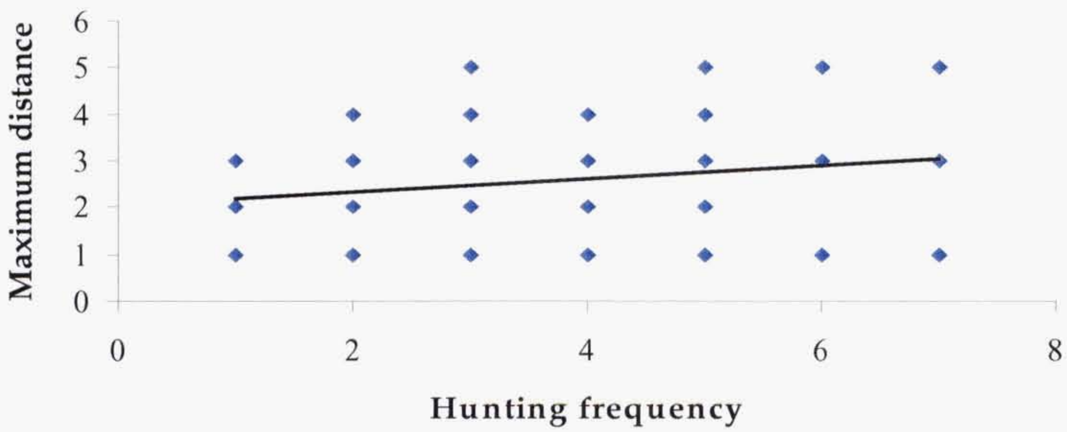


Figure 3.4. Relationship between the frequency of hunting and the maximum distance cat owners reported having seen their cat(s) away from home (N=160 cats). The numeric values correspond to the hunting frequency shown in Figure 3.2.

3.4 DISCUSSION

Half of the householders surveyed around Travis Wetland reported that they did not own a cat. This is similar to a figure quoted by Clifton (2001) that 53% of New Zealand households are without a cat. A survey conducted by Reark Research (1994) found that 25% of households in Australian capital cities owned at least one cat, and surveys in Britain (Woods 2001) suggest that 25% of households own at least one cat. Cat ownership in New Zealand therefore appears to be much higher than in Britain or Australia.

A very high percentage of cat owners living around Travis Wetland (95%) reported that their cats had been desexed, mostly before 12 months of age. Similar results have been found in Australia where 94% of cats were reported as being desexed in metropolitan Australia (Reark Reasearch 1994) and 98% in Canberra (Barratt 1995a). If a greater number of house cats were not desexed this may see Travis Wetland species come under more predation pressure by stray cats using the wetland as a foraging site. Populations of stray cats, if not desexed and cared for, have the potential to increase rapidly in numbers, spread diseases such as toxoplasmosis and ringworm to humans, causing a community nuisance (Richards 1994). Although no feral cats were caught or sighted at Travis Wetland during predator monitoring programmes conducted by the Christchurch City Council, or during this study, four residents living in Burwood Road, Mairehau Road and Curzon Place reported that they fed stray cats. Other residents surveyed also reported the presence of stray cats in the wetland.

Desexed cats were reported by owners to hunt more often than cats that had not been desexed. This result can be explained by the fact that over half of the cats (61%) not desexed were 12 months of age or younger. That older cats were reported to hunt significantly more than younger cats in this study may be explained by the large proportion of young cats between the ages of 1-24 months in the study (Figure 3.3). Martin & Bateson (1988) in Bradshaw (1992) suggest young cats do not become competent predators until they are almost 8 months old. Kittens in the hunting activity study (chapter 4) of less than 12 months of age were also found to retrieve little or no prey.

Nearly half of cat owners reported they fed their cats "all types of food" i.e., meat, dry food, canned food and table scraps, while the other half fed their cat only one type of food. The type of food that owners fed their cats in the survey did not significantly affect the frequency owners reported their cats hunted, but did significantly affect the total number of prey retrieved by cats in the hunting study (See Chapter 4). This difference in results between the door knock survey and hunting study could be due to one method being more accurate than the other. However the relationship between reported hunting frequency and the amount of prey owners observed their cats to retrieve was positive, suggesting that the response from both methods was similar and that cat owners are quite good at estimating the level of hunting their cat displays.

The frequency of hunting reported by cat owners in this study was not significantly affected by cat gender, cat age, age desexed, type of food fed, number of times fed a day, number of cats in the household or the average number of nights spent outside. The frequency of hunting reported for cats that wore a collar with a bell was higher than cats that did not wear a collar with a bell, although the result was not statistically significant. Frequency of hunting was influenced by the maximum distance owners reported having seen their cat away from home and whether the cat was desexed or not. Similarly, Barratt (1995a) concluded cat gender, age when desexed, collaring with a bell and the number of times fed a day did not affect the cats' predatory behaviour, whereas cat age, the number of nights spent outside and the distance of the cat owners' home to rural/ grassland habitat did have an affect. Barratt (1995a) suggests more detailed and specific experimental analyses of some of these factors would reduce the chance of errors occurring as a result of loosely defined or inadequately sampled categories. It may be that some of the questions asked in this survey are loosely defined. Other sources of error in this survey may be from owners answering questions incorrectly or recorder error.

The distance a cat moved away from home did significantly affect the amount of prey retrieved by cats (a result which is supported by the findings of the hunting study; chapter 4). This suggests that more prey are available away from home and that cats living around Travis Wetland may use the wetland as a foraging site. Barratt (1995b) similarly found house cats living adjacent to natural habitat did move into and use the habitat as a foraging site. These movement patterns are investigated directly in chapter 5.

4.1 INTRODUCTION

House cats are known to be efficient predators, however predation by house cats in New Zealand has largely been ignored by local authorities yet, house and feral cats are similar in that both are opportunistic and generalist predators (Fitzgerald 1988, Barratt 1995a, Gillies 1998, Woods 2001) that take similar types of prey (Liberg 1984, Gillies 1998). Conservationists now wonder whether house cats could impact on the New Zealand environment as feral cats have done (King 1984, King et al. 1986, Fitzgerald 1988, Diamond 1990).

There is growing concern by the Christchurch City Council and others as to whether the surrounding house cat population could have an impact on the faunal species of Travis Wetland, a habitat of high conservation value in Christchurch. This chapter attempts to assess the potential impact that house cats may have on Travis Wetland wildlife by determining the types and numbers of prey retrieved by house cats living around the wetland. It also examines whether a cat's physical characteristics, management or lifestyle influence hunting activity.

4.2 METHODS

Hunting activity was assessed by asking the owners of selected cats living adjacent to Travis Wetland to record and collect all prey items that their cats brought home. Similar assessments have been undertaken overseas by Churcher & Lawton (1987), Paton (1991 in Dickman 1993), Barratt (1997*b*) and in New Zealand by Gillies (1998).

In October 1999, households bordering Travis Wetland were hand delivered a reply free post pamphlet (Appendix 4.1) asking for their participation in a year- long survey of the prey items caught and brought home by their cats. There was a low response to this pamphlet drop (18 householders recruited) so when the same areas were surveyed by door knock in January/February 2000, a further request was made for volunteers for the study. An additional 80 residents were recruited at this time.

Residents recruited into the study were provided with a record sheet (Appendix 4.2) to record any prey items brought back to their home by their cats (Plate 4.1) and polyethylene bags to store any prey items that they were unable to identify. Residents were asked to freeze any such items for later identification, and these were collected monthly along with the record sheets. Recruited residents also filled out a survey questionnaire about their cat's physical attributes, management and lifestyle (Appendix 3.1). To keep residents interested in the study they were sent a pamphlet summarising the interim findings of the study (Appendix 4.3).

Prey items were identified to at least order level (and species level where possible) and were categorised as native or introduced. Predation on native and introduced animals, and variation in the number and the type of species caught by cats in relation to the cats physical attributes, lifestyle, management and the distance of the cat's home to the periphery of the wetland, were examined using Spearman's rank correlation.

Plate 4.1. Blackbird carcass and feathers distributed around the lounge by a cat. Photo courtesy of John and Joanna Koster.

4.3 RESULTS

A total of 98 cats were recruited into the hunting activity study between November 1999 and March 2000. Ten cats were unable to participate in the study for a whole year due to death (5) or their owners shifting out of the study area (5). These cats have not been included in analysis of annual prey take.

4.3.1 Total Prey Take

During the survey 88 cats brought home a total of 981 prey items (mean per cat = 11.5 ± 3.0 SE, range = 0 - 188), The number of prey caught by each cat ranged from 0 to 188 prey items per year (Figure 4.1). Most cats (80%) retrieved 10 or less prey items per year. For the 10 cats that caught 21 or more prey items per year, most of their prey were rodents or moths.

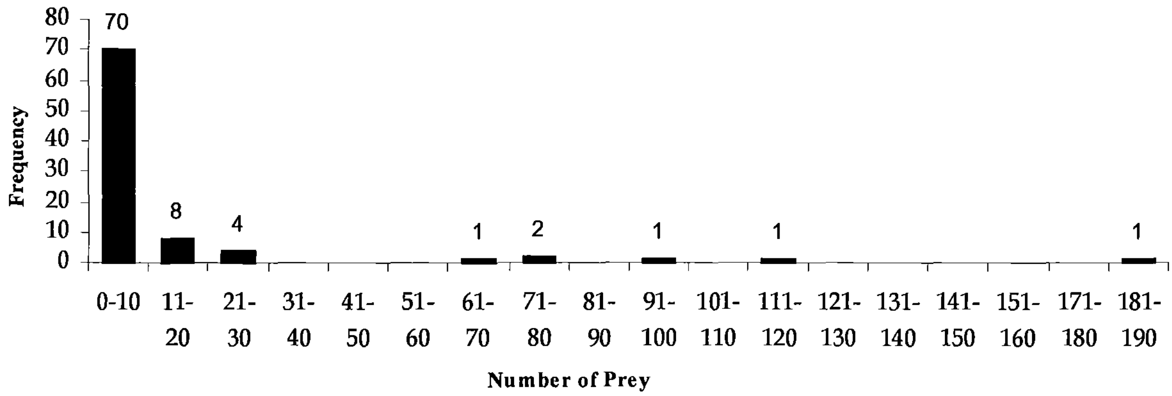


Figure 4.1 Frequency distribution of the total number of prey items retrieved by house cats (N=88) over a 12 month period.

4.3.2 Prey Composition

Rodents were the prey item retrieved most often by cats, comprising 38% of the total take (Figure 4.2). These rodents consisted of 370 house mice *Mus musculus* and 10 Norway rats *Rattus norvegicus.*

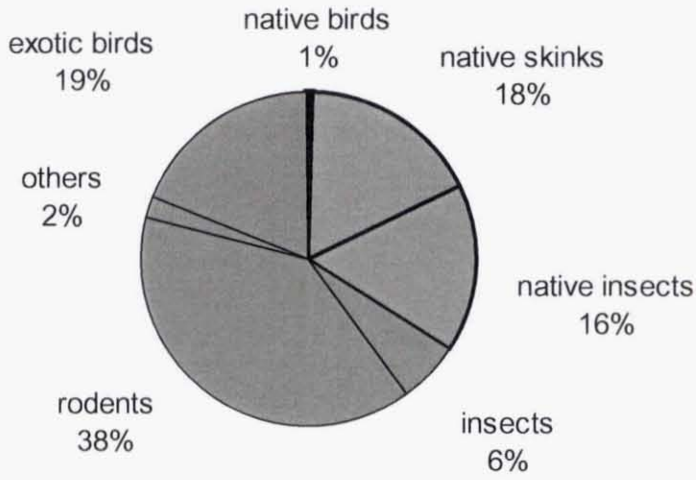


Figure 4.2. Prey items retrieved by 88 cats living around Travis Wetland between November 1999 and March 2001 (N=981 items).

A total of 199 birds were collected over the survey period (20% of the total prey retrieved). Sparrows, *Passer domesticus,* were the most common bird species making up over a third (37%) of all birds retrieved (Figure 4.3). Blackbirds, *Turdus merula,* goldfinches, *Carduelis carduelis britannica,* silvereyes, *Zosterops lateralis* and starlings, *Sturnus vulgaris,* were also common. Six native birds were retrieved including four fantails (*Rhipidura fuliginosa),* a kingfisher, (*Halcyon sancta vaganus)* and a welcome swallow, (*Hirundo tahitica neoxena).* "Unknown birds" consisted of six small passerines that were unidentifiable due to a lack of feathers.

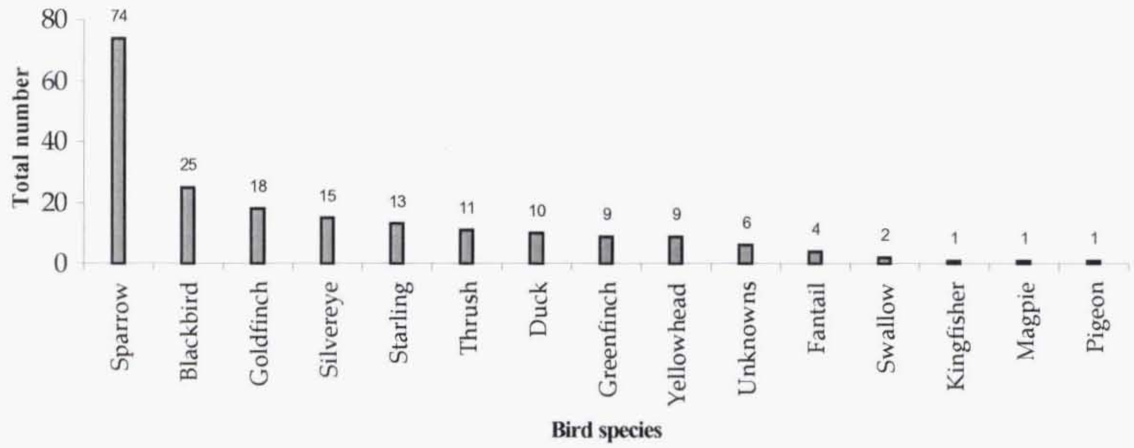


Figure 4.3. Numbers of birds retrieved by 88 cats living around Travis Wetland between November 1999 and March 2001 (n=199 birds).

A total of 221 invertebrates (22% of total prey items) were retrieved over the year. Native porina moths, *Wiseana spp.*, were the most common invertebrate (72% of all invertebrates retrieved) Figure 4.4). One 10-month old female cat retrieved most (92%) of the porina moths caught. The younger cats in the study (i.e., aged between 2 months and 5 years of age) retrieved most (95%) of the invertebrates.

A total of 172 native skinks, (*Oligosoma nigriplantare polychroma),* were brought in over the year. No other lizard species were retrieved. Native skinks made up 18% of total prey taken and nearly half (49%) of all native prey retrieved.

The 'others' category represents less commonly caught species, consisting of five whistling frogs , (*Litoria ewingii),* two goldfish, (*Carassius auratus)* and two juvenile stoats (*Mustela erminea).*

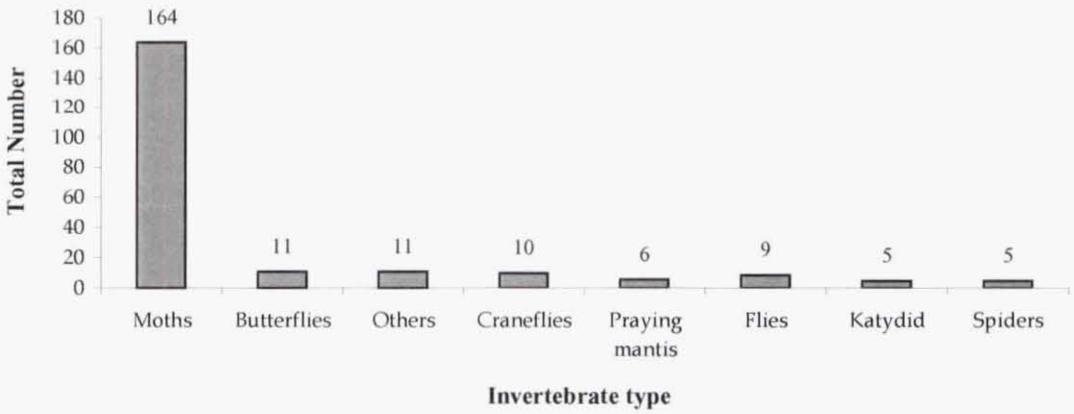


Figure 4.4. Numbers of invertebrates retrieved by 88 cats living around Travis Wetland between November 1999 and March 2001 (n=221 invertebrates).

