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Foraging by native and domestic ducks in urban lakes: behavioural implications of all that bread

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Wildlife feeding is a popular human-wildlife interaction throughout the Western World, yet remarkably little is known about the practice and its influences. This study investigated the effects of anthropological feeding upon the natural feeding ecology of the Pacific Black Duck *Anas superciliosa* and domestic duck taxa in ten urban lakes from South-east Queensland. Randomly chosen individuals were observed for five-minute sessions and their behaviours recorded during four time periods: Early Morning; Late Morning; Early Afternoon; and Late Afternoon. Foraging behaviours were collated into six behavioural categories of feeding, bread feeding, movement, resting, preening and social. A total of 200 ducks were observed, 144 Pacific Black Ducks and 56 domestic duck races. The natural foraging activities of the Pacific Black Duck occurred mainly in the early morning and late afternoon while domestic duck races foraged throughout the day. Both the Pacific Black Duck and domestic duck races spent a greater proportion of time foraging naturally than feeding on bread. Although conspicuous, bread feeding appeared to have little impact on the time spent obtaining natural foods. The study also speculated that bread feeding may be monopolized by a few dominant individuals.

INTRODUCTION

The feeding of wildlife, particularly birds, is a popular practice worldwide (Ballantyne and Hughes 2006; Jones and Reynolds 2008). Data collected in Australia have shown that significant numbers of people in Australia participate in wildlife feeding, both in domestic houseyards as well as in public settings such as urban parklands (Rollinson *et al.* 2003; Howard and Jones 2004; Oost 2007). Surprisingly, despite the widespread acceptance that wildlife feeding is 'unofficially unacceptable' in Australia (Jones 2003; Ishigame and Baxter 2007), numerous studies (see Jones and Reynolds 2008) have found participation rates to be similar to those of the United Kingdom and the United States where the practice is generally encouraged (Deis 1986; Cannon 1999).

Many negative impacts have been attributed to wildlife feeding including dependency on anthropogenic foods, changes in species behaviour (including attacks on humans), increases in local densities, enhanced risk of disease, as well as health risks such as malnutrition (Obrams 1996; Ballantyne and Hughes 2006; Ishigame and Baxter 2007) and botulism (Woodall 1982; Shayegani *et al.* 1984; Cliplef and Wobeser 1993; Feare *et al.* 1999). Others have highlighted the positive aspects of this common human-wildlife interaction (Toms 2003), citing the human health benefits of such contacts with nature (Miller 2005) and evidence that populations of certain threatened species are currently being sustained in urban areas in Europe directly because of wild bird feeding during severe winter seasons when resources are limited (Smith *et al.* 1980; Hoodless *et al.* 1999; Jones and Reynolds 2008; Robb *et al.* 2008; Chamberlain *et al.* 2009). Although some of these issues have been explored in certain bird taxa (Schoech *et al.* 2004; O'Leary and Jones 2006), many important issues relating to the feeding of wildlife in general remain remarkably poorly understood (Jones and Reynolds 2008). Indeed, we contend that one of the most widespread and popular forms of wildlife-human interaction – the feeding of ducks at urban lakes – has been entirely neglected (Chapman and Jones 2009, 2010). This lack of research is surprising given the likely ecological impacts of the vast amounts of anthropogenic foods – mainly bread - that daily enter these closed ecosystems and the possible nutritional effects on the ducks utilising this resource (Turner and Ruhl 2007). Here, however, we are interested in exploring some of the behavioural implications of duck feeding.

