Tolerance of a human observer by four ground-foraging bird species in urban and rural areas

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Megan Price

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Abstract

A rapidly expanding world population has led to greater urbanization and movement of population from rural areas to cities (Knight and Gutzwiller 1995) and urban expansion in Australia has involved the destruction and reduction of habitat for wildlife. Many different species of birds inhabit urban areas and one common attribute that may have allowed birds to colonise urban Australia is their tolerance of humans. To determine the tolerance of humans by the Common Blackbird, *Turdus merula*, Australian Magpie, *Gymnorhina tibicen*, Magpie-lark, *Grallina cyanoleuca*, and Willie wagtail, *Rhipidura leucophrys* in urban and rural areas of Victoria, three behavioural measures were used. The three measures were; *flush distance*, the distance between a bird and an approaching observer at which the bird flees, *post-flush distance*, the radial distance that the bird moves in a designated period after flushing and *foraging time*, the time devoted to foraging by a bird when an observer is within sight.

The flush distances of all species and the post-flush distances of Blackbirds, Magpies and Magpie-larks indicated that urban birds were more tolerant of an approaching human than conspecifics in rural areas. This has suggested that these urban birds have habituated to the presence of humans because urban birds encounter humans more often. However, the mean flush distance of Willie wagtails indicated that they were significantly more tolerant than the other species and their post-flush distances did not significantly differ in rural and urban areas. One interpretation of these results is that Willie wagtail body size, smaller than the other species, may increase their tolerance. Due to inadequate sample sizes of three of the species, Magpie foraging time indicated that Magpies foraged less when the observer was 'near' than 'far', however there was no difference in the time devoted to foraging between urban and rural areas. Less time devoted to foraging when the observer was 'near' in both urban and rural areas suggests that urban Magpies were instinctively vigilant of an observer regardless of frequent contact with humans.

The results of this study suggest that although these species in urban areas flee at smaller distances from the observer than rural conspecifics, the distance between paths and other areas of higher pedestrian traffic in parks can be increased to prevent disturbing these species too often. Finally, tolerance of humans appears to have allowed these species to successfully colonise urban areas in Victoria.

1.0 Introduction

Urban ecology has attracted greater interest in the last 15 to 20 years, as a rapidly expanding world population has led to greater urbanization and movement of population from rural areas to cities (Knight and Gutzwiller 1995). This movement has been apparent in Australia, as in 2001 the census showed that sixty-four percent of Australians lived in cities and much of Australia's recent population growth had occurred in the outer suburbs, particularly in Sydney and Melbourne (ABS 2001). If Australia's population continues to increase at the current rate of 1.3 % annually, the suburbs will become increasingly dense and will continue to encroach into rural environments, changing the dynamic of rural ecosystems (ABS 2001).

Although the 2001 census demonstrated a particularly marked increase in urbanisation in the last few decades, Victoria and its capital Melbourne have experienced this population shift since the first European settlements were established on Port Phillip Bay in 1835 (Frost and Murray 1993). Thus even by 1891 approximately two thirds of the Australian population already lived in cities and large towns (Frost and Murray 1993). Also, in the late 19th century the rural sector was encouraged to clear land, creating the extensive agricultural lands still apparent today throughout much of eastern Australia (Frost and Murray 1993).

This urban expansion has inevitably involved the destruction and reduction of crucial habitat for wildlife. Fortunately however, urbanization in Australia has included the establishment of parks and gardens and some remnant strips and patches of vegetation have also been retained. These areas provide habitat in the urban environment for some native

and exotic wildlife species, particularly those whose natural habitats are relatively open and simply structured.

Many different species of birds have successfully colonised cities in Australia. Clearly, humans and human activities do not disturb these birds sufficiently to cause local extinction or force them to abandon the urban environment. In Australian urban environments, native birds are protected from being harmed by humans by strict laws that prevent the deliberate killing of most wildlife. Similar legislation protects native birds in rural environments, but more exceptions are allowed and monitoring is less intense. Urban birds come into contact with people more frequently than rural birds. Therefore, urban birds potentially have a greater opportunity to learn that humans pose little threat and consequently they should become habituated to, and more tolerant of, humans (Cooke 1980; Burger and Gochfeld 1991). In addition, one of the common attributes of exotic birds that colonise cities is their ability to live commensally with humans and therefore they may have also habituated to the presence of humans (Primack 1998). Of course, some species may be naturally quite tolerant of humans, regardless of the extent of their contact with them.

Human-bird interactions are complex. The "decision" to flee or remain when humans approach is assumed to be based upon an unconscious cost:benefit analysis of the situation (Ydenberg and Dill 1986). Birds making such 'judgements' probably evaluate the distance away, direction and speed of the approaching person, so that they are able to minimise loss of foraging time by fleeing only when it is imperative to do so (Fernandez-Juricic *et al.* 2002). Usually a bird detects an approaching predator, or human, long before it actually flees, unless the bird's vision is obstructed by vegetation and therefore may observe the oncoming predator too late to delay fleeing (Ydenberg and Dill 1986). Therefore, birds should normally have ample time to assess the situation and, according to the economic

hypothesis, will flee when the costs of fleeing (loss of foraging time and site) are outweighed by the costs of staying (risking capture) (Ydenberg and Dill 1986; Fernandez-Juricic *et al.* 2002). However, conspicuous fleeing may sometimes attract more deadly predators and therefore an individual may sometimes "decide" to remain and be still and vigilant (Fernandez-Juricic *et al.* 2002).

Excessive human presence in close proximity to birds can reduce fitness by inducing very high levels of vigilance, where a very large proportion of time is devoted to visually scanning the environment for threats (Sadedin and Elgar 1998). This interrupts feeding and impairs foraging, patch selection and therefore potentially reduces fecundity and survival (Pravosudov and Grubb 1995; Riffell *et al.* 1996; Burger and Gochfeld 1998; Gutzwiller *et al.* 1998; Fernandez-Juricic 2000; Fernandez-Juricic *et al.* 2001a). Thus, birds require minimal disruption to their normal feeding and reproductive behaviour and at high human population densities, this can be achieved in part by an enhanced tolerance of humans. Consequently, one of the major factors that may have allowed certain birds, both exotic and native, to colonise urban areas successfully is their tolerance of human presence. Acquiring knowledge of the factors that influence avian tolerance of human presence could be valuable in devising strategies to diminish the likelihood of disturbing intrusion-sensitive birds in cities and elsewhere (Holmes *et al.* 1993; Gutzwiller *et al.* 1998).

Tolerance of humans by birds is indicated by their not fleeing when approached (Burger and Gochfeld 1991) and little or no time being devoted to vigilance when people are nearby (Burger and Gochfeld 1998). However, some birds are clearly disturbed by close proximity to humans, often moving away, ceasing feeding and breeding activities, and devoting more time to vigilance (Burger and Gochfeld 1991). Species of birds that are predominantly ground foragers or feed in the understorey must be more vulnerable to actual and potential

ground predators, such as humans, and therefore knowledge of their tolerance of human intrusion is critical in designing urban parks that will sustain a significant avifauna (Burger and Gochfeld 1991; Holmes *et al.* 1993; Gutzwiller *et al.* 1998). For ground-foraging birds, early morning feeding is crucial after the overnight fast and consequently selection may have favoured them being more tolerant at that time of day (Gutzwiller and Marcum 1997; Gutzwiller *et al.* 1998).

Flush distance, commonly termed flight distance, is the distance between a bird and an approaching human at which the bird flees, with greater flush distances indicating less tolerance (Gutzwiller *et al.* 1998; Fernandez-Juricic *et al.* 2001a). Post-flush distance has been defined as the radial distance that the bird moves in a designated period after flushing; it is related to 'detectability period', which is the amount of time that a bird remains near its initial flush point (Gutzwiller *et al.* 1998). The further the bird moves, the less tolerance is demonstrated. Foraging time is defined in studies of avian tolerance of human proximity as the time devoted to foraging by a bird when the observer is within sight; less time devoted to foraging and more to vigilance indicates less tolerance (Burger and Gochfeld 1998).

Many studies have focused on the tolerance of human proximity by a wide variety of mammals (Kramer and Bonenfant 1997), reptiles (Burger and Gochfeld 1990) and birds (Cooke 1980; Gutzwiller *et al.* 1998; Fernandez-Juricic *et al.* 2002). Several bird tolerance studies have examined the distance at which the observer is detected by the bird, termed the 'alert distance' (Fernandez-Juricic *et al.* 2001a; Fernandez-Juricic *et al.* 2002). Additionally or alternatively, they have studied flush or flight distance and post-flush distance (Cooke 1980; Gutzwiller *et al.* 1998; Fernandez-Juricic *et al.* 2002). Yet little attention has been focused on the potential difference in tolerance of urban and rural birds and no investigations have been conducted in Australia (Cooke 1980). Another aspect of

tolerance that has had scant attention, is the effect that approaching humans have on the amount of time devoted to foraging (or 'foraging time') (Burger and Gochfeld 1998). Generally tolerance studies have been used to determine the levels of disturbances experienced by birds (Burger and Gochfeld 1998; Fernandez-Juricic *et al.* 2002). Cooke (1980) found that several species were more tolerant in urban than in rural environments. He concluded that the urban birds had habituated to the presence of people. Other studies have found that avian tolerance levels are affected by the number of people nearby (Burger and Gochfeld 1991; Gutzwiller *et al.* 1998), flock size (Gutzwiller *et al.* 1998), bird body size (Cooke 1980; Burger and Gochfeld 1991) and percentage of shrub cover (Fernandez-Juricic *et al.* 2001a; Fernandez-Juricic *et al.* 2002).