4.3.3 Seasonal Distribution Of Prey Take

The mean number of rodents retrieved per month peaked in the autumn of each year (Figure 4.5).

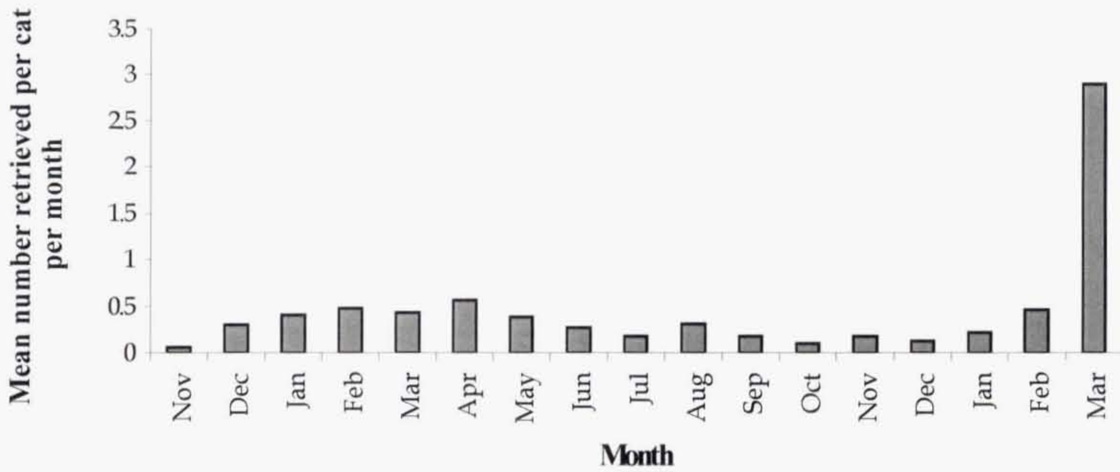


Figure 4.5 Mean number of rodent prey retrieved per month by 88 cats living around Travis Wetland between November 1999 and March 2001.

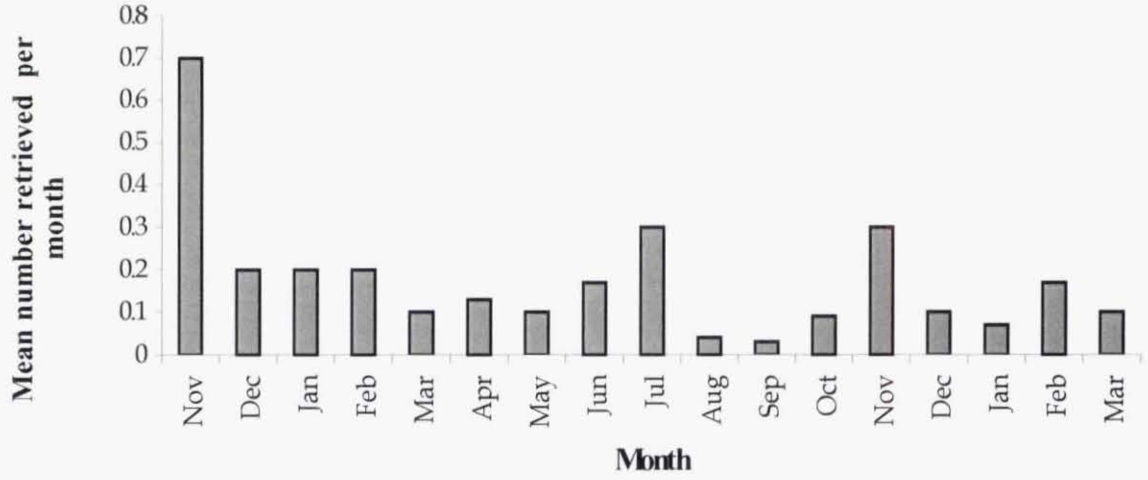


Figure 4.6 Mean number of birds retrieved per month by 88 cats living around Travis Wetland between November 1999 and March 2001.

Mean number of bird prey retrieved per cat per month was high in the summer of each year, and also in mid winter 2000 (Figure 4.6).

Retrieval rates for invertebrates were highest in autumn 2000 and were also high in spring 2000 and summer 2001 (Figure 4.7).

The average skink take per month was highest in late spring and also in late summer and autumn (Figure 4.8).

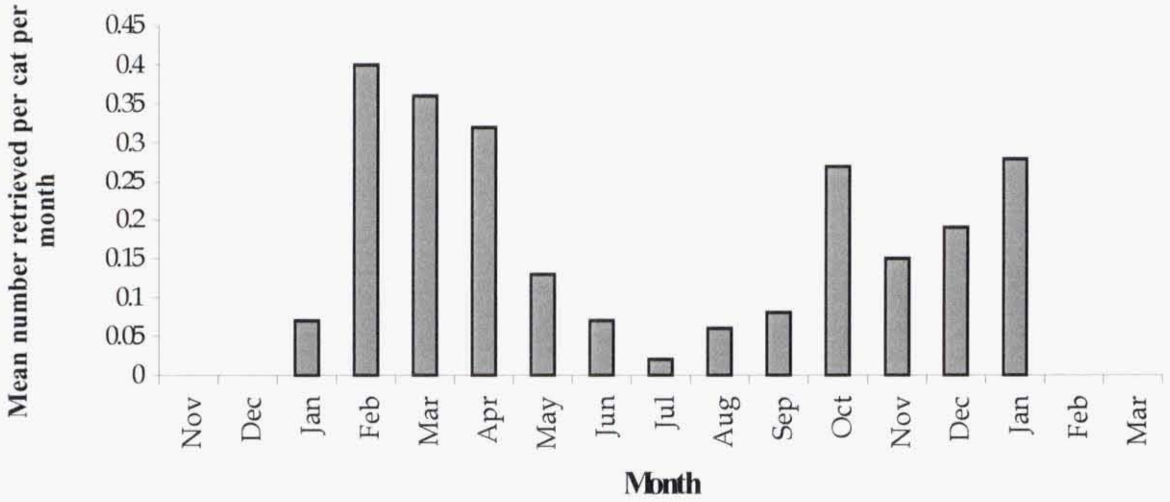


Figure 4.7 Mean number of invertebrate prey retrieved per month by 88 cats living around Travis Wetland between November 1999 and March 2001.

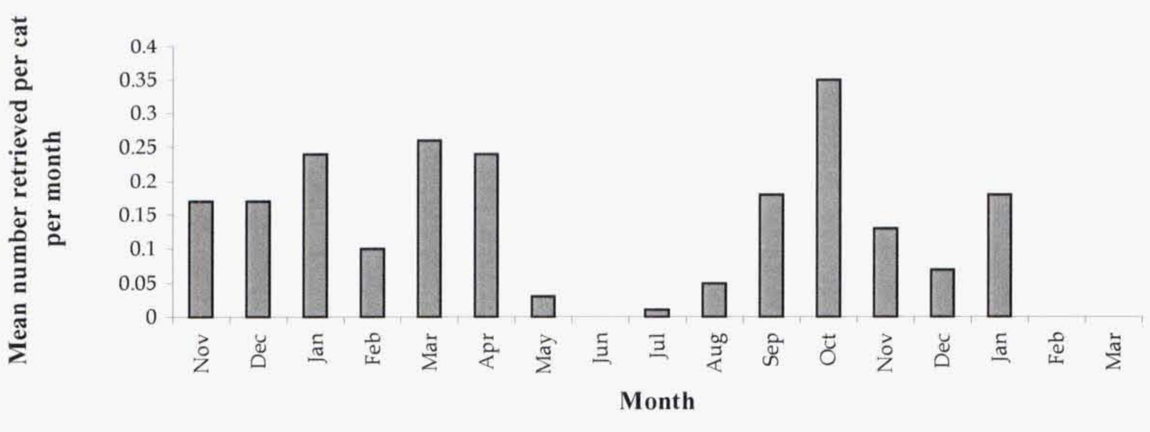


Figure 4.8. Mean number of skink prey retrieved per month by cats living around Travis Wetland between November 1999 and March 2001.

Total prey take of cats living around Travis Wetland demonstrates some degree of seasonality, being higher in summer than winter. More prey were taken in summer 1999/2000 than in summer 2000/2001 (Figure 4.9).

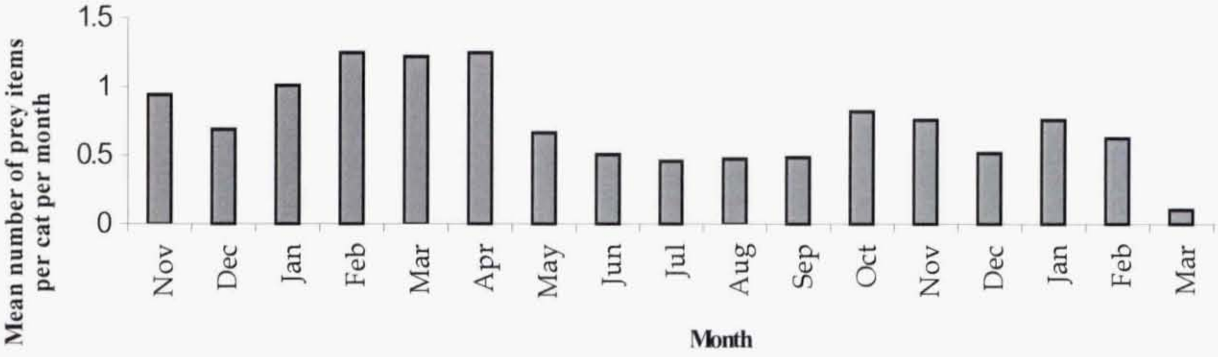


Figure 4.9. Mean numb er of prey retrieved per cat per month by 88 cats living around Travis Wetland between November 1999 and March 2001.

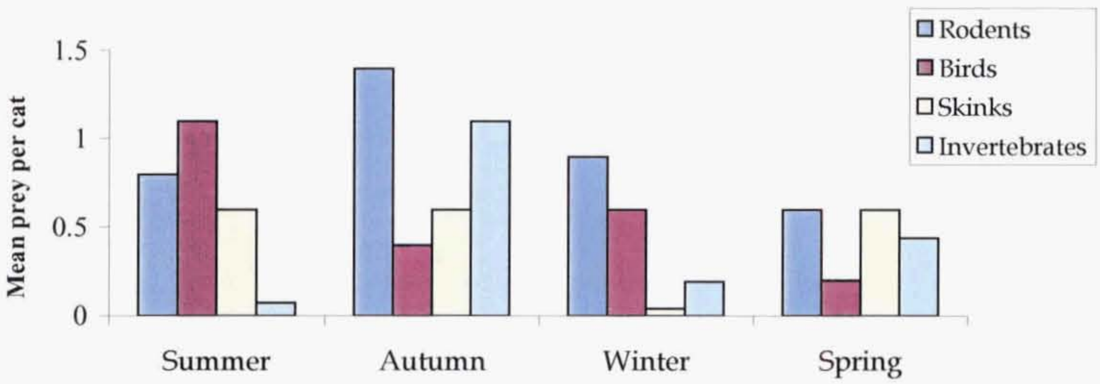


Figure 4.10. Seasonal difference in the mean number of different prey retrieved per cat per year.

Predation of rodents (97% house mice, 3% Norway rats) and invertebrates were greatest in autumn (Figure 4.10). Birds were taken more often in summer than other season, while skinks were taken consistently over all seasons except winter.

Several cats in the study were found to retrieve mostly one type of prey (Table 4.1).

Table 4.1. Examples of cats in the study that predominately caught one type of prey over a 12-month period.

Cat Name	Number of prey caught	% of prey type
Cuddles	117	99% mice
Hobb Goblin	28	68% birds
Jessie	65	60% birds
Katie	111	92% mice
Misty	179	98% insects
Stirfry	30	67% mice
Tammy	73	84% mice

4.3.4 Effect Of Cat Physical Characteristics, Management And Movements On Hunting Activity

Forty seven of the cats were female and 41 male (a ratio of 1.15 : 1). Four out of 88 cats in this study (5%) were not desexed. The age desexed was unknown by owners for 60% (53) of cats. Of the cats desexed, 91% were desexed at 12 months of age or younger. Cat age ranged from 2 months to 16 years. The mean age of cats in the study was 12 months ± 22 s.d. The proportion of cats considered an indeterminate breed was 64%, 27% were crossbred and 9% were purebred. The proportion of cats collared with a bell was 17 (19%). The proportion of cats fed different food types and at different frequencies are shown in Table 4.2.

Table 4.2. Percentage of cats fed different food types and frequency of feeding as reported by cat's owners.

Type of food	Percentage	No. of times fed a day	Percentage
Meat	12%	1	10%
Canned and dried food	18%	2	48%
Dry food	25%	3 or more	42%
All food types	45%		

Sex of a cat was not a significant predictor of prey caught (Mann-Whitney U; U=55, P=0.92). Age desexed had a significant affect on the number of skinks and total number of native animals caught. Cats desexed at an older age caught less skinks (Spearman's rank correlation; r_s= -0.28, P= 0.04) and less native animals (r_s= -0.33, P= 0.01). Younger cats had higher annual prey takes (r_s= -0.28, P= 0.01) and caught a greater number of introduced animals (r_s= -0.27, P= 0.01) than older cats. Neither cat breed (Kruskal-Wallis test; χ^2 = 1.65, P= 0.44) nor the number of times cats were fed a day (r_s= 0.14, P= 0.22) significantly affected the total number of animals caught per year.

A positive relationship was found between the frequency of hunting owners reported their cats had in the door knock survey (chapter 3) and the frequency of hunting subsequently observed during this hunting study (Pearson correlation; r_s= 0.38).

Although cats collared with a bell did retrieve more prey then cats without collars the result was not statistically significant (Kruskal-Wallis test; χ^2 = 1.03, P = 0.31).

The type of food fed to cats was found to significantly influence their hunting. Cats fed only meat caught more birds than cats fed only dry food ($\chi2$ = 7.8, P=0.05). Cats fed canned and dried food caught more birds than cats fed only dried food ($\chi2 = 8.4$, P=0.04).

Distance of a cat's home to the wetland periphery had a significant affect on hunting. Cats living close to the wetland had higher rates of hunting, retrieved a greater number of different species ($r_s = -0.56$, P = 0.01), retrieved more introduced animals Figure 4.11; ($r_s = -0.43$, P = 0.05) and retrieved a higher number of native animals Figure 4.12; ($r_s = -0.44$, P = 0.04).

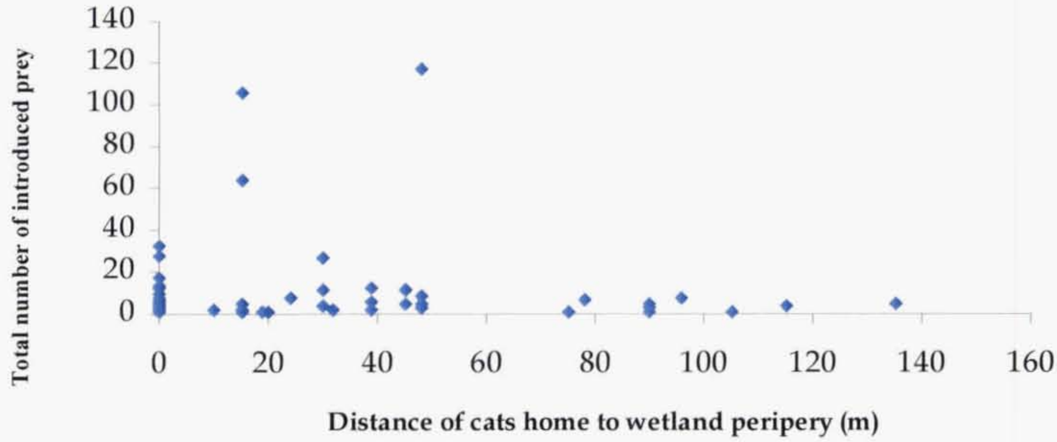
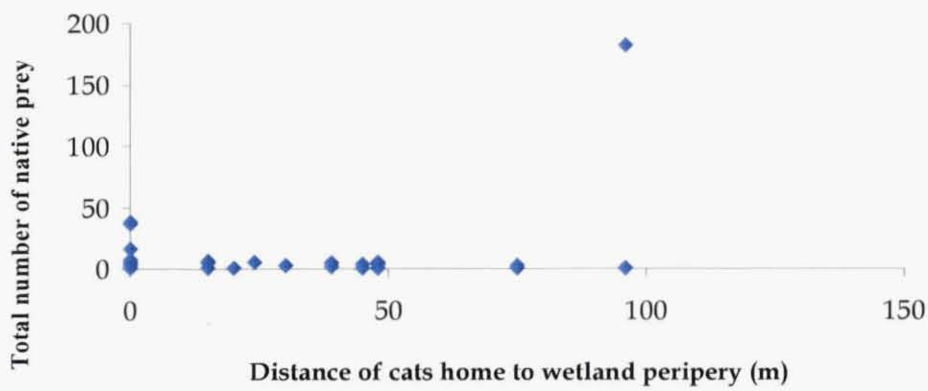


Figure 4.11. Relationship between the number of introduced prey retrieved and distance of the cat's home to the wetland periphery.



