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Four-legged friend or foe? Dog walking displaces native birds from natural areas

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Dog walking is among the world's most popular recreational activities, attracting millions of people to natural areas each year with diverse benefits to human and canine health. But conservation managers often ban dog walking from natural areas fearing that wildlife will see dogs as potential predators and abandon their natural habitats, resulting in outcry at the restricted access to public land. Arguments are passionate on both sides and debate has remained subjective and unresolved because experimental evidence of the ecological impacts of dog walking has been lacking. Here we show that dog walking in woodland leads to a 35% reduction in bird diversity and 41% reduction in abundance, both in areas where dog walking is common and where dogs are prohibited. These results argue against access by dog walkers to sensitive conservation areas.

Keywords: habituation; human disturbance; ecotourism; predation risk; domestic dog

1. INTRODUCTION

For thousands of years, dogs (*Canis lupus familiaris*) have been a favoured pet of human societies around the world (Serpell 1996). In the twenty-first century, dog ownership is as popular as ever, and dog walking is a major motivator for outdoor recreational activity (Wood *et al.* 2005) with diverse benefits to human and canine health (Bauman *et al.* 2001): it is even a legal requirement for animal welfare in some European cities. Dogs, or their close ancestors, have also evolved as top predators in many ecosystems and hunt a wide range of fauna (Macdonald & Sillero-Zubiri 2004). It is poorly known whether wildlife perceives domestic dogs as a predation risk and they may even habituate to such risk if threats are frequent and not realized (Lima & Bednekoff 1999). Recent extensive research has shown that human walkers (without dogs) can induce anti-predator responses in birds including vigilance and early flight, which may lead to a cascade of related responses that negatively affect birds (Blumstein & Daniel 2005). Off-lead dog walking can also disturb some species of breeding shorebirds from their nests (Lord *et al.* 2001). Cautious conservation managers and government legislation therefore typically ban domestic dogs from sensitive areas such as national parks and reserves. However, these bans induce strong protest from dog-walking lobbyists who cite a lack of evidence because multispecies responses of wildlife to dog walking are unknown.

In this study we experimentally manipulated dog walking at 90 sites in woodland on the urban fringe of Sydney, Australia and monitored the responses of multispecies bird assemblages, one of the key fauna groups at risk from disturbance (Hill *et al.* 1997). We used three treatments; walkers with dogs, walkers without dogs and a control (no walkers or dogs), and then counted birds seen and heard along 250 m transects for 10 min after treatments were applied. To test whether habituation to dog walking may occur, we surveyed in sites where dog walking was permitted and frequent, and in national park sites where dog walking was prohibited. To control for variation in dog behaviour, we also used a range of dog sizes and breeds and a range of different walkers, and dogs were kept on leads.

2. MATERIAL AND METHODS

The study was conducted at 90 sites located on urban fringe woodland of the Hornsby–Berowra–Cowan region, approximately 35 km north of Sydney. The vegetation is classified broadly as (Hawkesbury) sandstone woodland with Sydney sandstone gully and Sydney sandstone ridge top. In these types of habitat in eastern Australia, birds occur in 9.5% of scats of wild dogs, which include hybrids of domestic dogs and dingoes (*Canis lupus dingo*), Australia's native dog (Mitchell & Banks 2005). This area was chosen because it contains large remnants of woodland with trails that are either frequently dog walked or where dog walking is prohibited, and the use of the area is coming under increased pressure from residents of neighbouring suburbs. Frequently dog-walked sites ($n=45$) occurred on Crown land, council land and regional parkland around three suburbs where off-the-lead dog walking was prohibited. Infrequently dog-walked sites ($n=45$) occurred in two national parks. Dog-walking activity at frequented sites was on average 10 dog walkers and 12 walkers per hour in the morning (07.30–09.30 hours) and 6 dog walkers and 7 walkers in the afternoon (14.30–16.30 hours). Only two walkers in total were seen during all surveys of unfrequented sites and no dog walking was observed.

Native birds were surveyed along 250 m transects along well-established fire trails (width 3–5 m) randomly chosen from 1 : 25 000 maps of the area, allowing at least 150 m from forest edge to prevent edge effects. Each site received only one of the three treatments randomly allocated and no sites within 1 km of another were surveyed on any one day.