In a recent study, Chapman and Jones (2009) attempted to clarify some of the characteristics of duck feeding in a series of urban lakes in suburban Brisbane, south-east Queensland. This study confirmed the widespread popularity of the practice and found that significant numbers of people engaged regularly in feeding, that bread was overwhelmingly the most common food provided, and that, in this region, two taxa of duck were primarily involved in the interaction. These taxa were the Pacific Black Duck *Anas superciliosa* and various forms of domesticated duck. An earlier survey (Sinden *et al*. 2003) of waterbirds in Brisbane parklands discovered significant numbers of 11 races of these 'farmyard' waterfowl to be common in urban parks. Although the source of these birds is unknown, there is considerable anecdotal evidence that they originated on hobby farms in the region and were 'liberated' at urban lakes during the recent prolonged drought (Sinden *et al.* 2003).

Chapman and Jones (2009) also found that the domesticated duck taxa appear to be particularly favoured as recipients of bread feeding by the public. Moreover, being much larger in size the domestic breeds generally appeared to dominate competitions over food between native and domestic ducks. These observations suggested possible negative influences on the foraging behaviour of native species in urban lakes due to the presence of domestic ducks, an interaction mediated primarily by the ubiquitous feeding of duck by people.

A number of previous studies (Frith 1959; Norman *et al.* 1978; Hamilton *et al.* 2002) has investigated the natural feeding behaviour of Australian duck species. Interestingly, while Norman *et al*. (1978) emphasised the typical crepuscular pattern of foraging common in most species observed over a 10-week period in a species-rich Victorian site, Hamilton *et al.* (2002) found the natural feeding behaviour of the Pacific Black Duck to be relatively continuous throughout the day. The results of this study concluded that approximately 20–30 per cent of all Pacific Black Duck present were engaged in feeding across all time categories throughout the day.

The general aim of this present study was to investigate the patterns of foraging ecology of the two most abundant duck taxa present in urban lakes in Brisbane, the Pacific Black Duck and domestic races. However, because of the frequency of anthropogenic feeding at urban lakes, the influence of this food source was also investigated by comparing rates and behaviours associated with natural foraging and during periods when bread feeding was occurring. Given the findings of Hamilton *et al.* (2002), we hypothesised that the feeding activity of the Pacific Black Duck would be distributed relatively even throughout the day. For domesticated duck taxa, however, we speculated that their likely origins on farms would have resulted in a preference for human-derived foods, suggesting a concentration of feeding activity during the middle of the day when humans are more likely to be present at the sites.

METHODS

Study sites

Ten urban lakes distributed across Brisbane, previously identified as supporting water bird populations and known as locations were anthropogenic feeding occurs (Chapman and Jones 2009), were selected as study sites. Details are given in Table 1.

Observations of foraging behaviour

Over a two-month period (August 2009 – October 2009), each location was visited numerous times during weekday and weekend periods and within four time categories: early morning (sunrise – 0800 hrs); late morning (0800 hrs – 1200 hrs); early afternoon (1200 hrs – 1600 hrs); and late afternoon (1600 hrs until sunset). No observations were conducted at night. At each site a series of individual focal ducks were randomly selected and continuously observed for five minutes, with all behavioural states (see below) being identified and recorded using a voice recorder. Observations continued until 50 ducks had been observed during each time category, with 200 ducks (144 Pacific Black Ducks and 56 domestic ducks) recorded in total and observations being spread evenly over the ten lakes.

Each focal animal was observed for a total of 300 seconds with one of six generalized state: natural feeding; bread feeding; movement; resting; social; and preening - being recorded for each second. For periods of natural feeding, one of five specific feeding actions (up-ending; dipping; dabbling; grazing; and dredging - see Johnsgard (1965) for further details) was recorded as well.

Data analysis.

The mean total duration (per five-minute observation) for natural feeding behaviours of the Pacific Black Duck and domestic duck taxa were compared using a one-way ANOVA to test for any differences between time categories. ANOVA was also applied to bread feeding means of the Pacific Black Duck and domestic duck taxa to test for differences between time categories. Chi-square analysis was used to test between proportions of time that Pacific Black Duck and domestic duck taxa spent engaged in natural foraging compared to bread feeding.