Cats found to have small home ranges and small daily movements retrieved fewer prey. A positive relationship was found between hunting activity and average movements ($r_s = 0.51$, $P = 0.01$), maximum movements ($r_s = 0.56$, $P = 0.01$), proportion of time spent in the wetland ($r_s = 0.56$, $P = 0.01$), average distance moved in the wetland ($r_s = 0.68$, $P = 0.001$), maximum distance moved in the wetland ($r_s = 0.65$, $P = 0.001$) and the home range size of cats ($r_s = 0.51$, $P = 0.02$).

4.4 DISCUSSION

4.4.1 Prey Species Selection

Rodents were the most frequently caught prey of house cats living around Travis Wetland with the majority (97%) being house mice (*Mus musculus*). This finding is consistent with the widely held view that small mammals are the most important prey of cats on continents (Fitzgerald 1988). Turner & Meister (1988) and Bradshaw (1992) suggest that cats have evolved a 'sit and wait' hunting strategy in order to specialise in hunting small rodents. This result agrees with other house cat studies overseas (Eberhard 1954, Churcher & Lawton 1987, Barratt 1998) and some studies of feral cats in New Zealand (Langham 1990, Alterio & Moller 1997a). However this result differs from the only other published study on urban house cats in New Zealand (Gillies 1998), which found juvenile rats and invertebrates to be the most common prey, and of some feral cat diet studies in New Zealand (Gibb et al. 1978, Fitzgerald & Karl 1979, Alterio & Moller 1997), which found rabbits to be the important prey. This most likely reflects habitat-related differences in the availability of prey. Gillies (1998) found more rats at his forest fringe study site than at his fully urban site, which may indicate that forest is the more suitable habitat for rats than an urban environment such as Travis Wetland. No rabbits were caught in this study, yet several owners reported that when their cats had previously lived on farmland or closer to grassland they did retrieve rabbits.

The autumn peak in rodents being retrieved, which was most evident in April 2000 and March 2001, is consistent with a survey of Travis Wetland (Byrom 2000) which found a seasonal increase in mouse numbers during summer and autumn 2000. Badan (1979 in Murphy & Pickard 1990) similarly found house mouse populations peaked in autumn in two New Zealand forests.

Invertebrates were the second most common prey species retrieved by cats in this study and one of the most important prey of urban house cats in Auckland, New Zealand (Gillies 1998). In contrast, invertebrates have not been recorded at all in some urban house cat studies overseas (e.g., Liberg 1984, Churcher & Lawton 1987, Carss 1995, Barratt 1998). Cats in overseas studies had a much greater range and availability of mammalian prey and, therefore, invertebrates may be more important prey to house cats in New Zealand than cats overseas due to the lower diversity of mammalian prey available in New Zealand. Alternatively, it may be that some authors chose not to measure invertebrates, or have not measured them well. Fitzgerald (1988) noted that most cat dietary studies have not attempted to identify all invertebrates. The New Zealand native porina moths (*Wiseana* species) were the most commonly retrieved invertebrate (72% of all invertebrates recorded). Other native invertebrates commonly recorded were craneflies (*Leptotarsus* spp.), praying manitis (*Orthodera novaezealandiae*) and katydid (*Caedicia simplex*). In other studies crickets (*Teleogryllus commodus*) (Gillies 1998), beetles (*Costelytra zealandica*) (Langham 1990) and weta (*Hemideina thoracica*) (Fitzgerald & Karl 1979) were frequently caught species. A few crickets, beetles and weta were retrieved in this study but they were rare and thus recorded as 'other' in Figure 3.3. The high occurrence of native insects in this study is likely reflective of the suitability of Travis Wetland for native species (81% of invertebrates recorded at Travis Wetland are native; Macfarlane et al. 1998). Invertebrates were most frequently caught in autumn. This is consistent with other New Zealand studies (Fitzgerald & Karl 1979, Langham 1990, Gillies 1998) and surveys in the Galapagos islands (Konecny 1987).

Most (95%) invertebrates were caught by the younger cats in the study. Similarly, Gillies (1998) found juvenile cats (under 6 months old) retrieved 62.7% of invertebrates recorded in his study. Other studies of feral cats in New Zealand confirm that invertebrates are important prey of juvenile cats (Fitzgerald & Veitch 1985, Fitzgerald 1988, King *et. al* 1996). Kittens or sub-adult cats (1-3 years) may be more likely to catch invertebrates than are adult cats, as younger cats play more often than adult cats (Bradshaw 1992). Biben (1979, in Bradshaw 1992) found play behaviour is more likely to occur with small prey items than large prey items due to a lower risk of being injured by small prey.

The greater retrieval of rodents (38%) than birds (20%) by cats living around Travis Wetland agrees with most other studies of cats on continents. The high proportion of sparrows (42%) among the bird prey is consistent with the findings of Borkenhagen (1978 in Gillies 1998) in Germany, Churcher & Lawton (1987) in the United Kingdom, Gilles (1998) in New Zealand, Barratt (1998) in Australia, and Woods (2001) in the United Kingdom. In comparison, other bird species such as blackbirds, thrushes, chaffinches and waxeyes (Fitzgerald & Karl 1979), tui (Fitzgerald et al. 1991) and parakeets (Karl & Best 1982) have been more important in the diet of feral cats in New Zealand. The occurrence of fantails as prey in this study is consistent with studies of house cats in Auckland, Gillies (1998) and feral cats in New Zealand (Marshall 1961, Fitzgerald & Karl 1979, Karl & Best 1982, and Langham 1990). The high proportion of birds retrieved in late spring and summer has also been reported in New Zealand (Fitzgerald *et. al.* 1991) and overseas (Borkenhagen 1979 in Gillies 1998). The only wetland birds to be retrieved by cats in this study were mallard ducklings. Residents report that during the breeding season, September to December, mallard ducklings hatching from nests in the suburb are caught frequently by house cats due to their vulnerability when moving to and fro between the suburb and the wetland. No other wetland birds were retrieved by cats in the study, however several cats are known to have brought home pukeko chicks (Plate 4.2) and adults in previous years. Cats have also been observed stalking pukekos in the wetland (Plate 4.3) and one cat was observed jumping a fence with a juvenile duck in its mouth (Rima Herber pers. comm.)

Plate 4.2. Pukeko nest and chick at Travis Wetland.

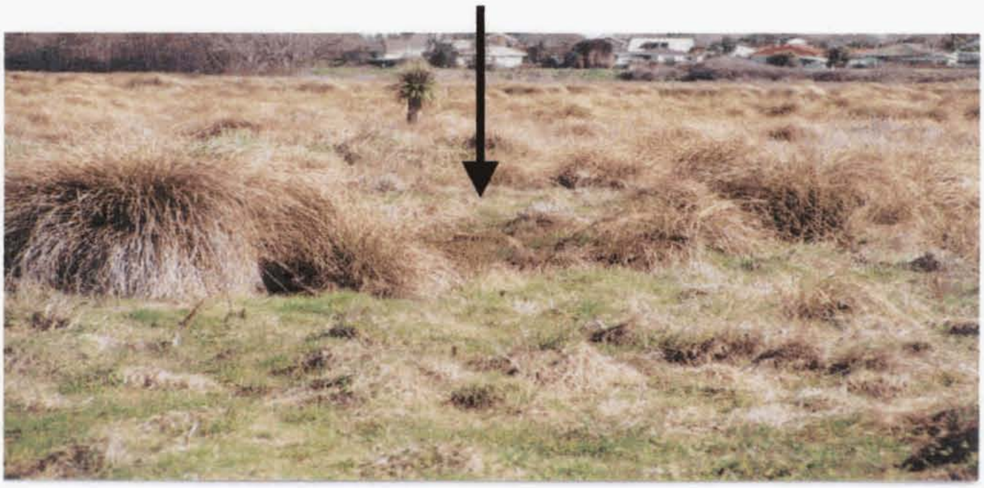


Plate 4.3. Cat stalking pukeko at Travis Wetland.

Skinks *Oligosoma nigriplantare polychroma* were frequently caught and were just as important as birds in the total prey take of cats living around Travis Wetland. This is consistent with findings worldwide that reptiles are important prey to cats and occur in more than 20% of gut contents at latitudes below 35 ° (Fitzgerald 1988). No other lizard species are recorded as occurring at Travis Wetland (Freeman & Freeman 1996). This result supports the view that although house cats prefer to depredate small mammals, they are opportunistic and generalist predators that will readily take other small prey when available (Fitzgerald 1988; Turner & Meister 1988; Gillies 1998).

Skinks were commonly caught during spring, summer and autumn. This differs from feral cat studies in New Zealand (e.g. Karl & Best 1982; Gillies 1998) where lizards were primarily caught only in summer and spring.

Only five frogs were retrieved, all whistling tree frogs (*Litoria ewingii*). Frogs were included in the prey retrieved by house cats in Auckland, New Zealand (Gillies 1998), Australia (Barratt 1997a) and the United Kingdom (Woods 2001), but were not in the diet of feral cats in New Zealand (Marshall 1961, Fitzgerald & Karl 1979, Karl & Best 1982, Langham 1990, Alterio & Moller 1997). Two goldfish were retrieved by cats from nearby neighbours' ponds. Several residents surveyed in the area reported seeing neighbourhood cats retrieve goldfish from their ponds and others mentioned that their cats had brought home eels in the past. The minor contribution of fish to the diet of feral cats in New Zealand is consistent with findings world-wide (Fitzgerald 1988). Fitzgerald & Karl (1979) did find that cats in the Orongorongo Valley, Wellington ate small fish and freshwater crayfish and Langham (1990) reported that cats on Hawke's Bay farmland ate small fish.

The inclusion of stoats (*Mustela erminea*) as prey of house cats has been reported previously (Gillies 1998). Stoats also appear in the diet of feral cats in New Zealand (Fitzgerald & Karl 1979). Both of the stoats retrieved by Travis Wetland cats were juveniles, caught in September and November. Young stoats are often caught in traps in mid-to late-November, when they first venture from the nest (King 1990), so this is presumably a time when they are also susceptible to predators.

Total predation varied seasonally and was highest in autumn, reflecting increased predation of both rodents and invertebrates in autumn. The shift in predation from birds in summer to rodents and invertebrates in autumn may reflect an increase in the abundance of house mice and a decrease in the availability of juvenile birds in autumn. Juvenile birds were most frequently retrieved during summer, when many nestlings are fledging and thus vulnerable to cat predation.

Some cats in this study had a strong preference for one type of prey. Of the 11 cats in the study that caught 20 or more prey items a year, seven (64%) focussed on one type of prey (Table 4.1). Other authors have similarly reported prey specialists (Heidemann & Vauk 1970 and Lups 1972 and Tabor 1983 in Turner & Meister 1988). It may be that such cats favour a particular hunting method that suits capture of a particular prey type. Turner & Meister (1988) state the 'sit and wait' hunting method is best for hunting mammals whereas the 'sight than stalk' method is best for hunting song birds. Barends-van Roon & Baerends (1979) found early experiences as a kitten with a particular prey type or diet influence hunting behaviour later in life.

Individual variation was evident in the hunting activity of house cats living around Travis Wetland. Barratt (1998) and Woods (2001) similarly found high individual variation in the hunting behaviour of urban house cats in Australia and the United Kingdom, respectively. Other authors (e.g. Mendl & Harcourt 1988, Fogle 1991) note that house cats display large variation in behaviour within the species.

In summary, results from this study support the finding that small mammals are the primary prey of cats on continents and the view that house cats are opportunistic hunters taking prey in proportion to its availability (Turner & Meister 1988, Fitzgerald 1988). The composition and abundance of prey found in this study reflect prey availability at Travis Wetland and differ from others studies in the abundance of frogs and the importance of lizards and invertebrates retrieved by house cats.

Several major assumptions have been made in this study. When comparing between various prey types it is assumed that all the prey types are observed equally by owners. A lower reporting rate of one species compared to another will lead to a bias in the estimated diet composition. It is also assumed that the composition of prey retrieved by cats is reasonably representative of all the prey they take. Another potential source of bias in the results is the difference in effort of cat owners participating in the study. Although most cat owners appeared keen to record the prey retrieved by their cats, there were times when owners forgot to record any prey seen over the month and relied on their memory to report any prey. Relying on memory may be less accurate then recording prey as it is seen. It is also assumed that the owners were being honest and accurate in their reporting of prey. There are few data on what percentage of the prey that cats catch is subsequently brought to their home. George (1974) found that only 50% of the prey caught by cats in his study were brought home. Therefore, it is certain that the numbers of prey being taken by cats in this study is actually higher than the numbers reported here.

Asking owners to identify prey themselves and only collecting and freezing prey that they were unable to identify may have led to some errors. Most prey caught were well-known species, but some owners may have mis-identified some prey (particularly similar birds species). Most cat owners appeared confident in knowing which cat in their household caught prey, but there is a possibility they may have sometimes been incorrect. Cat owners in this study appear to have been quite accurate in estimating and observing the prey caught by their cats, as a positive relationship was found between the hunting frequency cats owners estimated their cat had (in the initial door knock survey) and the number of prey they actually observed their cats catch over the subsequent 12 months (in the hunting study).

4.4.2 Effect Of Cat Physical Characteristics, Management And Movements On Hunting Activity

Some variation in the amount and type of prey retrieved by cats in this study can be explained by cat age, age the cat was de-sexed, type of food fed, distance of each cat's home from the wetland, and the home range size and movements of cats. Younger cats caught a greater number of introduced animals and had higher annual prey takes than did older cats. As a cat ages its reaction time slows as its senses and reflexes become poorer (Fogle 1991), and hunting therefore becomes less successful. Cats de-sexed at an older age caught less prey than those desexed at >1 year of age. Desexing in males is known to reduce fighting, roaming and spraying in some cats (Fogle 1991). It may be that a reduction in roaming (e.g., to forging sites such as Travis Wetland) is responsible for the decline in prey retrieved by cats de-sexed at an older age. The type of food fed to cats was found to significantly affect hunting. Cats fed only meat caught more birds and cats fed only dry food less birds than cats fed any other food type. Adamec (1976) found that when cats were fed highly palatable food (salmon) that their hunting was sometimes inhibited. Protein alone is not the most important factor in determining the choice of prey in cats. Aroma, texture, consistency, taste and previous experience also play a part (Fogel 1991). This may explain why cats fed only meat (i.e., with high levels of protein in their diet) still consume more birds than did cats fed any other food type. Cats fed dried and canned food caught more birds and cats fed dry food less birds than cats fed any other food type. The essential amino acid tryptophan found in meat is known to stimulate the brain hormone serotonin, which is involved in mood, sleep, wakefulness and body rhythms (Fogle 1991). It may even be that serotonin influences hunting behaviour in house cats and as dry food provides less protein and, therefore, serotonin than meat, these cats hunt less. The statistical result of a higher number of native insects caught by cats fed dry food only is likely to be strongly influenced by one cat, who was fed dry food only, who took a number of native insects.

Cats living close to the wetland retrieved a greater number and diversity of prey than cats living further away. This suggests that a greater abundance of rodents and native birds and skinks are found near the wetland than the surrounding suburb. Similarly, Churcher & Lawton (1987), Fitzgerald (1988) and Barratt (1998) all found that house cats living on the edge of cities or near wild areas caught more prey than did cats living in the centre of cities or suburban areas. This suggests that Travis Wetland provides cats with a greater diversity and abundance of prey than is found in the suburb itself and that cats living around Travis Wetland are therefore encouraged to use the wetland as a foraging site. Prey availability and abundance therefore appear to be factors affecting the hunting behaviour of the cats living around Travis Wetland.

A positive relationship between hunting activity and the movement of cats was evident, indicating prey availability and abundance do help determine the home range size and movements of house cats living around Travis Wetland. This concurs with the findings of other studies of feral cats (Fitzgerald & Karl 1986, Liberg & Sandell 1988, Bradshaw 1992, Mirmovitch 1995).