The dog-walking treatment involved a person walking a domestic dog on lead along the trail; the human-walking treatment was a procedural control in which a person alone walked along the trail; and the control treatment was where no treatment was imposed upon the site. The dogs were from a variety of breeds (and therefore temperaments, sizes and shapes) and ages, and each dog was used only a maximum of four times randomly allocated to treatments. A variety of walkers of various heights were also used, allocated at random to replicate surveys.

Dog walker and walker subjects walked at the pace at which they would normally walk a dog and moved beyond the transect end to prevent concentration of the treatment effect. Immediately following the 'treatment' (commencing 20 s after the walker/dog walker had set off), the transect was surveyed for birds over 10 min by a single observer (JB). All birds seen or heard within 50 m of the trail were included as the maximum likely zone of influence of a dog; birds flying overhead were excluded. We recorded the position in the strata (canopy, understorey or ground) and distance from trail (0–10, 10–20 and 20–50 m) ensuring that double counts were minimized. Surveying was confined to fine weather (no rain and wind less than 10 km h^{-1}), and we also recorded temperature (°C) and wind speed (km h^{-1}) and scored cloud cover on a 1–10 scale. Surveys were conducted in the periods around dawn and dusk, between 07.30 and 10.00 hours, and then 14.00 and 16.30 hours when birds are generally most active.

A priori power analysis from pilot study samples indicated that at least 13 replicates would be required to detect an effect size of 20% between treatment and control, deemed a reasonably subtle effect of dog walking likely to be of concern to land managers. This sample size was increased to 15 replicate surveys of each treatment.

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Because walkers alone induced an effect on birds intermediate to that caused by the addition of dogs, we then tested whether two persons walking would also cause a greater response in birds compared with one person walking alone (Beale & Monaghan 2004). This experiment used identical protocols to those described above using only two treatments; one walker or two walkers, of a range of sizes and body shapes and randomly allocated to surveys. We surveyed 30 sites in frequently dog-walked areas and 30 sites in infrequently dog-walked areas; 15 sites for each treatment.

In the tests for dog-walking effects, neither temperature nor cloud cover showed a relationship to the number of bird species (diversity) or individuals (abundance) observed ($p>0.25$) and so were excluded from analyses. As expected, diversity and abundance showed a negative relationship with wind speed ($\mathrm{km\,h^{-1}}$), and wind speed was included as a covariate in an ANCOVA for treatment and history effects. Normality was confirmed by visual analysis of distributions and normal quantile plots and homogeneity of variances confirmed using Levene's test in JMP (v. 6; SAS Institute, Inc., Cary, NC, 1989–2005). Homogeneity of slopes was confirmed by initially running models with all possible interactions between the covariate and main effects, and any terms with $p>0.25$ were dropped from the model.

Changes in the distribution of birds in the forest due to treatment effects were examined in two ways: first, using the proportion of the total number of bird individuals observed (seen and heard), detected at a distance of 0–10 m from the trail, and second, by the proportion of the total number of bird individuals detected in the canopy layer. This approach was used to avoid problems of independence associated with multiple categories in proportional data, but targeted the key predictions of a response to dog threat. Single linear regressions confirmed that the distribution variable was not related to any of the weather covariates. The test for multiple walker effects followed the same protocols except that no weather covariates were associated with bird diversity or abundance, so ANOVA's were used.

3. RESULTS

Dog walking caused a 41% reduction in the numbers of bird individuals detected ($F_{2,83}=14.73$, $p<0.001$) and a 35% reduction in species richness ($F_{2,83}=10.76$, $p<0.001$) compared with untreated controls (figure 1). Humans walking alone also induced some disturbance but typically less than half that induced by dogs (Tukey's *post hoc* test: dog walking < walking < control for diversity and abundance). Notably, there was no interaction between dog-walking treatments and prior access by dog walkers. Ground dwelling birds appeared most affected; 50% of the species recorded in control sites were absent from dog-walked sites. For birds which did not flee the site, there were 76% fewer individuals within 10 m of the trail ($F_{2,83}=13.72$, $p<0.001$) when dog walking occurred compared with control sites, suggesting that birds were seeking refuge away from the immediate vicinity of the threat. In the experiment testing bird responses to single and multiple walkers without dogs, bird abundance ($F_{1,56}=0.04$, $p=0.83$) and diversity ($F_{1,56}=0.14$, $p=0.70$) did not change with the addition of another human. This confirms that birds responded uniquely and additively when dogs accompany walkers.