RESULTS

Duck abundance

Three native species were identified across the ten locations (Table 2): Pacific Black Duck, Australian Wood Duck

Table 1

Descriptions of duck feeding locations, the lakes and their facilities of 10 urban sites in South-east Queensland.

Location Name	Suburb	Lat.S / Long.E	Area (ha)	Play Area	Picnic Area	Viewing Area	Signs
1 North Lakes	Mango Hill	27°13'19.25"S 153°01'16.34"E	1.66	✓	✓	✓	
2 Underwood Park	Priestdale	27°36'8.94"S 153°08'55.28"E	0.76	✓	✓	✓	
3 Centenary Lakes	Caboolture	27°05'14.86"S 152°57'1.04"E	1.82	✓	✓		
4 Fred Francis Park	Bracken Ridge	27°18'39.15"S 153°01'17.02"E	1.28	✓	✓		
5 Sherwood Forest Park	Sherwood	27°31'55.27"S 152°58'29.18"E	1.43		✓	✓	✓
6 Minnippi Parklands	Tingalpa	27°29'0.24"S 153°06'52.03"E	0.81	✓	✓		
7 Riverdale Parklands	Meadowbank	27°40'28.35"S 153°09'12.67"E	0.76	✓	✓	✓	
8 Lakewood Estate Park	Parkinson	27°38'2.97"S 153°02'21.64"E	1.17	✓	✓	✓	
9 Nudgee Waterhole	Nudgee	27°22'30.64"S 153°05'42.89"E	2.25	✓		✓	✓
10 Lockrose St. Park	Mitchelton	27°24'52.40"S 152°57'58.24"E	0.09	✓	✓		

Chenonetta jubata and Hardhead *Aythya australis*. The most abundant species by far, with a total of 231 individuals, was the Pacific Black Duck which was found at all locations. Numbers of Pacific Black Ducks ranged from 48 to 2 per site. Domestic ducks were observed at eight of the 10 locations.

Natural foraging

Natural foraging behaviours of the Pacific Black Duck were observed in all four time categories (Figure 1) of which the most time spent foraging naturally occurring in the early afternoon (76.39 ± 14.29 seconds per five-minute period) and the least amount of time occurring in the late morning (26.79 ± 11.51 seconds); the mean duration of late morning foraging was significantly lower than the other time categories ($F = 8.80$, $p < 0.05$, $df = 1,3$).

Domestic duck taxa foraged on natural foods in all time categories (Figure 1) with the most amount of natural foraging occurring in the early afternoon (87.08 ± 29.04 seconds per five-minute period) and the least being in the early morning (63.45 ±27.30 seconds). There were no significant differences for total times of foraging behaviours recorded between the time categories.

Pacific Black Ducks and domestic duck taxa were observed undertaking each form of foraging behavioural categories (Table 3) with dabbling being the most observed foraging behaviour of the Pacific Black Duck (36.8%) and dipping (40.3 %) being the most common feeding type of domestic taxa. Dredging was the least observed foraging type for both Pacific Black Ducks (0.6 %) and domestic (0.9 %).

Bread feeding

Pacific Black Ducks were recorded feeding on bread in all time categories (Fig. 2) with the mean total detected in the late afternoon (26.77 ±13.38 seconds per five-minute period) being significantly higher than all other time periods ($F = 10.54$, $p < 0.05$, $df = 1,3$). Bread feeding by the domestic duck taxa was observed in the early morning, late morning and late afternoon but not in the early afternoon (Fig. 2). The mean total duration ranged from 26.77 ± 24.75 seconds per five-minute period to 3.125 ± 2.26 seconds; there were no significant differences between the time categories.

A comparison of the proportion of time ducks spent either natural foraging or bread feeding indicated that both Pacific

Table 2

Numbers of ducks observed at 10 urban lake locations in South-east Queensland.