Feral cats and house cats exhibit similar hunting behaviours, which supports the suggestion that it is not solely hunger that influences hunting behaviour of well-fed house cats (Polsky 1975, Adamec 1976, Leyhausen 1979).

The presence of natural habitat adjacent to a suburb highly influenced the hunting activity of these cats. The movements and use of adjacent habitat by cats is discussed in the following chapter.

Chapter 5 Home Range Size, Movement Patterns And Habitat Use

5.1 INTRODUCTION

Relatively little is known about the movements of house cats worldwide, although one Australian study (Barratt 1995a) provides a good insight. Barratt (1995a) concluded that house cats regularly travel from suburbs into adjoining natural habitat, making large movements at night that put nocturnal species at particular risk.

Development in New Zealand has meant the total clearance and reduction of many natural habitats to remnants. Travis Wetland is one such remnant that provides an example of the type of habitat that once covered most of the Canterbury Plains (Figure 5.1.). Such an extensive loss of habitat in Canterbury means that many wetland birds rely on Travis Wetland. Due to the increased significance of Travis Wetland for maintaining bird populations, the aim of this chapter was to determine whether cats living adjacent to Travis Wetland use the wetland, how large are their home range sizes and movements are and how much time they spent in the wetland.

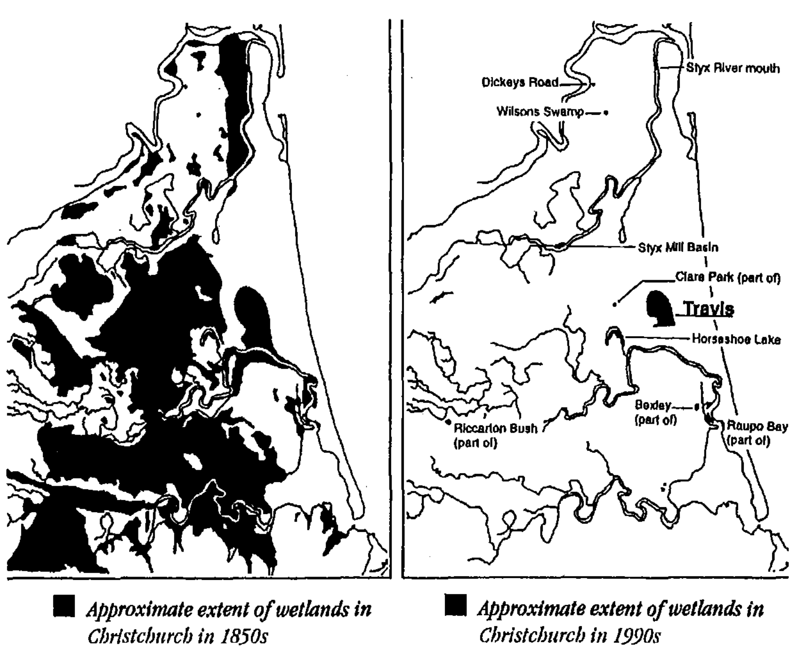


Figure 5.1. Approximate extent of wetland loss in Christchurch from 1850s -1990s (Source Travis Wetland Landscape Development Plan 1998).

5.2 METHODS

To determine whether cats were using Travis Wetland, a sample of domestic cats were fitted with radio-collars (Plate 5.1) that allowed their movements to be tracked. The cats selected for the radio study were obtained from two sources. Four were obtained through live trapping that was being conducted by the Christchurch City Council as part of their predator-monitoring programme in October 1999 and February 2000. Any domestic cats trapped by Council staff were fitted with a temporary plastic collar with an attached note asking the cat's owner to contact me to discuss whether they would be willing for their cat to be radio tracked (Plate 5.2.). Any feral cats trapped would also have been fitted with a radio collar however, no feral cats were trapped.

Additional cats were obtained through the door knock survey detailed in Chapter 3. Each resident that owned a cat was asked for their participation in having their cat(s) radio collared. A total of 22 cats entered the study, however one cat was withdrawn soon after due to its intolerance to the collar, leaving a sample size of 21 for the analyses reported here (Table 5.1).

Radio collars consisted of "Titley" two stage microlight transmitters with whip aerial attached to a leather pet collar. These transmitters had a 1-year battery life and a maximum range of 1km. Ten radio collars were rotated among the 21 cats. Cats with collars were located hourly over 4-6 hour shifts once a week for 4 weeks so as to obtain a total of 24 observations representing each hour of the day (Barratt 1998). Radio tracking was carried out on foot using a three-element hand-held yagi antenna and Regal 1000 tracking receiver.

Plate 5.1 'Tammy' one of the 21 cat's radio collared with her radio collar on.

Plate 5.2. Cat fitted with temporary collar and note.

Each cat was located by close-approach tracking and consequent visual contact (if time permitted) or by triangulation of bearings taken from two or more tracking points (Samuel & Fuller 1994). Bearings were based on peak signal strength and were determined using a Suunto compass.

Only one observer was in the field at a time during the day, so a motor vehicle was used to travel promptly between the tracking points - the time interval between the first and second bearing being taken was typically 3-4 minutes.

Table 5.1. Name, sex and age of the 21 radio-collared cats tracked during this study. All these cats had previously been desexed by their owners.

Cat Name	Sex	Age (yrs)
Alfy	M	3
Ally	F	1
Angel	F	16
Ant	F	13
Asha	F	13
Big Puss	M	8
Churchill	M	8
Cuddles	M	2
Gatino	M	4
Hercules	M	11
Jems	F	12
Little Puss	M	6
Misty	F	8
Monty	M	2
Paws	M	8
Rosy	F	7
Sally	F	4
Snoopy	M	12
Tammy	F	2
Wiskas	M	8
Zeus	M	5

Preliminary trials with transmitters placed at known locations suggested that most bearings could be obtained with a accuracy of ± 3 degrees. However, some signals suffered from interference due to metal roofs and other structures surrounding the study area. A note was made of any bearings taken from signals thought to be influenced by interference of this type and, if time permitted, a new bearing was taken from a point that avoided the interference.

Minimum convex polygon (MCP) estimates of home range area were calculated using the CALHOME Home Range Analysis Program (Kie et al. 1994). Maximum and average distances moved away from home to a furthest location for each cat were estimated manually by plotting the locations on a Christchurch City Council map (1:15580 scale). Both wind strength and cloud cover were recorded at hourly intervals by visual estimation. Wind strength was estimated as no wind, light breeze, breezy or very breezy and cloud cover to the closest 20% cover. Effect of wind strength, cloud cover, time of day, and season on the maximum distance cats moved away from home and into the wetland were tested using non-parametric Kruskal-Wallis tests. The effect of gender and age on home range size and average and maximum movements made away from home and in to the wetland were tested using Mann-Whitney U tests. Means in this study are presented ± standard deviation.

Any cats sighted at Travis Wetland were recorded during monitoring sessions and by Christchurch City Council park ranger staff from May 1999 to April 2001. Park ranger staff were given a note book with a map of the wetland split into girds to record the location of any cats sighted at the wetland.

5.3 RESULTS

5.3.1 Home Range Area Estimates And Movement Patterns

Between 47 and 102 radio fixes were recorded for each cat. The number of fixes for each cat varied due to one cat shifting from the study area, four owners not wanting their cats to wear a radio collar while the cat was ill, and the need to rotate the 10 available collars among 21 different cats.

MCP home range area estimates, and other movement data, for the 21 cats are shown in Table 5.2. Home range sizes varied greatly between individuals, ranging from 0.1ha to 10.1ha. Eight cats had home range sizes less than 1 ha, 10 had range sizes between 1 and 5 ha, and 3 had range sizes larger than 5 ha.

Alfy, the Burwood hospital spinal unit cat, had the largest estimated home range size (10ha). Alfy may have a larger home range than this estimate, as on four occasions he was somewhere in the pine plantation behind the hospital, where an accurate fix of his location could not be obtained due to radio interference from the trees in the plantation. The cat with the smallest home range size (0.2ha) was Rosy, a 7-year-old female cat.

The maximum distance cats moved away from their home varied from 29m-276m, average movements from 5m to 106m (Table 5.3). Tammy made the largest single movement from home (276m) and Monty had the largest average movement (106m). Zeus had the smallest maximum movement (44m) and Paws had the smallest average movement from home (5m). Twenty nine percent of cats made maximum movements from home of 49m or less (all of these were older than 5 years of age) and 43% had maximum movements between 50m and 99m (Figure 5.2).

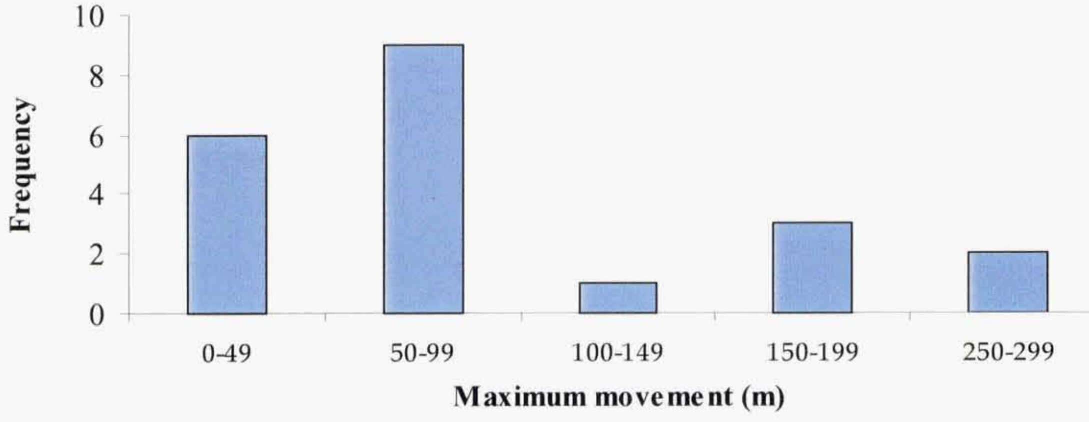


Figure 5.2. Frequency distribution of the maximum movements made away from their home by 21 cats.

Table 5.2. Name, home range size, maximum and average movements made from home to furthest location during a tracking session, percentage of fixes located not 'at home' and 'in the wetland' and total number of radio fixes for each radio collared cat (n=21).

Cat name	MCP home range size 100% (ha)	Max move (m)	Ave move (m)	% of fixes away from home	% of fixes in the wetland	Total no. of fixes
Alfy	10.0	250	63	33	10	67
Ally	0.6	51	15	17	0	83
Angel	1.6	70	24	44	25	71
Ant	1.8	72	15	30	0	63
Asha	1.1	72	10	21	0	99
Big Puss	3.4	84	36	43	6	54
Churchill	0.2	30	6	0	0	76
Cuddles	6.6	192	45	36	17	90
Gatino	4.0	110	69	66	15	102
Hercules	0.6	45	10	23	0	80
Jems	0.3	29	20	8	0	87
Little Puss	3.5	78	39	43	2	58
Misty	0.5	43	23	27	0	45
Monty	9.4	165	106	69	49	74
Paws	0.4	50	5	13	2	68
Rosy	0.1	38	9	15	0	47
Sally	4.3	94	46	61	20	64
Snoopy	2.6	82	18	24	0	100
Tammy	4.3	276	45	17	17	88
Wiskas	3.8	165	17	14	9	77
Zeus	0.2	44	8	15	0	82

The average home range size for female cats was 1.6ha (±1.2) and for male cats 3.7ha (±3.0). Male movements tended to be greater than female movements although the result was not statistically significant (Table 5.3). Maximum movements made by female cats from home to a furthest location was 82m (±75), and male cats 105m (±67). Males tended to make larger diurnal and nocturnal movements than females. Males had larger nocturnal movements than diurnal while females had larger diurnal than nocturnal movements. Males tended to spend a greater percentage of time away from home and in the wetland than did females (Table 5.4).

Table 5.3. Male (n=12) and female (n=9) home range size, maximum, average, diurnal and nocturnal movements made from home to furthest location and percentage of radio fixes located not at home. Mann-Whitney U tests for the effect of cat gender on movements is also shown. Means presented ± SD.

	Home range size MCP 100% (ha)	Max move (m)	Ave move (m)	Max diurnal move (m)	Max nocturnal move (m)	% of fixes away from home
Male	3.7± 3.0	35±31	35± 31	41± 38	51± 55	32± 21
Female	1.6± 1.2	82± 75	23± 14	32± 20	26± 15	26± 17
Mann-Whitney U test	U=49 P=0.63	U=42 P=0.32	U=56 P=0.97	U=37 P=0.49	U=38 P=0.59	U=49 P=0.63

Table 5.4. Male (n=12) and female (n=9) maximum and average movements made in to the wetland and percentage of radio fixes located in the wetland. Mann-Whitney U tests for the affect of cat gender on movements is also shown. Means presented ± SD.

	Max distance into wetland	Ave distance into wetland	% of fixes into wetland
Male	34± 35	18± 19	9± 14
Female	31± 65	18± 36	7± 11
Mann-Whitney U test	U=28, P=0.21	U=28, P=0.22	U=51, P=0.75

The radio-tracked cats varied in age between 1 and 16 years. Eight cats were in the age class 1-5 years, seven cats were 6-10 years and six cats were 11-15 years. Cats between the ages of 1 and 3 years had the largest average movements (Figure 5.2). Cat age had a significant effect on average distances moved and average distances moved in the wetland (Table 5.5). Cat age did not have a significant effect on home range size, maximum distances moved from home to furthest location, maximum distance moved in the wetland, percentage of radio fixes in the wetland or at home, average diurnal movements or average nocturnal movements (Table 5.5).

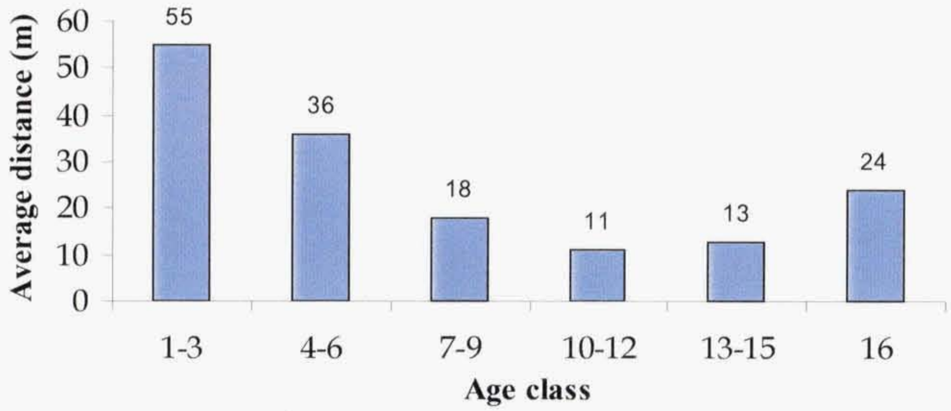


Figure 5.3. Average distance moved by cats from different age classes.

Table 5.5. Spearman's rank correlations for the relationship between cat age and movements. Statistically significant results are denoted by a ♦.

	Home range size	Ave distance	Max distance	% radio fixes not at home	Average diurnal movements	Average nocturnal movement
Age	r_s=-0.4 P=0.99	r_s=-0.56 P= 0.01 ♦	r_s=-0.37 P=0.09	r_s=-0.24 P=0.28	r_s=-0.40 P=0.09	r_s=-0.20 P=0.39

Table 5.6. Spearman's rank correlations for the relationship between cat age and movements in the wetland. Statistically significant results are denoted by a ♦.