The main aim of this study was to determine whether there were significant intraspecific differences in tolerance of human proximity between rural and urban environments. The four species studied were the native Australian Magpie, *Gymnorhina tibicen*, Magpie-lark, *Grallina cyanoleuca*, and Willie wagtail, *Rhipidura leucophrys* and the exotic Common Blackbird, *Turdus merula*. Using the behavioural measures outlined above as indications of tolerance of human proximity, the species were observed responding to an observer in rural and urban areas, whilst simultaneously taking into account the possible effects of flock size, distance to nearest cover, the occurrence of other people and dogs. The hypothesis to be tested was that individuals of the studied species would be more tolerant in urban than in rural areas, because they have habituated to the presence of people.

A secondary aim of this investigation was to determine whether the four species varied in their tolerance of human proximity. Australian Magpies and Willie wagtails are notoriously aggressive to humans around their nest sites (Blakers *et al.* 1984; Simpson and Day 1999), whereas Common Blackbirds and Magpie-larks usually respond to human intrusion at nest

sites only with alarm behaviour (Blakers *et al.* 1984). Given these species differences in response to humans whilst breeding, I predicted that Magpies and Willie wagtails would be less 'fearful' of an approaching human and would have smaller mean flush and post-flush distances than the other two species.

2.0 Materials and Methods

2.1 Study sites

This study was conducted in southern Victoria, which has extensive pastoral and agricultural land bordering on the capital city of Melbourne. The study focused on two types of sites, urban and rural. Urban sites comprised of a mixture of urban parks and roadsides in suburban Melbourne within 30 km of, but excluding, the Central Business District. Rural sites consisted mainly of pastoral land and roadsides adjacent to farmland at least 10 km beyond the suburban fringe and 1 km from the nearest town. There were sixteen urban sites and the majority of sites were similar in size approximately 50 to 150 hectares (see Appendix 1 for list)(Figure 2). There were approximately twenty-four rural sites and they varied in size from 10 acre blocks up to 50 km of roadside (Appendix 1)(Figure 1). The selection of study sites included open bushland, such as roadside corridors, farmland, for example paddocks and crop fields, or lawns, including sporting grounds and gardens. The open nature of these sites was chosen to allow greater visibility and a higher probability of observing ground-foraging birds.

For the duration of the study from the 15 April to the 28 August, 2003, observation sessions occurred on weekday mornings and afternoons, and each session typically lasted an hour. The bird species were observed from 9:00 to 11:30 am (AEST) and from 14:00 to 16:30 pm (AEST) to control for any possible diurnal difference in tolerance of humans. To reduce re-sampling of particular birds and to increase statistical independence of the data, a site was not re-sampled on the same day or within a week of the last observation session and no site was sampled more than twice during the study.

2.2 Study Species

The bird species in this study were common birds in both rural and urban areas. The Australian Magpie, *Gymnorhina tibicen*, is known for its aggressiveness towards humans when it is breeding, being highly protective of its young (Figure 4). It was assumed that its tolerance of humans might also change in parallel, and therefore, once nest-building had begun in mid-August it was no longer observed. Magpies generally occur in extended family groups of two to twenty individuals, and these groups defend permanent territories on which they obtain all their food and select nesting and roosting sites (Blakers *et al.* 1984). Magpie body length ranges from approximately 36 to 44 cm (Simpson and Day 1999). Magpies are predominantly ground feeders, consuming ground-dwelling insects, soft-bodied invertebrates and seeds (Blakers *et al.* 1984). Australian Magpies inhabit bushland, pastoral land and nearly all habitats within suburbia, from parks and gardens to residential streets.

The Magpie-lark, *Grallina cyanoleuca*, is widespread throughout Victoria. Breeding Magpie-lark adults occupy pair territories, yet post-breeding birds can form flocks of 10 to 100+ individuals (Blakers *et al.* 1984; Simpson and Day 1999)(Figure 5). Magpie-larks are 28 to 32 cm in length and inhabit pasture, plains and other open areas, including lawns and sporting grounds, provided that surface water is available to construct their mud nests (Blakers *et al.* 1984; Simpson and Day 1999). They mainly forage on the ground, feeding on small insects (Blakers *et al.* 1984). Although Magpie-larks are not commonly aggressive to humans, they are often involved in fights with Magpies.

The Willie wagtail, *Rhipidura leucophrys*, ranges in length from 19 to 21.5 cm and generally lives in pairs or family groups (Simpson and Day 1999)(Figure 6). It is found everywhere except forests with high rainfall, but it particularly prefers woodland margins,

roadside vegetation and open country, including farms and urban parks, provided that there are trees for nesting (Blakers *et al.* 1984). Willie wagtails feed on insects that they flush with their wings and fanned wagging tail and will often pursue them in the air; however, most foraging is done on the ground (Blakers *et al.* 1984). The Willie wagtail is often aggressive to other birds (Blakers *et al.* 1984; Simpson and Day 1999). The species is commonly observed riding on the backs of livestock, catching insects that they flush and feeding on ticks on their skin (Blakers *et al.* 1984). Willie wagtails also often perch on fences by roads, possibly to prey upon insects that are flushed by cars.

The Common Blackbird, *Turdus merula*, is a native of Eurasia and was introduced to Australia before 1862, by which time it was already established in Melbourne (Blakers *et al.* 1984)(Figure 3). The Blackbird is approximately 25 cm long and feeds mainly on earthworms, insects, snails, spiders, fruit and seeds (Blakers *et al.* 1984; Simpson and Day 1999). The species inhabits disturbed land, such as gardens, parks, orchards and farmland, but has also colonised open woodland and wet forest (Blakers *et al.* 1984; Simpson and Day 1999). Blackbirds are generally found in pairs or small groups.

Figure 1 Roadside corridor in rural western Victoria, near Dunkeld. Magpies and Willie wagtails generally found along roads like this.

Figure 2 Banyule Flats Reserve in Heidelberg, expanses of mown grassland surrounded by trees.

Figure 3 The rear view of a Common Blackbird, commonly found in mown grassland.

Figure 4 The Australian Magpie, commonly seen in urban parks and rural agricultural land.

Figure 5 Magpie-larks are commonly sighted in urban parks and rural agricultural land, provided there is surface water for their mud nests.

Figure 6 Willie wagtails are often seen on the move and wagging their tail.

2.3 Observation guidelines

Observations were made only on individuals on the ground or below the observer's eye level. At that height, the birds were potentially exposed to a direct threat of harm when in proximity to humans. When the observer approached a flock, the first individual sighted was selected as the focal bird. Juveniles were not included in the observations, as it was assumed that they might have reacted differently to approach by an observer than adults. However, because juveniles of some species resembled adults, they may occasionally have been sampled accidentally. Nevertheless, this was probably an infrequent occurrence since the study was conducted when juvenile abundance was likely to be low. A possible confounding factor that has been discussed in other bird tolerance studies is the observer's clothing colour (Gutzwiller and Marcum 1997) and therefore the same colour clothing was worn throughout the study.

After locating a focal individual with either the naked eye or binoculars and moving into a position with an unobstructed view, behavioural observations began.

2.4 Behavioural measures

To investigate tolerance, data on flush distance, post-flush distance and foraging time were collected. Flush and post-flush distance measurements were collected sequentially, as post-flush distance obviously required the bird to be flushed first. Particular observation sessions usually focused on either flush and post-flush distances or foraging time. Thus any one individual did not usually provide both types of behavioural records. For each observation, habitat type, flock size, distance to nearest cover and the presence of people other than the experimenter and dogs were quantified to control for the possible influence of these variables. Habitat categorisation was based on the type of vegetation, for example exotic, native or grassland or whether it was along a roadside. Thus, 'roadside bushland'

was remnant native vegetation by the side of the road and 'lawn' included open areas of mowed grass in parks and on sporting ovals (for all habitats, see Appendix 2). Flocks were identified as the number of all conspecifics within 10 m of the focal individual, including the focal bird. Distance to nearest cover was defined as either trees or bushes and was visually estimated in categories from 1 to 14, each category was an interval of 5 m, for example, category 1 was 0-5 m and category 2 was 5-10 m (Appendix 3). Occurrence of people and dogs was recorded as the number of people other than the experimenter and dogs within a 20 m radius of the focal bird.