4. DISCUSSION

These results reveal that even dogs restrained on leads can disturb birds sufficiently to induce displacement and cause a depauperate local bird fauna. These effects were in excess of significant impacts caused by human disturbance, which also caused to decline in diversity and abundance. Responses to transient human disturbance are well known

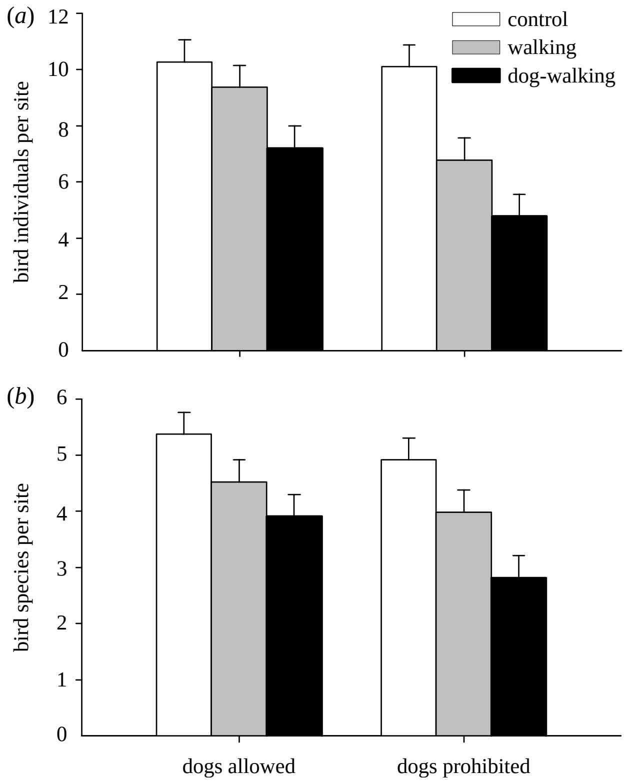

Figure 1. Dog walking in natural areas reduces (*a*) bird abundance and (*b*) bird diversity. Ninety sites were treated with either walkers with dogs on leads (black bars), walkers alone (grey bars) or no treatment (white bars). Half the sites were in areas where dog walking was permitted and the other where dogs were prohibited. Values represent least-squared means ±s.e. from an ANCOVA which included significant wind effects.

(Blumstein *et al.* 2005) and predicted to lead to population-level impacts on some birds species (Hill *et al.* 1997). We found no net difference in bird diversity or abundance between areas with and without regular dog walking receiving the same treatment, suggesting that long-term impacts in this area may be small.

That the effects of dogs occurred even where dog walking was frequent suggests further that local wildlife does not become habituated to continued disturbance. Foraging theory predicts that risk-aversive behaviour will be lost if cues to predation risk are not spatially or temporally variable, or if they are not reinforced (Blumstein & Daniel 2005; but see Blumstein 2006; Blumstein *et al.* 2006). Factors inducing habituation to predation risk in wild animals are relatively understudied, but there is evidence that some birds in urban areas habituate to disturbance by humans when risk is not realized (Keller 1989). In our study areas, it is unlikely that predation risk from dog walking is frequently realized because off-the-lead dog walking is not allowed, although it did occur occasionally. It is probable though that roaming domestic dogs maintain predation pressure on birds, even though their numbers would be very low compared with the intensity of use by dog walkers.

The dramatic reduction in bird diversity and abundance in response to dog walking has immediate implications for other popular recreational activities pursued by humans. This includes bird watching and ecotourism where visitor satisfaction shows a strong relationship to numbers of species seen (Naidoo & Adamowicz 2005). Wildlife surveys, which are used throughout the world to map bird distributions and factors affecting spatial patterns (e.g. Blackburn *et al.* 1999), could also be compromised if conducted when and where dog walking had recently occurred. It is also possible that the particular sensitivity of ground dwelling birds to dog walking (Blumstein *et al.* 2005) may lead to a cascade of potential behavioural changes in birds with implications for their local conservation (Hill *et al.* 1997). Our results therefore support the long-term prohibition of dog walking from sensitive conservation areas.

Surveys were conducted with approval from the UNSW Animal Care and Ethics Committee.

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