	Max distance into wetland	Ave distance into wetland	% radio fixes in wetland
Age	r_s=-0.41 P=0.06	r_s=-0.43 P=0.04 ♦	r_s=-0.40 P=0.06

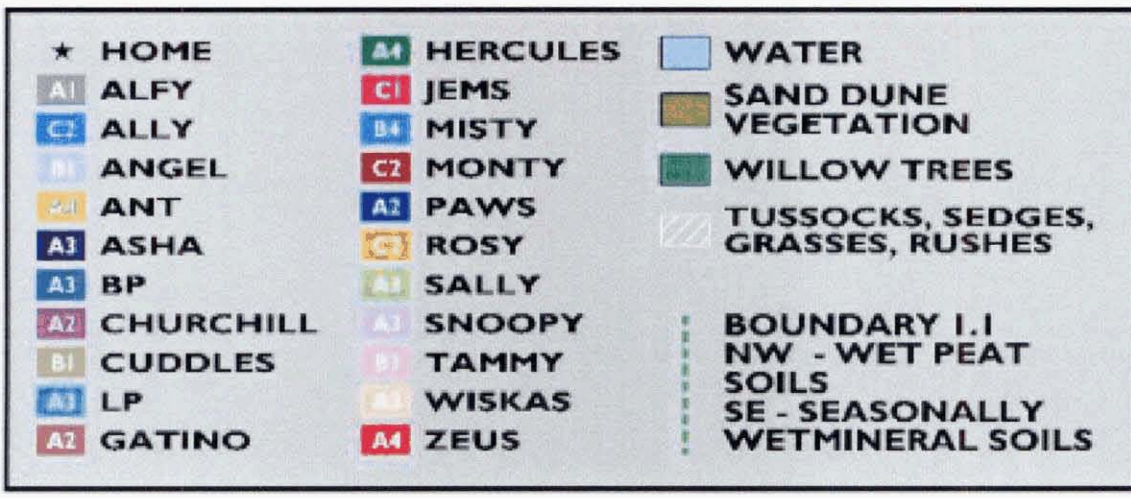
Table 5.7. Habitat use by 21 radio-collared cats from May 2000 to March 2001. Total number of fixes (n) and percentage of locations in each habitat type are shown.

Cat name	n	Home (%)	Suburb (%)	Wetland (%)
Alfy	67	67	23	10
Ally	79	82	18	0
Angel	69	58	17	25
Ant	63	85	15	0
Asha	95	81	19	0
Big Puss	52	60	35	5
Churchill	58	91	9	0
Cuddles	89	64	20	16
Gatino	101	34	52	14
Hercules	75	80	20	0
Jems	86	95	5	0
Little Puss	50	48	50	2
Misty	44	75	15	0
Monty	71	31	18	51
Paws	68	85	13	2
Rosy	47	83	17	0
Sally	63	40	40	20
Snoopy	90	81	19	0
Tammy	88	56	5	39
Wiskas	77	84	7	9
Zeus	82	90	10	0

About half of the radio-tracked cats (52%) entered the wetland at some point during the study (Table 5.8). Nine of the eleven cats entering the wetland moved less than 100m through the wetland. Tammy had the largest maximum movement from home into the wetland (198m) and Paws had the smallest (17m). Angel, Monty, Sally, Tammy and Wiskas all had home ranges that were skewed toward the wetland (approximately 60-90% of their home range area; see figure 5.4). Radio-collared cats using the wetland were able to move through areas of trees, shrubs and wet swampland in the Northwest area of the wetland. Both Monty and Tammy were able to cross ditches and swales by either jumping or moving around them (personal observations).

Figure 5.4. Map of Tra vis Wetland and the surrounding suburb, showing minimum convex polygon home range estimates of 21 radio collared cats monitored from May 2000 – March 2001.

KEY



pg 71


A
B
C
1
2
3
4
BURWOOD HOSPITAL
MAIREHAU ROAD
DAYTONA
CURZON
KAILUA
MAIREHAU ROAD
INWOODS ROAD
JADE
COTTONWOOD ST
BOLERO
MEDINA
TAPIRI
BEACH ROAD
FROSTS ROAD
STAFFORDSHIRE
CHARTWELL
KINNER
BURWOOD ROAD
HELMSDALE
NEWHAVEN
CLAREVALE
COUNTRY
DRIVE
COUNTRY
ST. PAULS
TRAVIS
GLASTONBURY
24C
NORTH
0
100
200
300
400
500m
SCALE 1 : 5000 AT A3

Table 5.8. Name, distance of cat's home to periphery of wetland, average and maximum distance moved into wetland and number of radio fixes, for 21 radio - collared cats.

Cat name	Distance of cat's home to wetland margin (m)	Average movement into wetland (m)	Maximum movement into wetland (m)	Number of observations (n)
Alfy	154	14	77	67
Ally	129	0	0	83
Angel	0	25	39	71
Ant	300	0	0	63
Asha	126	0	0	99
Big Puss	0	16	33	54
Churchill	329	0	0	76
Cuddles	142	50	50	90
Gatino	81	22	27	102
Hercules	97	0	0	80
Jems	202	0	0	87
Little Puss	0	18	22	58
Misty	164	0	0	45
Monty	0	64	72	74
Paws	0	6	17	68
Rosy	40	0	0	47
Sally	0	28	39	64
Snoopy	126	0	0	100
Tammy	0	111	198	88
Wiskas	0	35	105	77
Zeus	97	0	0	82

5.3.2 Effect Of Distance Of Cats Home To Wetland Periphery

Three cats (Alfy, Cuddles and Gatino) traveled past houses to use the wetland. The other eight lived on properties backing directly onto the wetland's periphery. Cats living on the periphery of the wetland were found to move significantly further into the wetland than cats that did not. The negative relationship between average movements in the wetland and the distance of the cats' home to the periphery of the wetland can be seen in Figure 5.5.

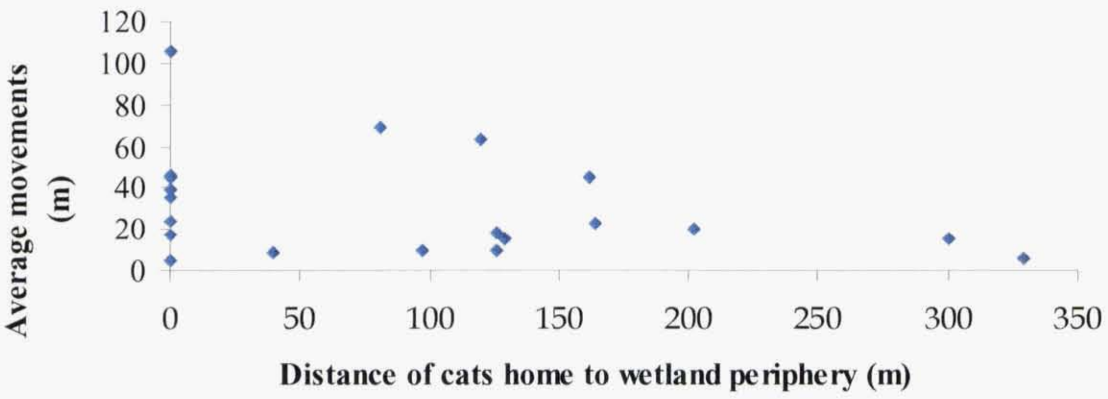


Figure 5.5. Average movements into the wetland by cats living at varying distances from the wetland periphery.

Those cats living closer to the wetland had larger average movements into the wetland (Spearman's rank correlation; r_s=-0.62, P=0.004), larger maximum movements in the wetland (Spearman's rank correlation; r_s=-0.70, P=0.009) and were located more frequently in the wetland (Spearman's rank correlation; r_s=-0.57, P=0.009) than cats living further away.

5.3.3 Effect Of Prey Availability On Movement

Cats with small home ranges and small movements retrieved less prey than more mobile cats. A positive relationship was found between the total number of prey reported by owners and average movements (r_s = 0.51, P = 0.01), maximum movements (r_s = 0.56, P = 0.01), proportion of time spent in the wetland (r_s = 0.56, P = 0.01), average distance moved in the wetland (r_s = 0.68, P = 0.001), maximum distance moved in the wetland (r_s = 0.65, P = 0.001) and the home range size of cats (r_s = 0.51, P = 0.02).

5.3.4 Effect Of Season On Movements

Cats were found to move greater mean distances in winter than in any other season of the year (Kruskal-Wallis test; χ^2=52.6, P= 0.001) (Table 5.9). Males made greater movements than females overall, although the difference was not statistically significant (Kruskal-Wallis test; χ^2=0.9, P= 0.35).

Table 5.9. Mean distance (m) moved from home to a furthest location by 21 house cats during different seasons of the year. Means presented ± SD.

Season	Males (n=12)		Females (n=9)
Spring	12.1± 12	Spring	11.0± 9
Summer	15.1± 17	Summer	9.6± 14
Autumn	16.4± 13	Autumn	9.4± 10
Winter	32.2± 22	Winter	23.0± 19

5.3.5 Effect Of Season On Habitat Use

During all seasons of the year, cats spent significantly more time on average at home than in the suburb or wetland (Figure 5.6). Similar amounts of time (9-13%) were spent in the wetland during summer, autumn and winter but less time (5%) was spent there in spring (Friedman test; $\chi^2 = 18$, P=0.001). Cats were more likely to be in the suburb during winter and spring than during summer and autumn (Friedman test; $\chi^2 = 21$, P=0.001).

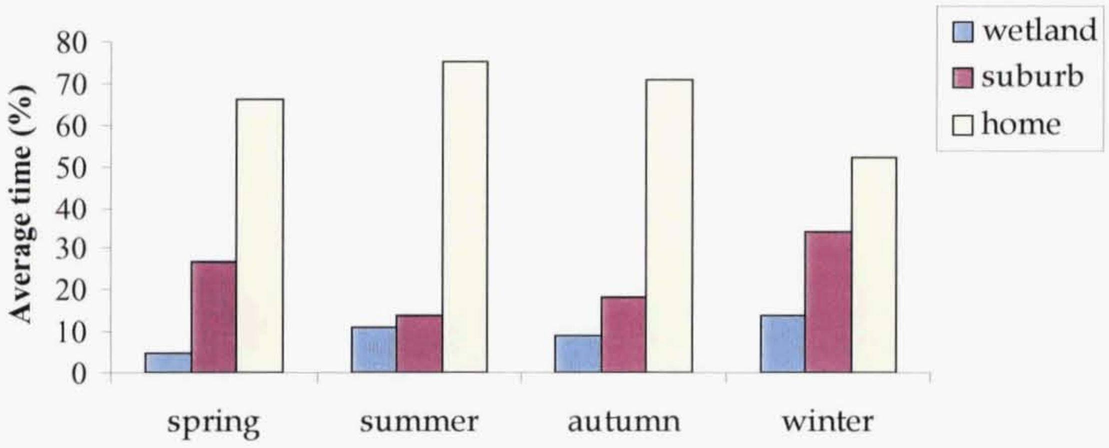


Figure 5.6. Seasonal variation in the average percentage of time spent by cats in different habitat types.

5.3.6 Effect Of Time Of The Day On Habitat Use

Cats were more likely to be in the wetland in the morning than in the afternoon or evening (Figure 5.7) although the difference was not statistically significant (Kruskal-Wallis; χ^2=0.41, P=0.9). Cats were most likely to be at home in the evening.

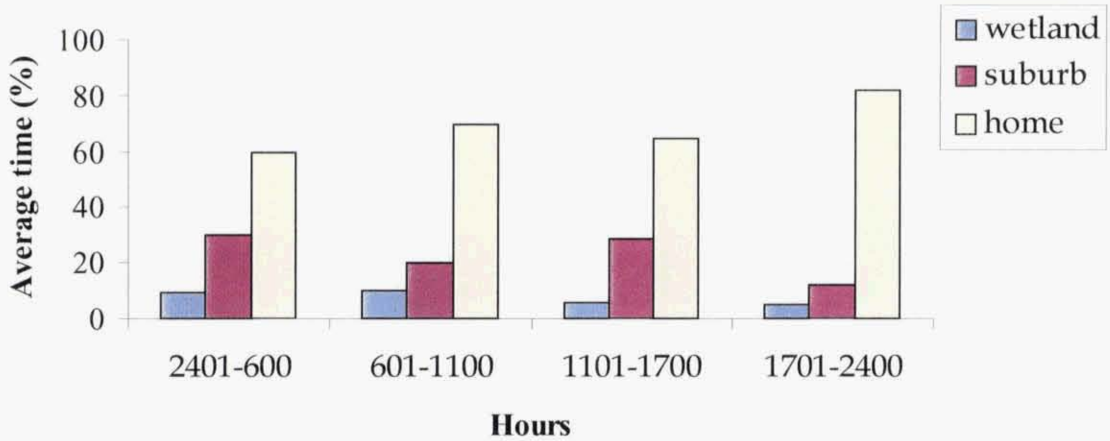


Figure 5.7. Average percentage of time spent by cats in different habitat types at different times of the day.

5.3.7 Effect Of Weather On Habitat Use

Cloud cover and rain had a marked effect on the cats' use of the wetland (Kruskal-Wallis; $\chi^2 = 8.5$, $P = 0.03$) and suburb (Kruskal-Wallis; $\chi^2 = 7.6$, $P = 0.05$) (Figure 5.8). Cat activity in the wetland and suburb was lowest during rain and higher in the wetland when cloud cover was low.

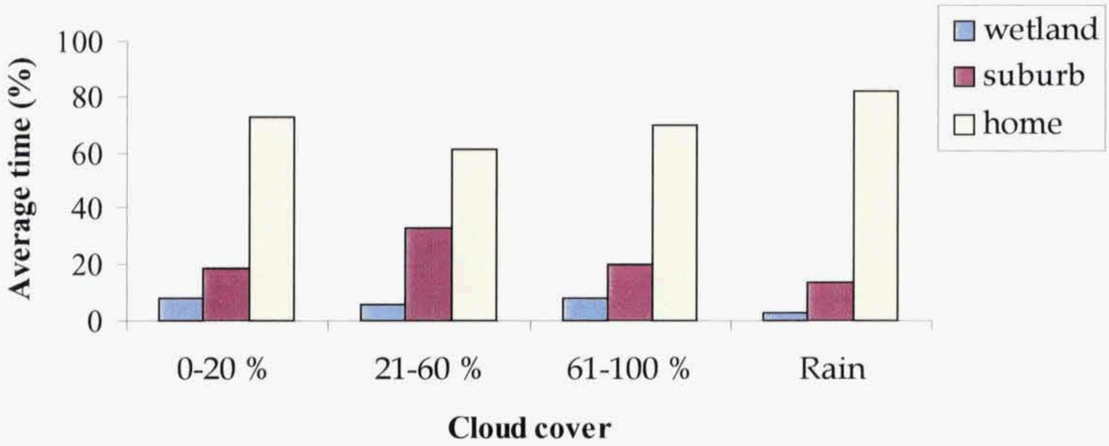


Figure 5.8. Average percentage of time spent by cats in different habitat types during different cloud cover.

Activity of cats was significantly affected by wind levels in the suburb (Kruskal-Wallis; $\chi^2 = 14.9$, $P = 0.001$) but not in the wetland. Cats were more likely to be found in the suburb than at home when there was no wind and less likely to be in the suburb during high wind.

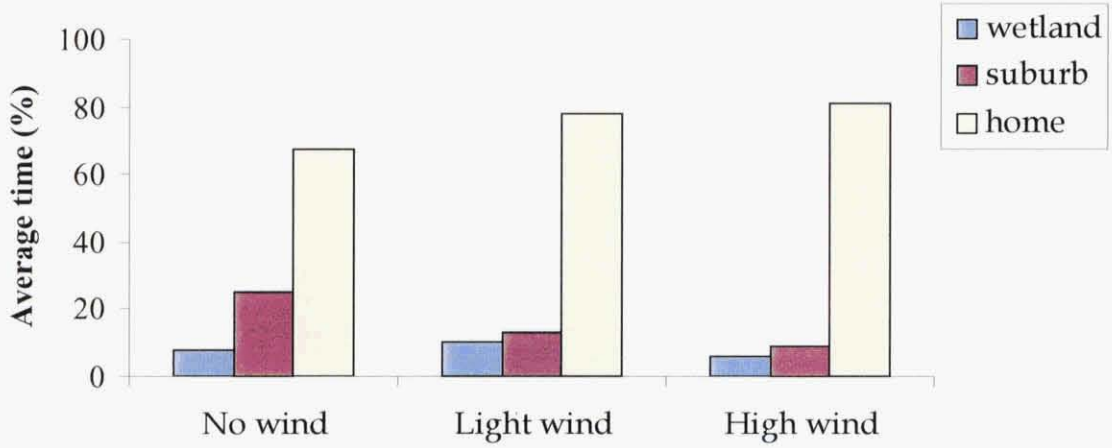


Figure 5.9. Average percentage of time spent by cats in different habitat types during different wind strengths.

5.3.8 Sightings Of Cats At Travis Wetland

Cats sighted at Travis Wetland not included in the radio tracking study were seen moving through all main habitat types at Travis Wetland although they were most often seen in grass on the wetland's periphery (Figure 5.10 and Plate 5.3). Cats appeared to prefer habitat that provided shelter, such as tall grass, swampland (tussocks, rushes and sedges) and among trees. Walking tracks were used by cats as a travel route around the wetland (Plate 5.4). Few cats (4%) were sighted in the drier Southeast area of the wetland. Two cats were sighted in water at the wetland; one in a water trough in the grazed Southeast area (Figure 5.4 Grid B3) and one on the edge of a ponding area close to Frosts Road. Cats have been seen swimming across swales at the Southern end of the wetland (Clare Washington pers. comm.). Residents living along the Southern periphery of the wetland (Grid B3 in Figure 5.4) have seen cats swimming across swales to islands that are used as nesting sites by birds (Plate 5.5) (Deborah Andrews pers. comm.).