2.5 Flush and Post-flush distances

Flush distance was the distance between the bird and observer when the bird moved away on being approached by the observer. *Post-flush distance* was the maximum radial distance the bird moved within 30 seconds of flushing (Figure 7).

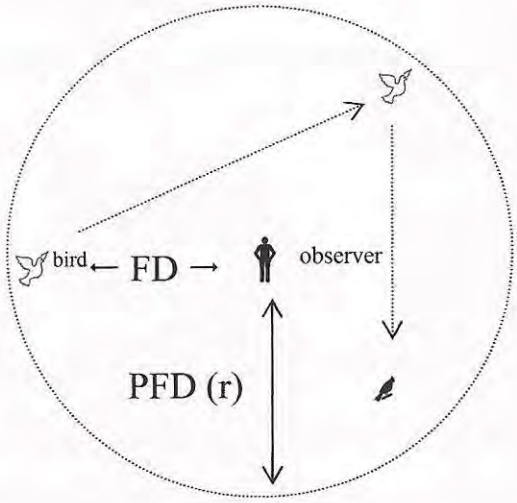

Figure 7 *Flush distance* (FD) and the maximum radial (r) distance the bird moves after flushing, or *post-flush distance* (PFD).

2.5.1 Flush distance

Flushing was stimulated by the experimenter directly approaching the focal bird at a steady pace of approximately 2.5 to 3.5 km/h in a stereotyped manner, and the bird was continuously monitored until it flushed. When it flushed, the observer stopped and the precise location from which the bird flushed was noted, along with the mode of escape. Once 30 sec had elapsed and the *post-flush distance* had been recorded (see section 2.5.2), the observer paced out the distance to the bird's flushing location. Later these paced distances were converted to meters by measuring an average observer pace length. This calibration was calculated on a variety of terrains and over differing distances. Measurements of flush distance on birds in flocks were confined to one record, as when one bird flushed, the whole flock generally followed suit.

2.5.2 Post-flush distance

In the following 30 sec after the focal bird flushed, it was observed continuously to estimate the maximum distance it moved from the observer's location (Figure 7). This *post-flush distance* was recorded categorically, the categories being, 0-2, 2-5, 5-10, 10-15 and >15 m (categories 1-5); the last category included observations of birds that either moved more than 15 m yet within the observer's view or birds that flew >15 m out of sight, which was the typical occurrence.

2.6 Foraging time

Foraging time measurements were made only on birds that were foraging when first observed. Foraging was deemed to be when birds were in a relaxed posture and either looking down, actively feeding or searching for food by walking or running whilst their vision appeared to be focused on or close to the ground. Some birds also scratched in the dirt for food. The only exception to this definition were the Willie wagtails, which used their tails and wings when foraging (Webb-Pullman and Elgar 1998). Tail-wagging

involved fanning the tail and wagging it from side to side and wing-flashing involved briefly opening and then re-folding the wings. Tail-wags and wing-flashes accompanied by hops, running and small flights appeared to flush prey, so that the bird could then take flight and pursue it. Individuals of all species became stationary and upright when vigilant, and although fighting and preening rarely occurred, birds observed undertaking these actions were considered as not foraging.

Foraging time was defined as the proportion of a 30 sec interval spent foraging when the observer was either near to or far from the focal bird. Using these two distances allowed investigation of whether birds that were in closer proximity to the observer foraged proportionately less than birds observed from a greater distance. Foraging disrupted by the presence of the observer indicated less tolerance of human proximity. 'Near' involved observing from 1 to 2 m more than the species' mean flush distance, which ranged for all species from 5 to 15 m in the urban and 10 to 20 m in the rural sites and was determined from preliminary observations. 'Far' involved the observer being at least 5 to 10 m more than the flush distance away from the focal bird. In practice this was 20 to 35 m in urban areas and 25 to 45 m in rural areas. It proved too difficult to record 'near' and 'far' foraging times for the same individual. Therefore, individuals were haphazardly assigned to either a 'near' or 'far' type of observation. Once the observer was in position, the possible confounding variables mentioned above for flush distance were noted. With the aid of an electronic timer which generated an audible signal at 5 sec intervals, instantaneous sampling was employed to record the proportion of time spent foraging during the 30 sec period.

2.7 Statistical Analyses

All statistical analyses were performed with SYSTAT 10® for Windows and the α-alpha level was set at 0.05. *Flush distances* were logarithmically transformed to improve normality. The possible influencing co-variables had to be converted into a categorical form because of their uneven distribution; for example, a large proportion of flock sizes were either one or two with only a few being greater than four. This conversion was also used to pool the distances to nearest cover more than and including category 3 for flush distance (Appendix 3). The occurrence of people and dogs was collapsed into the two categories absent or present.

A t-test was used to determine whether flush distance and foraging time varied among habitats, however, this could only be done on a restricted subset of habitats because of small sample sizes. A similar approach was used in analysing the mode of escape, in addition to a t-test a Pearson's chi-square test of independence was first used to determine whether there were differences in flight and non-flight escapes for rural and urban areas, which would make it unnecessary to pool urban and rural flush distances.

An analysis of variance was used to compare the *flush distance* of the four species and the two locations (rural and urban) in a General Linear Model. A Post Hoc Tukey HSD Multiple Comparison test was then carried out to determine the specific pattern of species differences in *flush distance*. The possible influencing co-variables were included as additional factors in this analysis, but excluded any interactions that involved these co-variables given the uneven distribution of the co-variables between rural and urban areas. For example, the absence of any people other than the observer in rural areas made it impossible to compare the interaction of location and the absence/presence of people.

Post-flush distances were analysed using Pearson chi square for each species to compare any difference between rural and urban areas. Categories 1-4 were pooled due to more than a fifth of expected frequencies were less than 5, therefore there were two categories used in the analysis, <15 m and >15 m.

Due to inadequate sample sizes for Blackbird, Magpie-lark and Willie wagtail foraging times, only Magpie foraging data could be analysed. The proportion of time spent foraging over 30 secs was analysed in a similar manner to that used for flush distance. The factors in this ANOVA were location (rural and urban) and observer proximity (far and near). The General Linear Model used also included the possible influencing co-variables of flock size, distance to cover and the presence/absence of people and dogs.

3.0 Results

3.1 Abundance

Although the population densities of the study species were not measured, abundances of Blackbirds and Magpie-larks appeared to be greater in urban than rural areas, because these species were encountered much more often in the former environment. However, Magpies appeared to be equally abundant in both environments. Willie wagtails were more abundant in rural areas, where they were encountered much more frequently in the study sites than in urban parks of a similar size.

3.2 Flush distances

3.2.1 Mode of escape

Individuals of all four species flew more often than they walked or ran when escaping from the observer in both rural and urban environments. Analysis of flight and non-flight escapes in the rural and urban environments confirmed that rural birds of all species flew significantly more often than urban birds and rural birds rarely chose terrestrial locomotion to escape from the observer (Pearson chi-square; $\chi^2_{(1)} = 32.03,\ P < 0.05$). After pooling escape modes into 'terrestrial location' (such as walking and running) and 'flight', it was evident that urban Blackbird, Magpie and Willie wagtail flush distances were not significantly different for the two types of escape modes (Table 1). However, urban Magpie-lark flush distances were significantly greater when they flew away than when they escaped by terrestrial locomotion (Table 1). So few terrestrial locomotion escapes were made by any species in the rural environment, that comparisons of flush distance for flight and non-flight escapes were not feasible.

Table 1 Flush distance summary statistics and t-tests for escape tactics of all four species.

Species	Escape Mode	n	Flush distances Mean ± SD m	df	t	P
Blackbird	Flight	19	13.36 ± 9.50 m	28	1.21	> 0.05
	Terrestrial	11	8.41 ± 4.90 m			
Magpie	Flight	15	12.29 ± 6.35 m	25	0.99	> 0.05
	Terrestrial	12	9.51 ± 5.12 m			
Magpie-lark	Flight	19	14.35 ± 7.38 m	31	3.40	< 0.01
	Terrestrial	14	7.65 ± 6.20 m			
Willie wagtail	Flight	15	9.28 ± 4.41 m	18	1.45	> 0.05
	Terrestrial	5	7.10 ± 5.00 m			

3.2.2 Influence of habitat differences

Habitats in both urban and rural environments were selected by the observer for their openness, and therefore habitat disparities between the two environments are unlikely to account for any rural-urban difference in tolerance of humans. The four species occurred in a variety of rural habitats, including paddocks and grassland. In urban areas, all four species occurred most frequently on mown grassland, such as that found on sports grounds. The flush distances of urban Blackbirds, Magpies and Willie wagtails were not significantly influenced by whether they occurred in mowed grassland or in all other habitats combined (**Blackbird**: *Mown grassland*: n = 25, (mean flush distance ± sd) 10.80 ± 7.96, *Other habitats*: n = 5, 15.31 ± 10.39, $t_{(28)} = -1.22$. **Magpie**: *Mown grassland*: n = 16, 10.39 ± 5.31, *Open*: n = 11, 12.02 ± 6.81, $t_{(25)} = -0.63$. **Willie wagtail**: *Mown grassland*: n = 15, 9.37 ± 4.36, *Other habitats*: n = 5, 6.82 ± 5.00, $t_{(18)} = 1.68$, *P in all cases >0.05*). It was not

feasible to test the significance of variation in flush distance as a function of rural and urban habitat type in more detail than this due to small sample sizes.