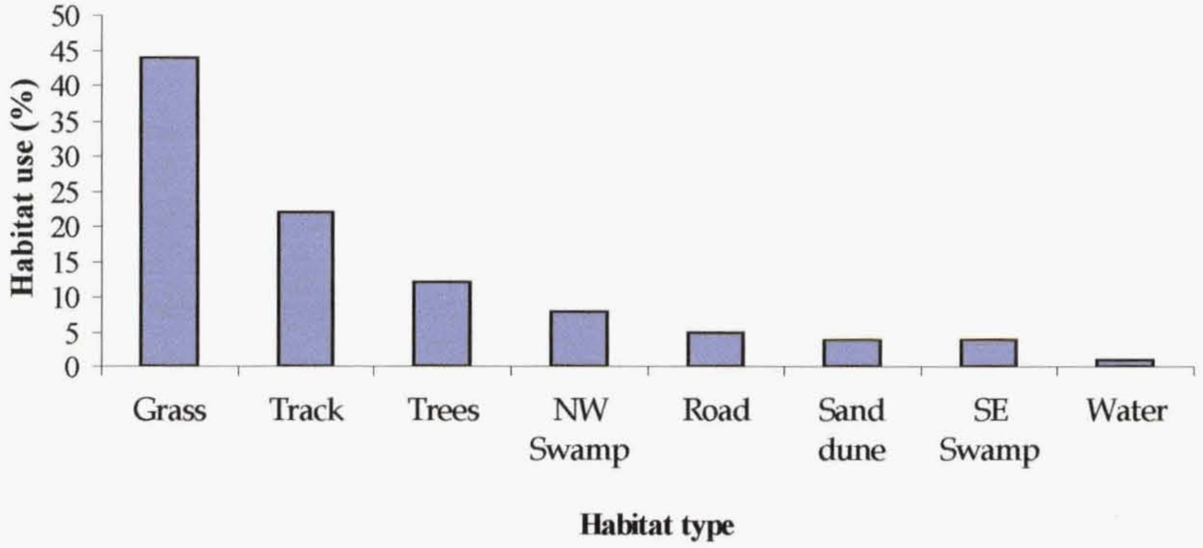


Figure 5.10. Percentage of sightings of cats in various habitat types at Travis Wetland (May 1999 to April 2001; n=141 sightings).

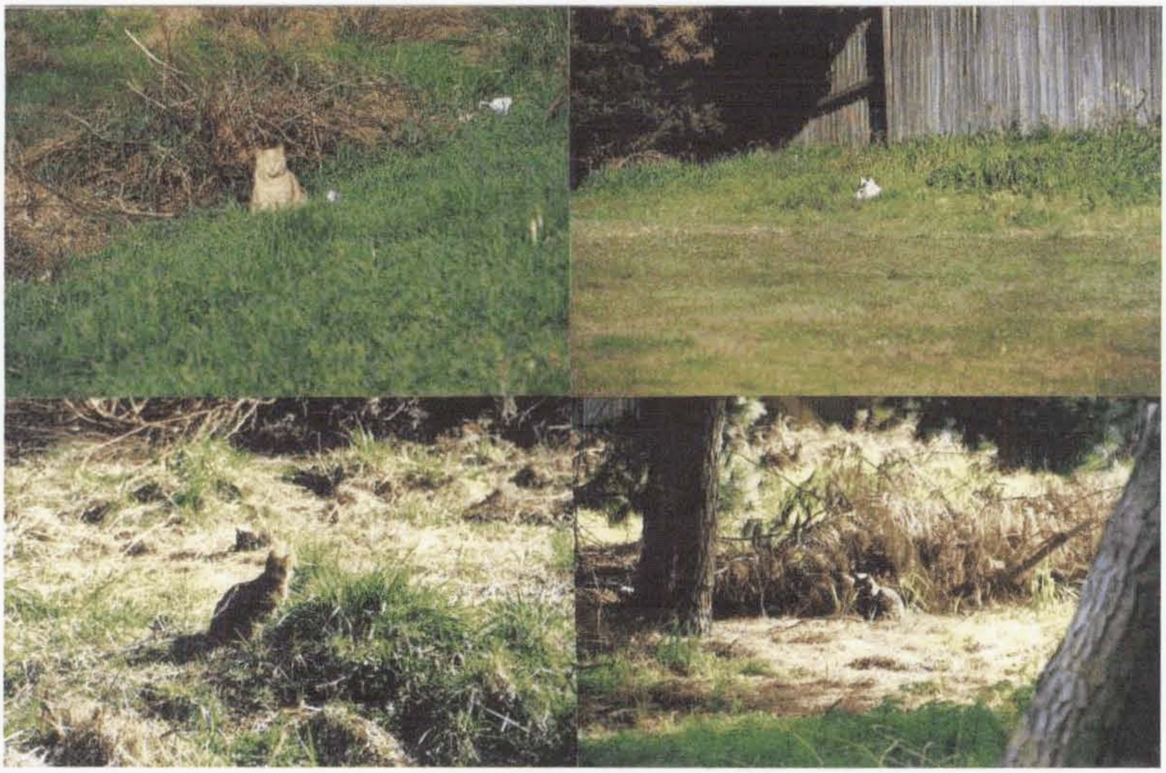


Plate 5.3. Cats sighted in grass on the periphery of Travis Wetland.

Plate 5.4. Cat using walking track to move around Travis Wetland.

Plate 5.5. Travis Wetland swale with island on the left used as a nesting site for birds.

5.3.9 Estimation Of Number Of Cats Using Travis Wetland

All cats living on the periphery entered the wetland, whereas only 23% of those living further from the wetland did (Table 5.10). This difference is not statistically significant (Fisher Exact Test: P=0.14) but may well be a real effect that would prove to be statistically significant if more data were available. I therefore calculated two estimates of how many cats were using the wetland. As an upper estimate, I assumed that 52% of 494 cats in the total survey area used the wetland (See Table 5.10), which generates an estimate of c. 260 cats. As a lower estimate, I assumed that 100% of 74 cats on the periphery and 23% of 420 cats not on the periphery used the wetland, which generates an estimate of c. 170 cats.

Table 5.10. Estimates of cats entering Travis Wetland from households in the surrounding 196ha of suburb.

	Number of households	Estimated number of cats[1]	Number of cats tracked	Number of radio collared cats entering wetland [2]	
Periphery of wetland	93	74	8	8	(100%)
Rest of survey area	524	420	13	3	(23%)
Total survey area	617	494	21	11	(52%)

[1] Assuming 0.8 cats per household - see chapter 3.
[2].From tracking study - see chapter 5.

5.4 DISCUSSION

Home range sizes and movements varied greatly between the cats. The cat with the largest home range size (10ha) was a desexed male and the cat with the smallest (0.2ha) was a desexed female. Male home ranges tended to be larger than female ranges although the difference was not statistically significant. Other studies of urban house cats (Barratt 1995a; Chipman 1990 in Bradshaw 1992) and of feral cats in New Zealand (Dowding 1997; Gillies 1998) similarly found male range size to be larger than female. Liberg & Sandell (1988) suggest that on average male ranges are 3.5 times larger than females, as male range size is determined by the distribution and density of females.. In this study, however all males were desexed and desexed house cats are known to roam less than intact ones (Fogel 1991).

The average home range size of house cats in this study was smaller than that of urban house cats in Barratt's (1995a) study and of feral cats (Fitzgerald & Karl 1986, Page et al. 1992, Langham 1992, Dowding 1997, Norbury et. al. 1998). High cat population density may help explain the small home ranges of cats in this study, as Liberg & Sandell (1988) suggest that cats decrease their home range size with increasing cat population density. Cat density is much greater in an urban environment than a rural environment and therefore the movement of urban house cats is restricted compared to that of feral cats. Bradshaw (1992) has suggested that some cats stay close to home to avoid confrontations with other cats. The mean number of house cats per household in this study was 0.8, whereas in Canberra, Australia, Barratt (1995a) found that the average number of house cats per household was only 0.4. House cats living adjacent to Travis Wetland did make smaller movements into the wetland than did house cats living adjacent to remnant grassland/woodland habitat in Canberra, Australia.

Home range overlap occurred mostly between cats from the same residence (as found by Barratt 1997b and Das in Barratt 1997b). Home range overlap was seen between two males from one residence and a female from a second residence 30m away. This result is consistent with observations that male and female territories and home ranges tend to overlap extensively (Liberg & Sandell 1988; Bradshaw 1992).

Male cat movements tended to be longer at night and female movements longer during the day, although again these differences were not statistically significant. Langham (1992) and Barratt (1995a) similarly found female movements were greater during the day than at night during spring and summer when rearing kittens, however female cats in this study were all desexed and none were rearing kittens. Female cats in this study may be choosing to move further during the day (when owners are at work) and less at night (when owners are at home providing food). Turner & Meister (1988) suggest there has been an increase in the diurnal activity of cats due to the provision of food by people.

Some variation in the home range size and movements of cats in this study can be explained by cat age. The cats that made the largest average movements were all from the 1-3 years old age class. Greater movements by younger cats has also been found in other urban cat populations (Mirmovitch 1995) and feral cats (Konecny 1987), but not in some other studies of feral cats (e.g. Liberg 1980, Fitzgerald & Karl 1986 and Gillies 1998 who all report that the movements of sub-adult males were smaller than adult males). In the case of feral cats it may be that territoriality is more important than age in determining the movements of feral cats. House cats are generally less territorial than feral cats (Bradshaw 1992, Fogle 1991) and they have a reliable food source that is usually protected from other cats. Leyhausen (1988) suggests that dominant, aggressive cats tend to maintain larger ranges than subordinate cats, which are typically the younger individuals (Fogle 1991).

Competition for foraging space may also help explain movement patterns of cats in this study. Bradshaw (1992) suggests that young cats may not hold any territory apart from the interior of their home and so may have to take lengthy routes in between the territories of other cats to reach hunting grounds. Due to the high density of cats living around Travis Wetland, young cats may find they have to move further to avoid the territories and foraging patches of other cats.

Distance of the cat's home to the periphery of the wetland was found to have a significant affect on cat movements. Cats living on the wetland periphery moved further in the wetland and had home ranges skewed towards the wetland (Figure 5.4). Similarly, urban house cats living next to open woodland habitat in Australia were found to have home ranges skewed towards the adjacent habitat (Barratt 1995a). Cats living close to the wetland have few roads, fences, other cat territories and disturbances such as dogs or humans to avoid in order to get to the wetland. Cats living close may therefore have more energy and incentive to travel further in the wetland than cats living further away. Cats may be encouraged to travel and include the wetland in their home range due to the availability of prey and the foraging, sunning and resting sites the wetland provides. Cats with large home ranges and large movements in the wetland were also found to retrieve more prey, which suggests that cats do use Travis Wetland as a foraging site.

Cats of both sexes made larger movements and were located more often in the suburb and wetland in winter than in summer. Other studies (e.g. George 1974, Jones & Coman 1982, Izawa 1983, and Liberg 1984) have found that in summer movements of feral cats decreased during the day to avoid hot weather and in winter increased during the day. Cats spent significantly more time at home and less time in the suburb or wetland when cloud cover was low (0-20%), presumably because they were avoiding direct sun in daylight hours. Cats moved less and avoided spending time in the suburb or wetland during periods of strong winds and rain. House cats in this study appear to reduce their activity and movements, avoiding the suburb and wetland during periods of extreme weather.

Cats were least likely to be in the wetland and suburb during the hours 1701-2400hrs, which corresponds with the principal time when most cat owners are at home and active. Barratt (1995a) found that the activity of house cats in Australia dipped around 1800hrs and was lowest in early to mid evening when cats were at home interacting with their owners. Cats spent more time in the wetland between the hours of 2400-1100hrs which may reflect a decrease in owners' activity after 2400hrs and cats avoiding the heat of the day returning home for shelter and rest, as cats are most likely to sleep around midday and in the middle of the night (Fogel 1991). Feral cats are generally found to be most active at dusk and dawn (Jones & Coman 1982, Izawa 1983, Konecny 1987, Fogel 1991, Bradshaw 1992). House cats in this study were more active at dawn than dusk, spending more time in the wetland during 2401-600 hrs and in the suburb during 2400-600 hrs. Similarly, Barratt (1995a) found house cats in Australia were most active at around midnight and not dusk. Barratt (1995a) suggests the difference in activity between feral and house cats is due to the lack of dependence of house cats on prey for food, unlike feral cats whose prey, principally (birds) are most active at both dusk and dawn.

Cats may spend more time in the wetland in summer and winter than any other season due to the activity and availability of their prey. Prey availability had a significant influence on the movement and activity of house cats in this study, as the cats that spent more time in the wetland had larger home ranges, moved greater distances and caught more prey than those rarely in the wetland. Konecny (1987) found that differences in periods of activity of feral cats on the Galapogos Islands depended on prey density. Cats may be more likely to travel and spend time at Travis Wetland in winter than in any other season possibly due to a decrease in the availability and activity of prey in their own backyards. Skinks are found on properties around Travis Wetland and were retrieved less by cats in winter than any other season. The common skink *Oligosoma polychroma* caught by cats in this study is a diurnal skink that hibernates in winter. As skinks are scarce in winter, cats may travel to Travis Wetland in search of alternative prey. Cats may spent more time in the wetland in summer than other seasons when most birds at Travis wetland are nesting and are more vulnerable to predation.

A greater occurrence of cats in the suburb and less in the wetland in spring may not solely reflect prey avaliblity. More skinks and invertebrates were caught in spring than any other season, which may be equally available on the cat's own property as in the suburb. Many cat owners reported that invertebrates and skinks were caught by cats on the property. Activity of cats in the suburb in spring may be related to social behaviour, as the mating season of house cats occurs in spring. Although all cats in this study were desexed there may still be a change in house cat behaviour in spring, as desexing is thought to have little effect on the behaviour of female cats and increased daylength in spring is known to stimulate oestrus in female cats (Fogel 1991).

The cats monitored spent most of their time at home and Barratt (1995a) similarly found this for urban house cats in Australian. House cats presumably spend time at home so as to be close to their primary food supply and owners and perhaps because prey are available on their property. Residents living around Travis wetland have noticed that mice tend to move from the wetland to their properties in winter. Skinks and birds may also become more available in the suburb when they are most active. Owners have reported the movement of mallard ducks from the wetland to their properties in spring, when ducks tend to nest in the suburb. Therefore cats living around Travis Wetland do not always have to leave their property to capture prey.

House cats in this study may also spend considerable time at home so as to avoid confrontations with other cats. A dense population of house cats as around Travis Wetland may increase the number of confrontations cats experience, as many cats are trying to defend a territory in a small area. Only four cats (three males and one female) spent the majority of their time away from home. These cats all appear to have been quite social and tolerated by other cats in the area. One of the males was known to scavenge the food of other cats in the area and yet still be tolerated by these cats.

Most cats sighted at the wetland were on the wetland periphery (Plate 5.6). Results from predator monitoring surveys conducted by the Christchurch City Council also found house cats were present in larger numbers on the periphery than the internal of the wetland (Figure 5.10). This suggests that the more productive parts of the wetland for nesting birds, near ponding areas and ditches in the internal parts of the wetland (Plate 5.7) may be to some extent protected from cat predation.

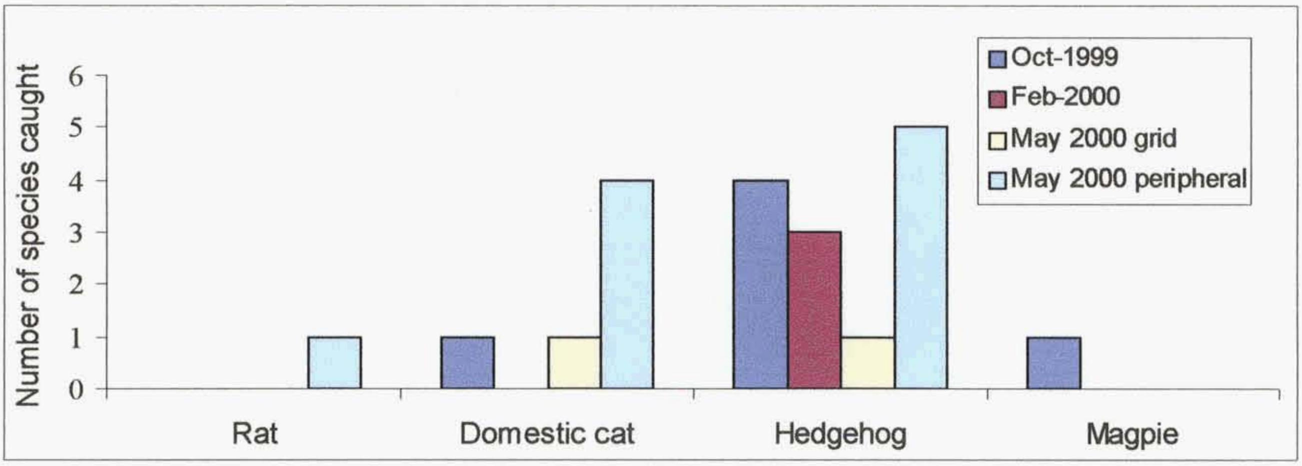


Figure 5.11. Numbers of predators trapped with live-traps during three trapping sessions in October 1999, February 2000 and May 2000. (from Byrom 2000).

Plate 5.6 Cat moving on wetland periphery.

Plate 5.7 Example of internal habitat at Travis Wetland used as nesting sites for pied stilts.

Cats may be found frequently on the wetland periphery due to the high number of mice found on the periphery (Byrom 2000). Cats have been seen hunting pukekos, mice and skinks adjacent to walking tracks on the wetland periphery (Plate 5.8).

Cats were able to move through all types of habitat at Travis Wetland including mud and water and were often sighted in vegetation such as tall grasses, tussocks and amongst willows. These types of vegetation appear to act as resting and sunning sites for cats (Plate 5.9). Walking tracks are used frequently by cats as a way of moving around the wetland periphery and cats are often seen gathering on the tracks. Other authors (Leyhausen 1956 and Izawa et al. 1982) have also reported groups of cats gathering in open spaces, yet little is known about the role of these gatherings. Izawa (et al. 1982) suggests that the gathering of cats in his study was to form social bonds between cats of the same feeding group. The gathering of cats in this study also appears to be some sort of socialising behaviour.

Plate 5.8. Cat stalking prey on wetland periphery.

Plate 5.9. Cat resting among grass and tussock

The sighting of fewer cats in the Southeast area of the wetland may be due to the absence of peripheral housing in this area. This may suggest that the majority of cats using Travis Wetland will be from housing on the periphery of the wetland. The sighting of cats swimming across defensive swales to islands used, as nesting sites for birds at Travis Wetland is disappointing. Cats may be swimming across the swales to hunt nestlings on the islands. Cats at the wetland have also been observed jumping across drains and ditches.

Four cats radio collared in this study crossed ditches and one cat live trapped in the Christchurch City Council predator monitoring programme was seen to jump straight across an approximate 1.5m wide ditch.

Movement patterns and habitat use of house cats living around Travis Wetland may be influenced by the dependence of owners for food, density of the surrounding cat population, cat age, seasonal changes in weather, prey availability and social interactions with owners and other cats. Implications of the movement of suburban house cats into adjacent natural habitat that provides foraging and resting sites for house cats is discussed in the next chapter.

Chapter 6 General Discussion And Conclusions

6.1 Potential Cat Impacts On Travis Wetland Wildlife

It is estimated that between c. 170 and 260 cats are visiting Travis Wetland from surrounding housing. While (81%) of cats radio tracked at Travis Wetland moved less than 100m into the wetland and most cats at Travis Wetland are seen on the periphery, nevertheless cats have been sighted in the internal parts of the wetland. It may be possible that not all cats visiting Travis Wetland are using the wetland as a foraging site but for socialising and sunning and resting sites. However, all cats radio tracked in the wetland were found to retrieve prey and the more time a cat spent and travelled in to the wetland the more prey it retrieved. What impact cats reaching the internal parts of the wetland is unknown. Cats living in households on the wetland periphery were the ones that moved furthest into the wetland so these cats probably have the greatest predation impact on Travis Wetland species.

Use of the wetland periphery by house cats has the potential to influence the distribution and abundance of species on that periphery, however to date there is no evidence of any major shifts of species away from the periphery. Predator monitoring (Byrom 2000) found a greater number of mice, rats, hedgehogs, ferrets, stoats and cats occur on the wetland periphery than in the internal parts of the wetland. Similarly, a survey of lizard fauna indicated that skinks *Oligosoma polychroma* were most common in grassland near the periphery of the wetland, probably because *Oligosoma polychroma* tends to inhabit open areas of low vegetation or debris cover (Freeman & Freeman 1996).

House cats may therefore use the periphery of the wetland more than internal parts, due to the greater availability and abundance of prey found there. The use of habitat edges by predators is not uncommon and has been recorded in grassland on the Otago Peninsula, New Zealand (Alterio, et al. 1998). Greater use of the wetland periphery suggests that bird populations nesting in internal parts of the wetland are at less risk from the predation of house cats, than birds and other species occurring on the edges of the wetland. A greater number of stilt, pukeko, spur wing plover, mallard duck and Canadian geese nests are found in the more internal parts of the wetland near drains and ponding areas (personal observations) (Plate 5.7).

The presence of ideal habitat for *Oligosoma polychroma* on the wetland periphery and the fact that *Oligosoma* is a diurnal lizard species, active during the day increases its vulnerability to house cat predation at Travis Wetland. House cats in this study were found to be active on the wetland periphery during the day. The importance of skinks as prey of house cats in this study may be of concern. Predation by introduced mammals (rats, mice, stoats, cats, hedgehogs) is known to be a very serious problem for lizards in New Zealand (Towns & Daugherty 1994, Whitaker & Gaze 1999) and over half of *Oligosoma* species known to exist in New Zealand are at risk (Whitaker 1998). Cats are known to be very effective predators of lizards (Fitzgerald 1990) and where skink populations are small and isolated cat hunting strategies mean they have the capacity to deplete or remove local populations (Whitaker 1998). *Oligosoma polychroma* is not only at risk from house cats at Travis Wetland, but rats, mice, stoats, ferrets and hedgehogs. When lizard populations in New Zealand have been excluded from predators they have shown remarkable increases in population density, spatial distribution, habitat use, behaviour and body size (Whitaker & Gaze 1999).

6.2 Potential Predator-Prey Interactions At Travis Wetland

House cats living around Travis Wetland caught a greater diversity and number of prey the closer to the wetland they lived. House cats in this study appear to be opportunistic predators that can readily switch from one prey to another in response to changes in prey availability. That house mice were the most common prey item retrieved by cats reflects both the availability of mice and the likely preference by house cats for small mammals (Turner & Meister 1988).

In an ecosystem like Travis Wetland there are many possible interactions between predators and prey that need to be considered before decisions regarding appropriate cat management are reached.

For example cat predation may help limit the number of mice that occur in the wetland and adjacent suburb, which may benefit native species at Travis Wetland such as lizards and invertebrates that are known prey of house mice in New Zealand (Murphy & Pickard 1990). The extent of any such benefit is unclear, however, invertebrate populations at Travis Wetland are relatively rich (Macfarlane et al. 1998). The presence of mice may even protect bird species at Travis Wetland by acting as prey for other predators such as stoats and ferrets and thereby reducing their need to prey on birds. Prey switching by cats due to seasonal changes in the availability of prey was evident in this study and has been reported elsewhere in New Zealand (e.g. Brown & Keedwell 1998, Norbury et al. 1998, Moller & Alterio 1999). If cats were to reduce mice populations to low levels at Travis Wetland as has been found of mammalian predators in Australia (Sinclair et al. 1990) then prey switching of ferrets and stoats from mice to birds, lizards and invertebrates could occur. On the other hand, the removal of cats from Travis Wetland could potentially result in an increase of stoats, as these were being caught by cats in this study. Without cats' mice and skink numbers could increase which in turn could increase the breeding success and population size of other predators. The effects of any potentially change in cat activity in the wetland clearly requires further investigation.

Because house cats typically receive food from their owners, their populations are not thought to be affected by population fluctuations in their live prey (Coleman et al. 2000). Barratt (1995a) suggests this is not necessarily a problem for prey populations, as many wild predators manage to maintain stable population densities without threatening their prey populations by living on alternative foods when their main prey is scare as occurred in this study.

6.3 POTENTIAL CITY-WIDE CAT IMPACTS

The number of houses in the Christchurch urban area is about 324,900 (New Zealand Population Dwelling Census, June 2000 estimate). If domestic cat demographics throughout the Christchurch urban area are similar to those around Travis Wetland, (i.e., 0.8 cats per household) then there would be approximately 260,000 domestic cats living in Christchurch City. Using the mean number of prey known to have been retrieved per cat per year (11.5, chapter 4), the estimated mean annual predation by cats living around an 196ha area of Travis Wetland containing 617 households, is 5,676 prey items per year and annual predation by cats living in the entire Christchurch urban area would be c. 3,000,000 prey items per year. Since domestic cats probably bring home only 50% of their prey (Coleman & Temple 1993) annual predation by cats in Christchurch is probably closer to 6,000,000 animals caught per year. If the prey selection of house cats elsewhere in Christchurch City were similar to that of the population around Travis Wetland, then this 6,000,000 total would consist of 2,228,000 rodents, 1,320,000 insects, 1,080,000 native skinks, 420,000 sparrows, 120,000 blackbirds, 60,000 silvereyes, 60,000 mallard ducks, 30,000 frogs, 24,000 fantails, 12,000 stoats, 12,000 goldfish, 6000 kingfishers and 6000 welcome swallows. This extrapolation of data obviously does not account for habitat and habitation differences between a small study area and Christchurch as a whole, so is only an approximation of true predation by the wider house cat population. For example, it is likely that the number of mice, skinks, frogs, stoats and kingfishers taken by house cats in this study is higher than in other areas of Christchurch City, as Travis Wetland provides particularly suitable habitat for such species.

Without information on the population dynamics of these species, such as their rates of natural mortality and recruitment, it is not possible to accurately quantify what impact this level of predation has on their populations. Predation of species such as mice, sparrows, blackbirds and silvereyes by house cats in an urban environment is unlikely to be of concern. Many such species breed successfully in urban environments and have persisted despite past cat predation. For example, Ogle (1982) found New Zealand forest bird species such as faintails *Rhipidura fuliginosa* and silvereyes *Zosterops lateralis*, which have low endemism, do well at colonising remnant habitats of all sizes. Barratt (1995b) suggests increased habitat diversity associated with aging of suburbs is increasingly likely to provide at least partial refuge for prey, reducing their susceptibility to predation at low densities. For bird communities the type and quality of refuge habitats, the distance from suburbs to source habitats and the availability and diversity of urban habitat determines the richness and abundance of bird populations in urban environments (Green 1984 in Barratt 1995a). Therefore habitat availability may be more important in influencing bird populations in some urban habitats than predation by house cats.

6.4 Recommendations and Further Research

While defensive swales and ditches at Travis Wetland do not restrict the movement of all cats they will deter some, as it appears only a small number of cats swim across swales and jump ditches to enter internal parts of the wetland. Currently there is still not enough information to accurately assess how many cats are using the internal parts of the wetland. Therefore it is recommended that monitoring of cats by radio tracking continues, to increase information on the movements of cats in the internal parts of the wetland.

As most of the cats monitored in this study lived within 200m of the wetland, the maximum distance that cats will travel from the suburb was not able to be assessed. It is recommended that further monitoring of cats be conducted to estimate how many cats living greater than 200m away use the wetland. This information is required to be able to consider the introduction of cat buffer zones in housing development next to ecologically sensitive areas in New Zealand.

It is not yet known what impact house cats are actually having on wildlife at Travis Wetland. Further research is required that can quantitatively assess cat impacts by relating predation pressure to breeding success and natural mortality of populations predated by cats at Travis Wetland. Therefore monitoring of nesting birds, skinks and frogs is recommended at Travis Wetland.

The skink *Oligosoma polychroma* is considered common in Christchurch (Freeman & Freeman 1996) and is widespread throughout the South Island (Gill & Whitaker 1996). Nevertheless it is the only known lizard species at Travis Wetland, there is no extensive information on its abundance there, and it is commonly depredated by cats. It is therefore recommended that this species be considered a priority for further monitoring at Travis Wetland. Increased knowledge of *Oligosoma polychroma* population trends should be made an important objective for Travis Wetland. The implementation of a regular skink monitoring programme would help determine any changes in the *Oligosoma polychroma* population, add to the little information available on the ecology of lizards in urban environments, and help determine if there is a need for active management efforts to protect them from cats.

The species of frog retrieved by cats in this study (*Litoria ewingii*) is less aquatic than other *Litoria* species in New Zealand (Newman 1982) and when not breeding is relatively independent of water (Gill 1978 in Newman 1982). This species may thus be particularly susceptible to cat predation. No information exists on frogs at Travis Wetland so it is recommended that monitoring be conducted to determine which species are present and the population trends of frogs. This will help assess any cat predation impacts on frog populations at Travis Wetland.

To determine any impact of cats on nesting wetland birds at Travis Wetland, surveys of nesting success and monitoring of artificial nests is recommended. The monitoring of nests on the periphery and internal parts of the wetland will help to determine whether the impact of cats is greater on the periphery or in the internal parts of the wetland (the latter being the most important for nesting birds at Travis Wetland).

Video surveillance of the behaviour of cats and other predators around real and artificial nests at Travis Wetland would provide a good research topic for future students.

As little is known of the impact of house cats on Travis Wetland wildlife or on predator/prey interactions in general at Travis Wetland, it is premature to recommend restrictions on cat movement or construction of further barriers to cat movement at Travis Wetland. If the movement of house cats into Travis Wetland was to ever be controlled or mitigated, then to avoid the problem of possible increases in populations of other predators, it is recommended that all predators should be targeted in any predator removal program at Travis Wetland (this supports an earlier suggestion by Byrom 2000).

House cats in this study wearing a collar with a bell retrieved more prey than cats without a bell, which suggests collars with bells are not effective in protecting wildlife. Many of these cats had previously been collared by their owners due to their hunting efficiency. Paton (1991 in Davis 1996) found on average non-belled domestic cats took 59% mammals, 62% birds, 32% reptiles, whereas belled cats took 58% mammals, 47% birds, and 37% reptiles indicating that bells do not prevent cats from taking wildlife. Similarly, Reark Research (1994), Reid & Speare (1995), Barratt (1998), Gillies (1998) and Gillies & Cutler (2001) all concluded collars with bells or alarms are ineffective at preventing cats from catching wildlife. Therefore the collaring of cats with bells is not recommended as a tool in managing the predation of Travis Wetland wildlife by cats.

House cat predation is not only a biological science issue in New Zealand, but very much a social science issue, and more information is required on the latter aspect of the problem. It is important that information on the behaviour and attitudes of cat owners be assessed. Experience in Australia has been that public consultation is the most effective way to implement cat management and controls and results in more lasting changes in behaviour (Richards 1994, Jennens 2000, Jackson 2000).

To help mange the house cat population around Travis Wetland it is recommended the Christchurch City Council encourage and promote responsible cat ownership (Appendix 4.1).

The Travis Wetland community would provide an ideal opportunity to trial a preliminary education campaign focused on informing cat owners of the issue of stray cats at Travis Wetland, predation impacts of house cats, ways to reduce the impact of predation and gauging how cat owners feel about cat management policies. Education campaigns in Australia, Israel, Italy, United Kingdom and United States have been successful in controlling stray and feral cat populations. Many residents living around Travis Wetland are already aware through hearing or participating in the study and through Christchurch City Council publications of the conservation values and issue of house cats at Travis Wetland. This community would be suitable for a trial, as residents were found to be approachable and sympathetic as 94% of residents contacted were prepared to indicate whether or not they owned a cat and 78% were prepared to complete a survey.

Cat owners in this study were found to be good at predicting how often their cat hunted, suggesting they may be observant to the prey retrieved by their cats. Therefore the method of asking cat owners to record the prey retrieved by their cats may be more reliable then thought, and effective in communities like Travis Wetland which is mostly of a higher socio-economic level (Health Services Research Centre, 1996) and where cat owners may be more responsible due to the high number of cats reported by owners as being desexed.

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APPENDIX 1.1

Predator and cat free subdivisions in New Zealand. Source New Zealand Forest and Bird, Wellington.