3.2.3 Influence of flock size, bystanders and distance to cover

Flock sizes of Blackbirds and Magpies ranged from one to six or seven. Magpie-larks and Willie wagtails were found in groups of one to five and one to three, respectively. Blackbirds, Magpies and Magpie-larks were found most often in pairs (Blackbird: 1.7 ± 1.2; Magpie: 2.4 ± 1.5; Magpie-lark: 1.7 ± 0.9; mean ± sd of group size), whilst Willie wagtails were chiefly found singly (mean: 1.293 ± 0.512).

Individuals of all species were, on average, mostly found within either 0-5 m or 5-10 m of the nearest cover, although one bird was found a maximum of 70 meters of nearest cover (Blackbird: 1.18 ± 0.39 m; Magpie: 2.23 ± 2.19 m; Magpie-lark: 1.87 ± 1.25 m; Willie wagtail: 1.73 ± 1.18 m; mean distance to cover ± sd). There were infrequent occurrences of people and dogs near focal birds during observations in both rural and urban areas. The overall occurrences of these bystanders were 0.4 ± 1.3 people/observation and 0.1 ± 0.5 dogs/observation (mean bystanders ± sd). A General Linear Model indicated that three of these four variables (flock size, distance to nearest cover and the presence/absence of dogs) did not significantly influence the flush distances of the four species (Table 2). However, the presence of people significantly reduced the flush distances of the four species (Table 2).

Table 2 ANOVA summary statistics for co-variables on flush distance.

Variable	Variable level	n	Flush distances Mean ± SD m	df	F-ratio	P
People	Absent	162	23.10 ± 18.55 m	1	8.73	< 0.01
present/absent	Present	32	8.85 ± 5.72 m			
Dogs	Absent	183	21.03 ± 18.24 m	1	2.90	> 0.05
present/absent	Present	11	16.06 ± 10.26 m			
Distance to	1	121	19.81 ± 16.50 m			
cover	2	39	18.37 ± 19.76 m	1	0.001	> 0.05
	≥ 3	34	26.85 ± 19.66 m			
Flock size	1	105	18.65 ± 15.03 m			
	2	53	21.84 ± 16.45 m	1	0.46	>0.05
	3	18	21.80 ± 26.35 m			
	≥ 4	18	28.76 ± 25.15 m			

3.2.4 Influence of location and species on flush distance

Analysis of the species and location differences showed that there was no significant interaction between species and location (rural/urban) (GLM: Species*Location interaction: $F_{(3)} = 0.56, P > 0.05$). However, the analysis clearly indicated that flush distances were significantly larger in rural than in urban areas (Location: $F_{(1)} = 126.52, P < 0.001$) (Table 3) and that they varied significantly among species (Species: $F_{(3)} = 3.65, P < 0.05$) (Figure 8). Further investigation using post hoc test Tukey HSD Multiple Comparisons, indicated that Willie Wagtail flush distances were significantly smaller than those of all the other species (Willie wagtail × Blackbird, Willie wagtail × Magpie, Willie wagtail × Magpie-lark, *P in all cases* < *0.05*) (Figure 8) (Table 3).

Table 3 Number of observations and mean flush distances of all species in rural and urban areas.

Species	n	Rural Flush distance Mean ± SD (m)	n	Urban Flush distance Mean ± SD (m)
Blackbird	20	35.48 ± 17.46	30	11.55 ± 8.38
Magpie	21	40.25 ± 28.19	27	11.05 ± 5.90
Magpie-lark	22	35.39 ± 13.92	33	11.51 ± 7.59
Willie wagtail	21	23.49 ± 12.09	20	8.73 ± 4.53

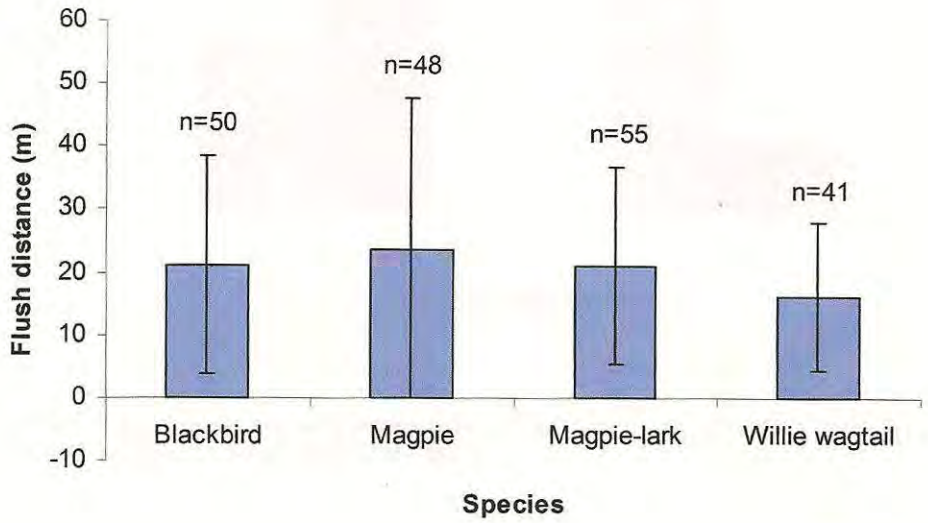

Figure 8 Overall mean flush distances of the four species. The number of observations of each of the species are given. Error bars are standard deviations.

3.3 Post-flush distances

After pooling categories 1-4 because of small expected frequencies, evaluation of the rural-urban difference for each of the species showed that the post-flush distances of three of the species significantly differed between the two locations (Blackbird: $\chi^2_{(1)} = 10.04, P < 0.01$; Magpie: $\chi^2_{(1)} = 8.27, P < 0.01$; Magpie-lark: $\chi^2_{(1)} = 14.59, P < 0.001$). Consequently, rural birds were significantly less tolerant as they fled more than 15 m from the observer

proportionately more often than urban birds (Figures 9-11). Additionally, urban Blackbirds, Magpies and Magpie-larks stayed in the immediate area (< 15 m) more often than rural birds. However, Willie wagtail post-flush distances did not significantly differ between rural and urban areas ($\chi^2_{(1)} = 2.47, P > 0.05$). Both rural and urban Willie wagtails stayed within 15 m of the observer when flushed proportionately more often than fleeing more than 15 m (Figure 12).

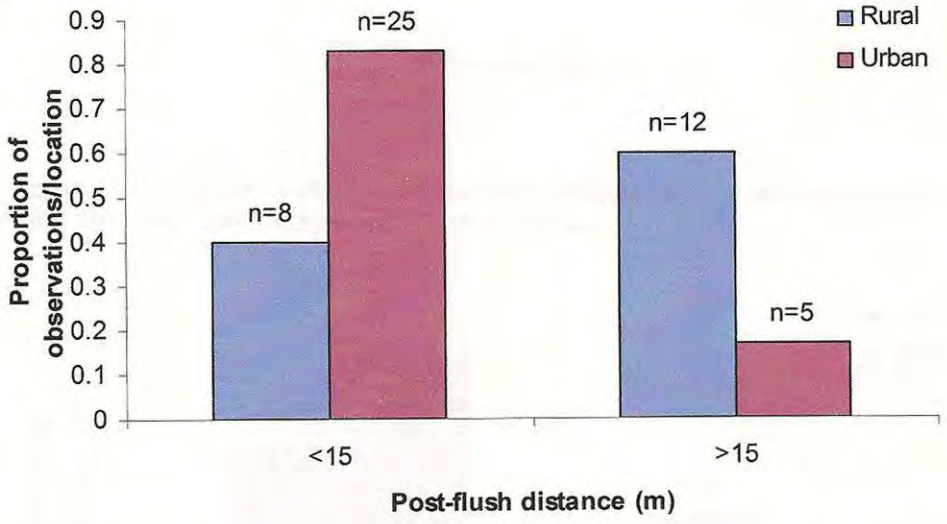

Figure 9 Proportion of observations for each category in rural and urban areas for Blackbird post-flush distances. Number of observations are given.

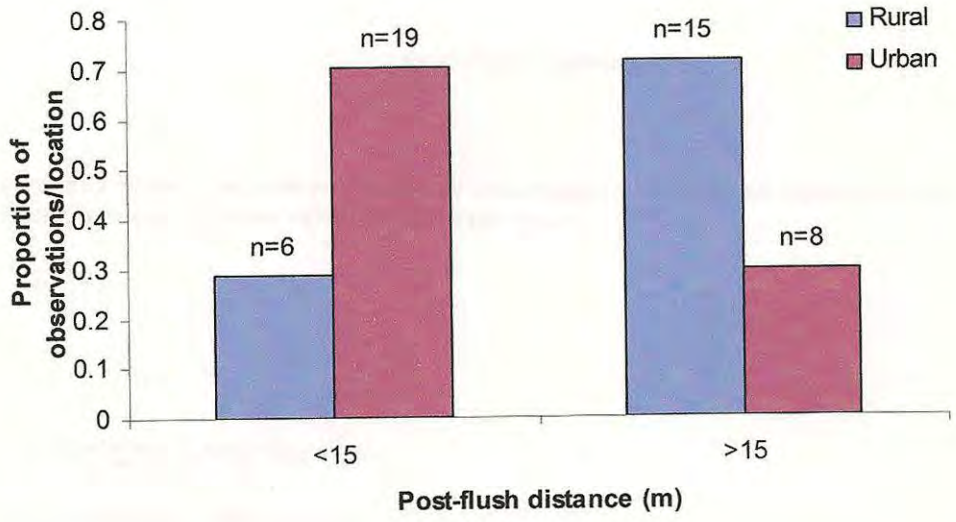

Figure 10 Proportion of observations for each category in rural and urban areas for Magpie post-flush distances. Number of observations are given.

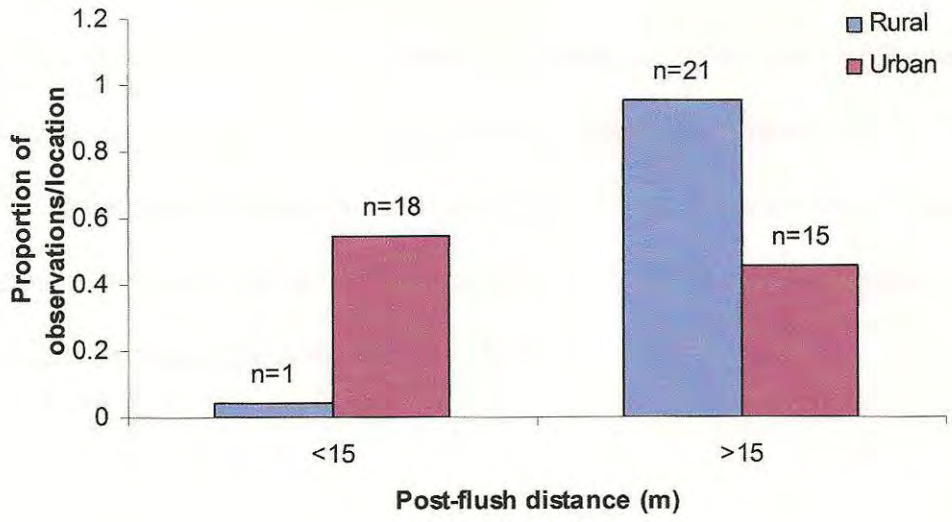

Figure 11 Proportion of observations for each category in rural and urban areas for Magpie-lark post-flush distances. Number of observations are given.

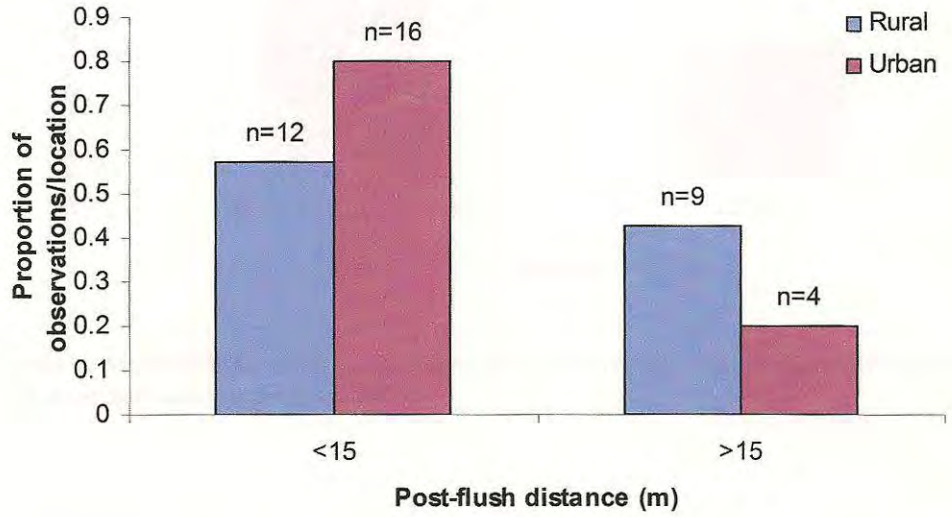

Figure 12 Proportion of observations for each category in rural and urban areas for Willie wagtail post-flush distances. Number of observations are given.

3.4 Magpie foraging time

3.4.1 Habitat differences

Urban Magpie foraging times were significantly greater in mown grassland than in other habitats, mainly open woodland-bushland and playground areas (Mown grassland: n = 34,

4.41 ± 1.84 (mean foraging time ± sd); Other habitats: n = 9, 2.56 ± 2.65; $t = 2.44$, $P < 0.05$; Figure 13), although the number of measurements for other habitats was small. Small sample sizes precluded conducting a similar meaningful analysis for the rural environment. Given that 'open' habitats were deliberately selected by the observer in both environments, habitat differences were thought unlikely to have been an influence on foraging time variation between the urban and rural areas.

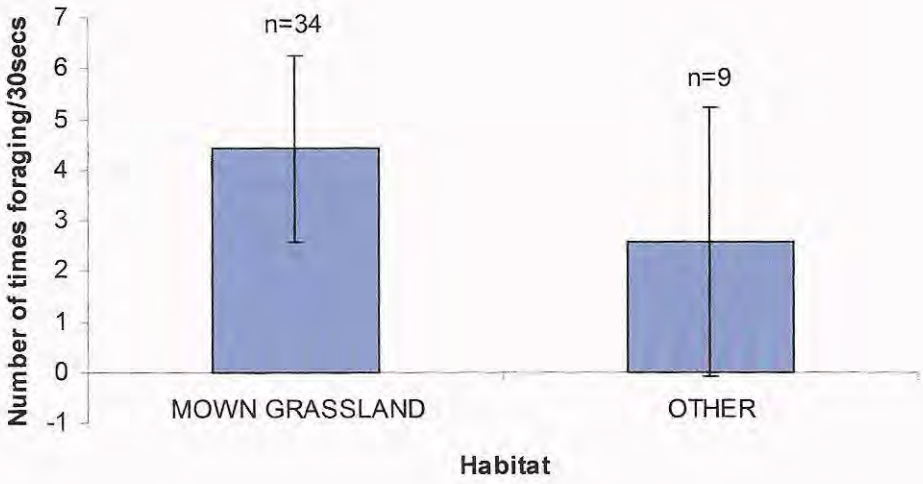

Figure 13 Habitat differences in the urban area for foraging time. Number of observations are given and error bars are standard deviations.

3.4.2 The influence of flock size, bystanders and distance to cover

Flock size ranged from one to seven, although Magpies mainly occurred singly or in pairs (2.0 ± 1.4; mean group size ± sd) and were most frequently found within 0-10 m (intervals 1 and 2) of nearest cover (2.62 mean distance ± 1.85 m). Occurrences of people and dogs nearby were very low in both the rural and urban areas, on average there were 0.07 ± 0.33 people/observation and 0.03 ± 0.21 dogs/observation. Inclusion of these factors, in an analysis of variance using a General Linear Model on the variable of interest, foraging time, showed that they did not affect foraging time (Table 4).

Table 4 Summary statistics and analysis of variance of co-variables on foraging time.

Variable	Variable level	n	Foraging time Mean ± SD	df	F-ratio	P
Flock size	1	45	4.09 ± 2.37			
	2	38	4.05 ± 2.64	1	1.37	> 0.05
	3	17	4.88 ± 1.50			
	≥4	9	3.56 ± 2.70			
Distance to	1	43	3.72 ± 2.58			
cover	2	22	4.27 ± 2.35			
	3	15	4.53 ± 2.26	1	0.84	> 0.05
	4	12	4.00 ± 2.66			
	≥5	17	4.88 ± 1.73			
People	Absent	103	4.18 ± 2.41	1	1.08	> 0.05
present/absent	Present	6	3.83 ± 1.94			
Dogs	Absent	107	4.16 ± 2.40	1	0.02	> 0.05
Present/absent	Present	2	4.00 ± 1.41			

3.4.3 Foraging time

Analyses of foraging time for location (rural and urban) and observer proximity (far and near), showed that there was not a significant interaction between the two factors (GLM: Location*Proximity: $F = 2.851$, $P = 0.094$). The results from each of the individual factors indicated there was not a difference between rural and urban foraging times (Location: $F = 0.006$, $P = 0.936$), however Magpies foraged significantly less when the observer was near than far, regardless of whether observations were in the rural or urban areas (Proximity: $F = 17.931$, $P < 0.001$) (Figure 14).