Location: Mahakirau Private Forest Estate, Coromandel Developer:

Council: Thames Coromandel District Council

Contact: Meg Graeme, Forest and Bird; Gerry Kessels, QEII Trust

Method: QEII Covenant

Date: -

Location: Te Ananui Farms, Peninsula Road, Whangamata, Coromandel

Developer: Neilsen (consultant Bernard Brown Associates Ltd)

Council: Thames Coromandel District Council

Contact: Meg Graeme, Forest and Bird

Method: Covenant

Date: 2001

Location: Duck Creek, Coromandel

Developer: -

Council: Thames Coromandel District Council

Contact: Meg Graeme, Forest and Bird

Method: Agreement on Covenant

Date: 2001

Location: South of Whitianga

Developer: John

Council: Thames Coromandel District Council

Contact: Meg Graeme, Forest and Bird

Method: Agreement on Covenant

Date: 2001

Location: Otaki Gorge, Kapiti

Developer: -

Council: Kapiti Coast District Council

Contact: Daphne Steele, KEA (Kapiti Envoirnmental Action Group)

Method: -

Date: 2001

Location: Waikanae, Kapiti

Developer: -

Council: Kapiti Coast District Council

Contact: Daphne Steele, KEA (Kapiti Envoirnmental Action Group)

Method: -

Date: 2001

Location: Bank of Wairoa River, Tauranga

Developer: Heybridge

Council: Western Bay of Plenty District Council

Contact: Basil Graeme, Forest and Bird

Method: Agreement on Covenant

Date: 2001

Location: Five Jems, Wahihi Beach

Developer: -

Council: Western Bay of Plenty District Council

Contact: Department of Conservation, Rotorua

Method: -

Date: 1996

Location: Ohiwa Harbour, Tauranga

Developer: -

Council: Western Bay of Plenty District Council

Contact: Maire Long, Fish and Game Eastern Region

Method: -

Date: -

Location: Athenree, Tauranga Harbour

Developer: -

Council: Western Bay of Plenty District Council

Contact: Basil Graeme, Forest and Bird

Method: Not successful

Date: 1996-1997

Location: Rangitane, Opito Bay, Northland

Developer: Owen Smith

Council: Far North District Council

Contact: Michael Winch, Forest and Bird

Method: Consent Order on non-complying subdivision

Date: 1996

Location: Rangitane, Opito Bay, Northland

Developer: Gibson

Council: Far North District Council

Contact: Michael Winch, Forest and Bird

Method: Convenant on subdivision lots

Date: 1992-1993

Location: Northland

Developer: Tony Coyte

Council: Far North District Council

Contact: Michael Winch, Forest and Bird

Method: Consent Order on subdivision lots

Date: 1996

Location: Rangitane, Northland

Developer: -

Council: Far North District Council

Contact: Michael Winch, Forest and Bird

Method: Consent Order on non-complying subdivision

Date: 1996

Location: Rangitane, Northland

Developer: -

Council: Far North District Council

Contact: Michael Winch, Forest and Bird

Method: Consent Order on non-complying subdivision

Date: 1996

Location: Rangitane, Opito Bay, Northland

Developer: Dreadon

Council: Far North District Council

Contact: Michael Winch, Forest and Bird

Method: -

Date: -

Location: Kerikeri, Northland

Developer: Canning

Council: Far North District Council

Contact: Michael Winch, Forest and Bird

Method: Consent order on subdivision

Date: -

Location: Opito Bay, Northland

Developer: Oceanview Properties Ltd

Council: Far North District Council

Contact: Michael Winch, Forest and Bird

Method: Not successful

Date: 1998

Location: Whangaroa Harbour, Northland

Developer: Perott

Council: Far North District Council

Contact: Michael Winch, Forest and Bird

Method: Consent order on subdivision

Date: 2000

Location: Kaiwharawhara, Wellington

Developer: Harbourside Developments Ltd

Council: Wellington City Council

Contact: John Cottle, Forest and Bird

Method: Covenant

Date: September 2001

APPENDIX 2.1

Forest and Bird draft cat management policy

Forest and Bird *Cat Policy*

FOREST & BIRD

Goal

The goal of this policy is to promote the protection of native species by minimising the impact of cats on native wildlife, while recognising the role that cats play as companion animals. Ideally, this goal would be achieved through ensuring that every cat in New Zealand is a responsibly owned domestic cat.

Objectives

To reduce the impact of domestic cats on native wildlife by encouraging people to follow the principles of responsible cat ownership.

To reduce the impact of stray and feral cats on native wildlife by removing them using humane and environmentally sound methods.

To work constructively with other organisations involved in cat management to reduce
the impact of cats on native wildlife.

Policies

1. Categories of cat

1.1 Forest and Bird recognises three categories of cat; domestic, stray and feral (see definitions pages 2 - 3) which are consistent with the categories recognised by other organisations involved in cat management.

2. Domestic cats

2.1 Forest and Bird recognises the role of cats as companion animals, and advocates responsible ownership of domestic cats. This advocacy is based on principles of responsible cat ownership (see principles page 3).

2.2 Forest and Bird considers that in areas of high ecological value, "wildlife friendly" status should be given, preventing the ownership of cats and other predators as pets.

(NOTE: A policy is required for wildlife friendly areas, which should include (1) how 'high ecological value' is defined, (2) what type of areas wildlife friendly status will be sought for, and (3) what conditions will be attached to wildlife friendly status.)

2.3 Forest and Bird will advocate greater legal responsibility by cat owners, including legislation requiring registration, identification and desexing* of domestic cats.

* Breeding cats should be registered as such, and kept in compliance with the standards of a registered cat breeder.

3. Stray cats

3.1 Forest and Bird supports the removal of stray cat populations from both urban and rural areas, and advocates greater responsibility from councils in dealing with stray cat problems in their area. Stray cat populations can be removed by domesticating, desexing and finding suitable homes for the cats or by humanely euthanasing the cats. Programmes to remove cats should be accompanied by control of prey species such as rodents.

4. Feral cats

4.1 Forest and Bird supports the eradication of feral cats from all native habitat, ensuring that trapping is carried out in accordance with the Animal Welfare Act and cats are killed humanely, and that eradication programmes include pest species that are prey of cats.

5. Conservation programmes requiring predator control

5.1 Predator control should be carried out humanely, efficiently and effectively, according to Forest and Bird's guidelines for branches involved in trapping and control.

5.2 Where conservation programmes include predator control, a statement on the aims and methods for control should be produced to act as a guide for staff and volunteers and ensure compliance with Forest and Bird guidelines.

6. Other organisations

6.1 Forest and Bird acknowledges the benefit of working with other groups involved in cat management, and will seek to work alongside other groups where goals for cat management are shared.

Further information

Definitions of cat categories

Domestic cats are owned and cared for by humans. They rely on humans for their basic needs including food, shelter and veterinary care. Even well fed domestic cats retain and use their hunting instinct, however responsible ownership can minimise the impact of a domestic cat on the local wildlife.

Stray cats are unowned cats, which live in or around human populations. They include abandoned domestic cats and cats born to strays. Stray cats rely on human populations for some of their needs, most of their food being scavenged from or provided by people. Stray cat populations often breed with and are added to from the population of domestic cats. It is possible to domesticate stray cats, thus reducing their impact on wildlife and improving their quality of life.

Feral cats are essentially wild animals that do not rely on humans for any of their needs. They live in the wild, often far from human populations, and survive through hunting and scavenging their food. Feral cat populations are self-sustaining and have the greatest impact on native wildlife. Feral cats may exist through necessity in colonies, although this is an unnatural and stressful situation for a territorial animal such as the cat.

Principles of responsible cat ownership

Being committed to caring for your cat throughout its life
Not giving cats or kittens as gifts
Desexing your cat
Never abandoning a cat
Providing proper care for cats while on holiday
Using identification, either a secure collar and tag or a microchip
Ensuring your cat is able to exercise and play (e.g. with moving toys)
Keeping your cat inside at night
Feeding your cat indoors, and not leaving food out for stray or feral cats
Protecting wildlife in your garden (e.g. preventing cat access to bird feeders and trees with nests)

(NOTE: Evidence suggests that neither bells nor warning collars are effective in reducing cat predation)

APPENDIX 2.2

New Zealand newspaper articles from November 1999-August 2001 on house cat research and the public's feelings towards cat management.

NB: Newspaper articles have been removed due to copyright.

APPENDIX 3.1

Questionnaire sheet used to survey Travis Wetland residents.

TRAVIS WETLAND CAT SURVEY

Thankyou for taking the time to complete this brief survey. All responses are confidential and anonymous. No individual cats or cat owners will be identified in the results.

Breed: ______________________________ Coat colour: _________________

Age of cat: ______ months, 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Size: Smaller than average Medium Larger than average Male Female

Neutered: Yes No Age when neutered: ____________

No. of times fed a day: none 1 2 3 4 5 6______________

Type of food fed: Canned food ☐ Dry food ☐ Table scraps ☐

How often does your cat usually bring home prey? (circle)

Daily Weekly Fortnightly Monthly More than once a year Less than once a year Never

No. of nights per week your cat usually spends outside: never 1 2 3 4 5 6 7

Does your cat were a bell? Yes No

No. of cats on neighboring properties (all sides): ______________________________

Have you ever seen your cat at Travis Wetland? Yes No If so, how often? ___

How far from your property have you seen your cat?

Neighbours property ☐ Across the road ☐ Less than 10 houses away ☐ More than 10 houses away ☐ Less than 1km away ☐

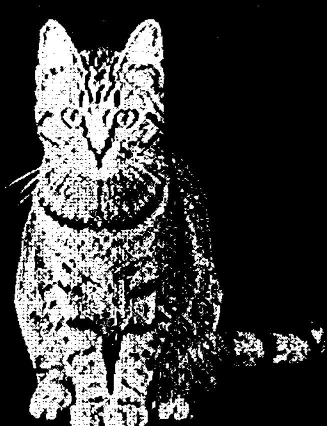
Would you have your cat collared with a bell if asked?

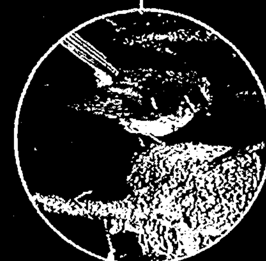
If you have any questions or concerns please contact Shelley Morgan at Ecology and Entomology Department, Lincoln University Ph 3252811. Or Kay Holder at Coast Care Christchurch City Council Ph 3821678
#

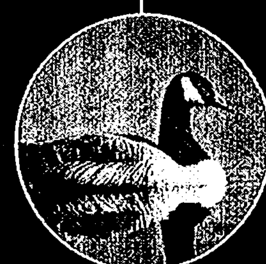
APPENDIX 4.1

Pamphlet used to recruit residents into the hunting study.

a closer look at what the cat's dragged in







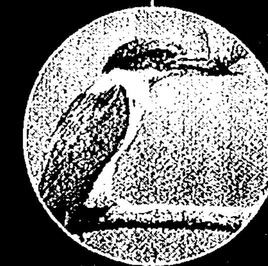
My name is Shelley Morgan. I am a Master of Science student at Lincoln University working in conjunction with the Christchurch City Council.

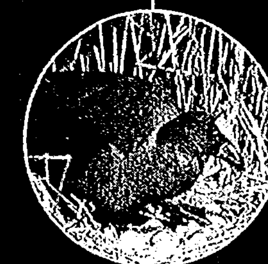
Travis Wetland is very important as it is the largest fresh water wetland left in Christchurch. It is home to over 57 different bird species, some of which are endangered.

For the Wetland to be restored it's vital that we gain more information on the hunting activities of cats in the area.

To determine the amount and type of wildlife caught by cats living adjacent to Travis Wetland, I need you to record and collect what your cat(s) bring home.

We have no desire to remove cats from the area, but want to see if there are any ways in which we can help cats and wildlife to co-exist more successfully.





In return for your much needed and appreciated help you will receive a free monthly sample of Nutrience Super Premium cat food.

If you are interested in helping me with my research please complete the tear off and post the back panel.

- ○ I would like further information on your research.
- ○ I am interested in helping you with your research.

name ____________________

address ____________________

____

phone ____________________

APPENDIX 4.2

Prey record sheet supplied to cat owners.

What does your cat bring home?

Birds					**Other**			
	Fantail	Oystercatcher	Sparrow	Tui	Hare	Skink	Stoat	Insects
Blackbird	Finch	Pukeko	Spur-winged plover	Waxeye	Mouse	Fish	Weasel	
Bunting	Gull	Pied Stilt	Starling	Yellowhammer	Rabbit	Eel		
Canadian goose	Harrier	Shag	Swallow		Rat	Frog		
Duck	Heron	Skylark	Thrush		Water rat	Ferret		

Prey item	Date	Time prey found	Type of prey What is it?	Is it an adult or a chick?	Place found	Collected ✓	Other comments
1				AD CH			
2				AD CH			
3				AD CH			
4				AD CH			
5				AD CH			
6				AD CH			
7				AD CH			
8				AD CH			
9				AD CH			
10				AD CH			
11				AD CH			
12				AD CH			
13				AD CH			
14				AD CH			
15				AD CH			

CAT NAME:________________ OWNERS NAME: ________________ ID NUMBER: ________

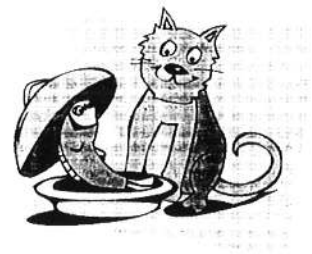
AREA: ________________ DATE COLLECTED:________________ MONTH: ________

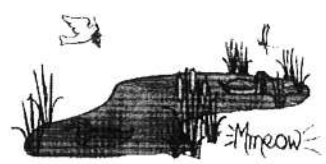
APPENDIX 4.3

Pamphlet with summary of results given to cat owners.

Summary of Prey Items brought home by cats living adjacent to Travis Wetland

November 1999 – April 2000





SHELLEY MORGAN
Researcher

Lincoln University, PO Box 84 Lincoln,
Canterbury
Phone: Home 03 385 3008, Mobile: 025 265 1440

Dear Cat Owner

This is a summary to let you know what results have been gathered so far in the Travis Wetland cat dietary study, and to thank you all so much for your overwhelming willingness to help in the study. Your continuing support in recording/ collecting your felines' dining-out habits is hugely appreciated.

Mice are the predominant prey caught, which has been the contribution of two particularly good mousers in the study. It appears some cats have a prey preference, and like to catch more of one type of animal. It has been mostly exotic birds caught so far, and it is encouraging to find there are few native birds being brought home by your cats.
Sparrows are the most frequently caught exotic bird and waxeyes the native bird found most often. The native skink *Oligosoma nigriplantare polychroma* is common in the diet of many cats, with some cats catching 3-4 a day.

I have included a recipe for Winter Bird Pudding, as I know many of you like to feed the birds in your garden. (No this is not a ploy to encourage your cats to catch more birds for my study!)

Remember it is very important not to feed any birds or wildlife in Travis Wetland.

- Feeding can make wild birds dependant on people.
- Feeding can encourage large numbers of introduced birds which can exclude native birds.

I will update you further on my results in September-October 2000.

Regards,

Shelley

Winter Bird Pudding

Waste fat
Sugar
Stalebread

Gently melt down fat, add sugar, stir in breadcrumbs until stiff, allow to harden
Hang in a place out of feline reach and enjoy watching!

Table 1: Total number of animals caught each month from November 1999-April 2000

Type of prey	Total no. of prey NOV-99	DEC	JAN-00	FEB	MAR	APR	Total
Blackbird	1			3	3	3	10
Duck	3		1				4
Fantail			1		2		3
Goldfinch	1			1	1	5	8
Sparrow		2	8	13	3	4	30
Starling	3	1	2	1			7
Swallow	1				1		2
Thrush		2	1	3	1		7
Waxeye	1		1	2	2		6
Yellowhammer		5	4	1	2		12
Mice	1		30	44	58	98	231
Rat		1		1		2	4
Frog			1	1	1		3
Fish			1				1
Skink	3	5	16	9	28	24	85
Insects			5	13	33	36	87
Bird unknown	2	1			1		4
Insects unknown					1		1
Total for month	16	17	71	92	137	172	505
* No. Of cats	16	26	62	89	95	86	

Total no. of animals caught Nov Apr	Total no. of exotic birds	Total no. of natve birds	Total no. of native reptiles	Animal caught most often	Total no. of cats in study	Cats bringing home prey	Cats not hunting or bring home prey
505	74	9	85	Mice	98	56%	43%

* Total number of cats participating in study each month