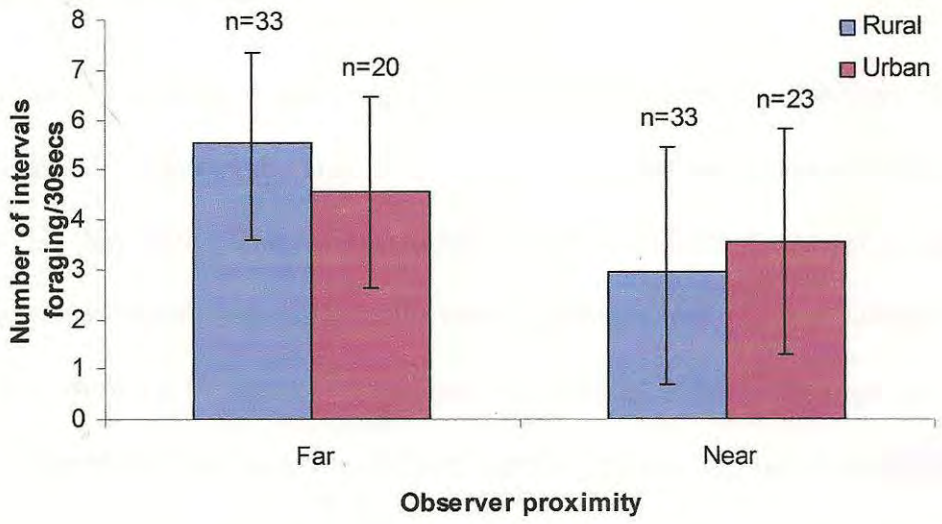

Figure 14 Magpie foraging time for urban and rural areas when observer proximity was 'near' or 'far' including number of observations and standard deviation error bars.

4.0 Discussion

The main findings of this project can be summarised briefly as follows: urban Magpie-larks flushed at significantly smaller distances when they walked away from the observer than when they flew. The flush distances of urban Blackbirds, Magpies and Willie wagtails were not significantly different in mown grassland and all other habitats combined. Flock size, distance to nearest cover and the presence/absence of dogs did not significantly influence the flush distances of any species. However, flush distances were significantly smaller when people other than the observer were nearby. The flush distances of all species were significantly smaller in urban than in rural areas and overall Willie wagtail flush distances were significantly smaller than the other three species. Post-flush distances also indicated that three of the species were more tolerant in urban areas than conspecifics in rural areas. Willie wagtail post-flush distances indicated that their tolerance did not significantly differ in rural and urban areas. Urban Magpies foraged significantly more in mown grassland than in other habitats, but their foraging time was not significantly affected by the flock size, proximity to cover or the presence of human and canine bystanders. Magpies foraged less when the observer was 'near' to rather than 'far' away from them; however, there was no difference between urban and rural Magpie mean foraging times in the presence of the observer.

4.1 Flush distance

4.1.1 Influence of mode of escape and habitat type on flush distance

Several escape tactics were used to flee from the approaching observer, but walking or more rapid locomotion, such as taking flight, were the most common forms. All four species in both rural and urban areas frequently took flight when fleeing, which for strongly flying bird species is usually the quickest and most effective way to escape. This suggests

that the birds assessed the oncoming observer as a threat as long as they remained on the ground, warranting a quick aerial escape, which would significantly reduce the possibility of capture. Urban Magpie-larks that flew when escaping from the observer had significantly longer flush distances than those that walked or ran. One interpretation of this counter-intuitive finding is that the threat posed by the observer was perceived differently by individual Magpie-larks and half of them evaluated it as great and consequently flushed earlier using the quickest escape behaviour. The more tolerant individuals may have come into contact with humans more often and therefore have learned to observe the approaching human's behaviour and assess his or her direction and speed so that they do not have to flee until it is absolutely necessary. Alternatively, the Magpie-larks that did not fly away when the observer was close may simply not have detected the approaching human as soon as those that flew because their line of sight was obstructed or they had not discerned that the observer was approaching directly, although my observation methods were designed to reduce these possibilities.

Magpies also chose to walk or run away from the observer nearly as often as flying when flushed. Given that urban Magpies usually remained within a short distance of the observer (<15m) after flushing, walking or running the short distance to cover may have been more efficient and less costly than taking off flying a short distance and landing in cover. Terrestrial locomotion may be an energetically more efficient mode of escape for Magpies and Magpie-larks because they are larger than the other two species studied (Ydenberg and Dill 1986; Fernandez-Juricic *et al.* 2002). Flight can be a less expensive way to move to a distant point than running, but this is not true for short distances (Schmidt-Nielsen 1975).

Habitat type did not influence the flush distances of urban Blackbirds, Magpies or Willie wagtails. The 'decision' to flee from the observer may thus not be influenced by the degree

of habitat 'openness', as mown grassland was more open than the other habitat types in the urban environment and all urban birds spent much time in this habitat, possibly because it is more productive in food resources for these species.

4.1.2 Flock size, bystanders and distance to cover effects on flush distance

All four species' flush distances were unaffected by flock size, distance to nearest cover and the abundance of dogs. Various studies have advanced differing theories on how flock size might affect flush distance or equivalent tolerance indicators. For example, it has been suggested that a large flock will detect and respond to a predator more quickly because more sense organs are monitoring the environment (Turner and Pitcher 1986; Fernandez-Juricic *et al.* 2002). The economic hypothesis asserts that if risk of predation or foraging efficiency vary with flock size, this will be reflected in flush distances (Ydenberg and Dill 1986). Flush distance may be reduced if the cost of remaining is small in large flocks owing to dilution of risk of predation (Ydenberg and Dill 1986). It has been widely demonstrated that individual animals apportion less time to vigilance and scanning as group size increases and consequently flocks scan more effectively and overall flock vigilance increases; therefore large flocks will detect the predator earlier than small flocks (Ydenberg and Dill 1986; Krebs and Davies 1987).

Members of all four species were most often observed in pairs or singly and flock sizes had no affect on flush distances. This suggests that although pairs or larger flocks would theoretically detect a predator sooner than a solitary bird (Caraco *et al.* 1980; Ydenberg and Dill 1986), fleeing was delayed in such groupings until the observer reached a distance that would stimulate a solitary bird to flee. Therefore, pairs may have assessed the potential threat as though they were alone, even though they may have detected the approaching observer sooner. The effect that the number of conspecifics present has on a focal bird's

flush distance and other tolerance indicators appears to be somewhat species-specific, as other studies have variously found both flock size and no flock size effect (Gutzwiller *et al.* 1998; Fernandez-Juricic *et al.* 2001a; Fernandez-Juricic *et al.* 2002). Gutzwiller *et al.* (1998) found for the species that they studied in Wyoming that flock size did not affect approach distances (flush distance), but did influence the detectability period, which is the amount of time that a bird remains near its initial flush point. Fernandez-Juricic *et al.* (2002) observed that the buffer distance, which is the difference between the alert and flush distance, of House sparrows (*Passer domesticus*) and Wood pigeons (*Columba palumbus*) increased as the number of conspecifics increased around the focal bird, whereas Blackbird (*Turdus merula*) and Magpie (*Pica pica*) buffer distances were not significantly affected by flock size. House sparrows and Wood pigeons delayed fleeing and the authors concluded that these species detected the observers earlier when in large flocks and the association between flock size and buffer distance may be related to the dilution effects of groups (Turner and Pitcher 1986; Fernandez-Juricic *et al.* 2002). Fernandez-Juricic *et al.* (2001a) found that the alert distances of the four species that they studied (see above) were not affected by the number of conspecifics present; the discrepancy between the two studies may indicate that the tolerance of humans by individuals of these species vary or buffer and alert distances differently estimate the tolerance of the species.

Distance to nearest cover did not influence the flush distances of the four species I studied. A bird is required to make "decisions" that reduces its risk of capture, such as electing to forage near enough to cover to be able flee to it quickly with little cost, whilst simultaneously avoiding vegetation cover obstructing the view of any approaching humans or predators. Individuals of all four species positioned themselves frequently within 10 m of cover and therefore they could detect the observer and readily flee to the nearby cover when necessary. The distance to cover may not have affected flush distances because it

was more beneficial to fly to cover any distance away than remain on the ground near the observer. Alternatively, the birds did not flee to shrub and tree cover, but simply fled far enough from the observer to maintain a 'safe' distance. Distance to cover was not correlated with the alert distances of House sparrows, Blackbirds, Woodpigeons and Magpies in Madrid; however, higher percentages of shrub and coniferous forest cover resulted in smaller flush, alert and buffer distances in some of these species, especially Blackbirds (Fernandez-Juricic *et al.* 2001a; Fernandez-Juricic *et al.* 2001b; Fernandez-Juricic *et al.* 2002). The authors concluded that this increased tolerance of humans was due to the greater availability of cover and therefore a lower perceived risk of predation (Fernandez-Juricic *et al.* 2001a; Fernandez-Juricic *et al.* 2001b; Fernandez-Juricic *et al.* 2002).

The presence of dogs did not affect the flush distances of the four species, whereas flush distances were significantly smaller in the presence of people other than the observer. One might think that dogs would typically be perceived as a major threat by birds, but these species may have learnt that they are unlikely to be attacked by dogs that are simply walking past rather than exhibiting stalking or predatory behaviour. Moreover, dogs that were not approaching the focal bird directly may have been considered as non-threatening. Fernandez-Juricic *et al.* (2001b) suggested that some birds might become habituated to the presence of dogs.

Flush distances were significantly smaller when people other than the observer were nearby. Conceivably these bird species may have considered the approaching observer as a member of the group of humans nearby and hence were more tolerant as they had learnt that groups of humans are potentially less dangerous than a single individual approaching in a direct manner. Alternatively, possibly the individual birds that were observed when other

people were nearby were in areas of higher pedestrian traffic and therefore had become habituated to groups of people. Burger and Gochfeld (1991) also found that as the number of people nearby increased, flush distance decreased and concluded the birds they studied had become habituated to the presence of nearby people and therefore allowed an experimenter to approach more closely.

4.1.3 Effects of an approaching observer on flush distance

Flush distances were shown to be greater in rural than urban areas, indicating that the urban birds were substantially more tolerant of an approaching observer. This contrast between urban and rural conspecifics suggests that the former were more tolerant of humans because they generally had more contact with them and had learned that they pose little threat. The alternative possibility that urban and rural populations are genetically distinct seems much less likely, particularly for all four species.

Presuming that habituation is the main reason for urban individuals' more pronounced tolerance, one might expect that naïve juveniles would be less tolerant of human presence than adults. However, experience of human behaviour whilst juvenile probably plays a critical role in shaping subsequent adult tolerance levels. Although humans rarely cause avian mortality in Australian cities, urban individuals of all four species flushed approximately 10 m from the observer. Consequently, they incurred substantially greater decreases in foraging time than if they had stayed until the observer was much closer (Fernandez-Juricic 2000; Fernandez-Juricic *et al.* 2002). However, they must presumably benefit from fleeing at their typical individual flush distances, because in urban areas humans frequently disturb birds and it would be too costly to repeatedly flee at a distance greater than is necessary to be 'safe'.

Cooke (1980) also found that individuals of several bird species were more tolerant in urban than in rural areas and attributed it to habituation. He found that suburban Common Blackbirds flushed at a distance of 11.4 ± 0.3 m (mean ± se), which is similar to the value recorded in this study (11.55 m), although his estimate was derived from a much bigger sample (n = 172) (Cooke 1980). However, interestingly there is a large discrepancy between the flush distances of rural Blackbirds in the present and Cooke's investigation (1980), with rural Blackbirds in England flushing at a mean distance of 20.9 ± 2.5 m compared with 35.5 m in rural Victoria. The disparity between the two results may be due to the human population differences between the two locations. In Great Britain, rural areas are generally more heavily populated than Victoria's rural environment (National-Statistics 2001). Fernandez-Juricic *et al.* (2001b) also studied Common Blackbird flush distances in four suburban wooded parks in Madrid, Spain. They found that the mean Blackbird flush distance for all parks combined was 8.62 m, although distances varied from approximately 7 to 11 m among the four parks (Fernandez-Juricic *et al.* 2001b). They found that the parks with the highest human visitation rates had the smallest Blackbird flush distances and also concluded that flush distances may have been shaped by habituation (Fernandez-Juricic *et al.* 2001b).

Interspecific comparisons of flush distances in the present study, showed that Willie wagtails (body length 19-21.5 cm) were significantly more tolerant than the larger species, the Blackbird (25 cm), Magpie (36-44 cm) and Magpie-lark (27-32 cm), but there were no size-related tolerance differences amongst the latter three species. Body size has been suggested in several studies to exert an influence on flush distance or other equivalent tolerance indicators, because a larger body mass is thought to reduce manoeuvrability and take-off capability (Metcalfe and Ure 1995). Therefore larger birds would need larger flush distances in order to ensure a safe escape. Moreover, smaller birds have a higher metabolic

intensity than larger ones and therefore should be less inclined to interrupt foraging and consequently might show greater tolerance towards an approaching human (Calder 1974; Fernandez-Juricic *et al.* 2001b). Fernandez-Juricic *et al.* (2001a) argue alternatively that larger species may have a greater ability to perceive distant humans. Better visual acuity may enable them to detect and react to approaching humans at greater distances than smaller birds and therefore appear to show less tolerance. However, it is not clear that visual acuity scales with mass in birds, so this explanation seems unlikely.

Several other studies have also attributed the greater tolerance of humans shown by some smaller species to body size per se for the sorts of reasons outlined above (Cooke 1980; Holmes *et al.* 1993; Fernandez-Juricic *et al.* 2001a; Fernandez-Juricic *et al.* 2001b). However, Cooke (1980) argued that the smaller species in his study are usually found in hedges and trees and therefore are less agitated by human presence as they only experience close proximity to humans when completely or partially hidden and relatively safe. Burger and Gochfeld (1991) found that larger birds allowed closer approach by more people than smaller birds in Northern India and argued that this was because larger birds may be less vulnerable to injury than smaller ones. The body size effect documented in the present study is consistent with the findings of most similar tolerance studies on birds. However, my study only investigated the tolerance of four species and studies of more species with a wider range of body sizes would be required to reach a better understanding of the relationship between body size and tolerance.

In any case, other factors may also influence the tolerance of Willie wagtails. For instance, they are very aggressive to many other birds (Simpson and Day 1999). One might predict that this generally low threshold for aggressive behaviour would be correlated with a relatively low level of 'fearfulness' towards actual and potential predators. However,

Magpies are also aggressive towards many other birds and, in the breeding season, humans, and their tolerance of humans was the least of the four species studied.

4.2 Effects of an approaching observer on post-flush distance

Another indicator that tolerance was significantly greater in urban Blackbirds, Magpies and Magpie-larks was provided by post-flush behaviour. Once flushed, rural Blackbirds, Magpies and Magpie-larks escaped more than 15 m proportionately more often than urban conspecifics, entirely abandoning feeding and vacating the foraging areas. Thus, urban but not rural individuals appear to have learned that fleeing just out of the path of an approaching human is sufficient to obviate any immediate danger. However, the post-flush distances of urban and rural Willie wagtails did not significantly differ and they remained proportionately more often within a short distance of the observer (<15 m). Consequently, Willie wagtails may be naturally less 'fearful' of the observer than the other three species. One might predict that the greater tolerance shown by Willie wagtails in this case was also due to their smaller body size. Willie wagtails may have fled a shorter distance than the other three species because they could take-off and manoeuvre without difficulty if the observer continued to pursue them. Smaller species also have a higher metabolic intensity and therefore Willie wagtails moved a short distance to avoid the approaching observer and minimised lost foraging opportunities.

4.3 Proportion of time that Magpies spent foraging in the presence of an observer

4.3.1 Influences of habitat on the time allocation to foraging

The foraging times of urban Magpies in the presence of an observer were proportionately greater when Magpies were observed in mown grassland rather than other habitats, which included open woodland/bushland and playgrounds. There is a small difference between

the two types of habitat, although they are both 'open' with no continuous canopy. Mown grassland is particularly 'open', typically with only one or two trees or bushes, and some lawn areas, such as sporting grounds, are entirely treeless. Woodland/bushland and playgrounds are also quite 'open'; however, clumps of trees and playground equipment may somewhat limit the field of vision of a foraging bird. Therefore, birds on mown grassland may be able to monitor a person's behaviour very thoroughly and consequently reduce vigilance time more than birds in the other habitats that have to move around trees and other objects to keep a human in sight. Magpies in open woodland/bushland and playgrounds may have chosen to forage on those patches because food density or quality was higher than in mown grassland. The cost of feeding there would be an increase in time allocated to vigilance and a reduction in that allocated to foraging, but the better food resources might compensate for this. Hence there may have been a trade-off operating between predation risk and food availability (Krebs and Kacelnik 1991)

4.3.2 The influence of flock size, bystanders and distance to cover on the proportion of time spent foraging

Flock size, human and dog bystanders and distance to cover did not affect the amount of time devoted to foraging in the presence of the human observer. Theoretically, and in flocks of many bird species, individual vigilance budgets should and do decrease as group size increases, consequently groups scan more effectively and the overall vigilance of the flock increases (Caraco 1979b; Caraco 1979a; Bertram 1980; Caraco *et al.* 1980; Krebs and Davies 1987). Magpies mainly occurred singly or in pairs and therefore there may have been little reduction in individual vigilance budgets, and so consequently foraging time was not affected by flock size. In addition, each bird raises its head to scan the area independently of any other bird and therefore Magpies may not be able to alter their

foraging time allocation unless there are enough birds in a flock (i.e. at least >2) to maintain constant vigilance (Krebs and Davies 1987).

The proportion of time devoted to foraging in the observer's presence was not significantly affected by the distance to nearest cover. Given that cover would not have obstructed the Magpies' view of the observer, the birds would have been able to monitor the observer regardless of the distance to cover. Furthermore, as with flush distances, dogs did not affect Magpies' foraging time in the presence of an observer. Magpies may have become habituated to dogs that frequent the areas they inhabit or may have been able distinguish between dogs that exhibit stalking or predatory behaviour and those that normally accompany their owners. Unlike the situation with flush distance, the presence of people other than the observer also did not affect the proportion of time devoted to foraging by Magpies. Conceivably, Magpies may have assessed groups of nearby people as non-threatening and therefore did not pay focused attention to them or their visual scanning rate was sufficient to observe all nearby people, including the observer.

4.3.3 Proportion of thirty second interval spent foraging in the presence of an observer

That Magpies foraged less when an observer was near them, regardless of whether the location was rural or urban, may indicate that they may be inherently 'wary' of humans. Magpies may be instinctively vigilant about any large animal that has been detected in their vicinity because vigilance will increase the chance of escape, despite the loss of foraging opportunities. However, the observer in this study consistently observed all birds from a 'near' position that was a few meters from the Magpie's mean flush distance, which was larger in rural areas. Thus, the discrepancy of observer distance may account for there being no difference in the proportion of time devoted to foraging between the two populations. According to the economic hypothesis (Ydenberg and Dill 1986), it would be

too costly for birds to be predominantly vigilant when humans are not close enough to pose an immediate threat and so this is possibly why birds observed from afar foraged proportionately more than those observed from close-up.

My results have indicated that urban Magpies are as vigilant as rural birds when approached closely by humans; however, foraging was only observed for 30 seconds, consequently urban Magpies may return to foraging sooner than rural birds after "assessing" the possible threat. Burger and Gochfeld (1998) also found that several bird species foraged less when people were closest; however they also investigated vigilance for 1 min after the humans had passed and found that, although birds recommenced normal feeding behaviour, they spent less time foraging than before the disturbances.

Although it is important to investigate the proportion of time devoted to foraging when humans are close-by, this alteration in behaviour is not necessarily harmful to the overall health and future survival of the bird (Burger and Gochfeld 1998). Urban Australian Magpies should have ample time to forage and consume enough energy and nutrients to meet their daily requirements, as Australian cities are less densely populated than cities such as Delhi and London, where it would be difficult for intrusion-sensitive birds to satisfy their daily food requirements due to the high level of disturbance.

4.4 Future research

Wildlife that are known to be, or suspected of being sensitive to human intrusion should be studied in high visitation tourist areas in Australia and overseas because these species may be particularly vulnerable to extinction in these areas. In addition, tolerance studies of wildlife that are especially important to an area, such as keystone and endangered species,

may assist in their management because they receive more attention from tourists than do other species.

There are further possibilities for rural-urban comparisons, as some species may turn out not to be more tolerant in urban areas. Expansion of the investigation to include urban and rural comparisons of the proportion of time devoted to foraging in other species may help in the management and conservation of these species; the present study was limited by insufficient data for Blackbirds and Magpie-larks in rural areas and Willie wagtails in urban areas due simply to time constraints.

Potential manipulative experiments could be attempted on the effect that the number of people nearby has on flush distance in order to further investigate the greater tolerance shown to an approaching human when other people are nearby. Furthermore, investigation into whether birds react differently to an approaching human and peripheral human traffic, as has been found in other animals (Burger and Gochfeld 1990), would assist in understanding the whole human tolerance phenomenon.

4.5 Implications for management and conservation

Bird conservation and management in urban areas is becoming progressively more important, because urbanization continues apace and wildlife conservation influences environmental policy decisions (Fernandez-Juricic *et al.* 2001a). Although the four species that I studied are quite tolerant of approaching humans in the urban environment, park design could be profitably altered to provide a reasonable distance between paths, picnic grounds and other high human traffic areas, so that birds can forage away from the majority of visitors. The results of this study suggest that at least 20 m should be left between paths and picnic grounds. This distance appears to exist in the Melbourne parks visited, although

probably not for the reason stated. This has also been recommended as a solution to disturbing birds in Madrid (Fernandez-Juricic 2000).

As Melbourne's urban population increases and expands, it is encouraging that rural Magpies, Magpie-larks and Willie wagtails presumably have the flexibility to habituate to increased encounter rates with directly approaching humans. Unfortunately, the exotic rural Blackbird will also habituate to any increases in encounters with humans. Without this habituation to human presence, these four species would clearly not have been as successful as the urban environment. Hence, one of the main factors that have allowed these species to invade and successfully colonise the urban areas of Melbourne is their tolerance of humans.

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Appendix 1

Urban and rural sites sampled

Table A 1 Summary of the urban and rural sites sampled throughout the study, with suburb, nearest town and an approximate melways reference (2000).

Urban Sites	Suburb	Melways Reference
Banyule Flats Reserve	Heidelberg	32 F2
Braeside Park	Braeside	88 E10
Bundoora Park	Bundoora	19 F2
Fawkner Park	South Yarra	2L C6
Fitzroy Gardens	East Melbourne	2G B2
Glen Waverley Reserve	Glen Waverley	71 C5
Glen Waverley Roadside	Glen Waverley	71 B3-B6, C5-C6
Jells Park	Wheelers Hill	71 K7
Kooyong Park	Kooyong	59 D3
Lum Reserve	Wheelers Hill	71 F11
Royal Botanic Gardens	Melbourne	2G B12
Royal Park	Parkville	29 D12
Royal Park South	Parkville	2A G3
The Grange Reserve	Clayton South	79 F8
Valley Reserve	Mount Waverley	70 F2
Wattle Park	Burwood	60 J3
Rural Sites (nearest town)	**Location and distance from Melbourne by road**	**Melways Reference**
Ararat	West ~208 km	526 E2
Bacchus Marsh	West ~60 km	511 F2

Beaufort	West ~164 km	526 H3
Bena	South-east ~116 km	512 T9
Drouin	South-east ~97 km	512 U6
Dunkeld	West ~262 km	526 C4
Euroa	North-east ~154 km	510 R3
Exford	West ~59 km	511 G2
Hamilton	West ~294 km	526 B4
Korumburra	South-east ~116 km	512 T10
Kyneton	North-west ~85 km	509 F9
Lake Bolac	West ~214 km	526 E4
Leongatha	South-east ~129 km	512 V10
Linton	West ~148 km	526 J4
Little River	South-west ~40 km	511 G4
Loch	South-east ~102 km	512 T9
Mansfield	North-east ~203 km	522 B11
Neerim East	East ~122 km	512 V5
Nigretta Falls (Wannon)	West ~314 km	526 A4 (Nigretta not named on map)
Seymour	North ~98 km	510 N6
Warragul	South-east ~103 km	512 V7
Warrayure (b/w Hamilton & Dunkeld)	West ~278 km	526 C4 (Warrayure not named on map)
Werribee	South-west ~36 km	511 H4
Yarra Glen	North-east ~55 km	510 Q1

Appendix 2

Habitat descriptions

Table A 2 Habitat types and a short description of their composition.

Habitat	Description
Lawn	Mowed grass, typically park fields and sporting ovals
Open woodland/bushland	Sparse exotic and native trees with grassy or shrubby ground cover, usually found in parks
Playground/woodchip	Large playgrounds that have woodchip ground cover and play equipment
Paddock	Sectioned fields with either crops or grass
Grassland	Native or exotic grass that has not been cut
Roadside bushland	Mainly native trees and bushes along the roadside
Roadside woodland	Exotic trees along the roadside, mainly clumps of pine trees
Roadside grassland	Grassland along the roadside
Roadside paddock	Paddocks situated adjacent to the road
Roadside lawn	Lawn alongside the road, eg. Nature strips
Roadside garden	Gardens adjacent to the road
Paddock/Open	Paddocks with clumps of trees along the fence line

Appendix 3

Co-variable values and conversions

Table A 3 Co-variables used in analyses and recorded values.

Co-variables for Flush distance and Foraging time	Value before conversion	Categories used in analysis
Flock size	1	1
	2	2
	3	3
	≥ 4	4
Distance to nearest cover (flush distance)	1 (0-5 m)	1
	2 (5-10 m)	2
	≥ 3 (> 10 m)	3
Distance to nearest cover (foraging time)	1 (0-5 m)	1
	2 (5-10 m)	2
	3 (10-15 m)	3
	4 (15-20 m)	4
	≥ 5 (> 20 m)	5
People nearby	0	0
	≥ 1	1
Dogs nearby	0	0
	≥ 1	1