Location	Pacific Black Duck	Australian Wood Duck	Hardhead	Domestic duck taxa
1. North Lakes	2	0	21	0
2. Underwood Park	21	1	6	7
3. Centenary Lakes	48	19	4	12
4. Fred Francis Park	41	13	0	11
5. Sherwood Forest Park	4	0	0	1
6. Minnippi Parklands	18	6	0	12
7. Riverdale Parklands	29	9	12	3
8. Lakewood Estate Park	32	0	3	0
9. Nudgee Waterhole Reserve	13	2	14	6
10. Lockrose St Park	23	4	0	3
Total	**231**	**54**	**60**	**55**

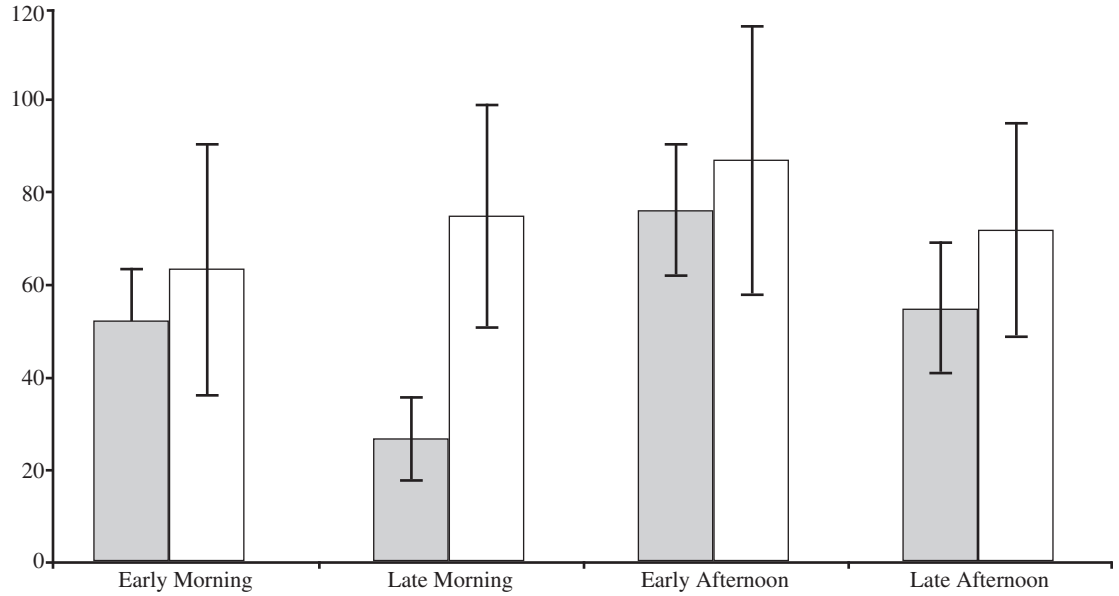

Figure 1. *Mean total of natural foraging (per 5 minutes period) of the Pacific Black Duck (grey bars) and domestic duck taxa (open bars) in each time category.*

Table 3

Estimated percentage (and standard error) of feeding behaviours of Pacific Black Ducks and domestic duck taxa in urban lakes in South-east Queensland

	Up-ending	Dipping	Dabbling	Grazing	Dredging
Pacific Black Duck	32.8 (6.2)	28.3 (3.4)	36.8 (3.5)	1.5 (2.3)	0.6 (0.2)
Domestic duck taxa	35.1 (10.1)	40.3 (9.9)	21.1 (3.5)	2.6 (3.7)	0.9 (0.4)

Black Ducks (Fig. 1 and Fig. 2; $\chi^2 = 41.0$, $p<0.0001$, $df = 3$) and domestic ducks (Fig. 1 and Fig. 2; $\chi^2 = 41.0$, $p <0.0001$, $df = 3$) spent more time feeding naturally than feeding on bread.

Activity patterns

To assess the influence of bread feeding on the activity patterns of ducks in urban lakes, we determined the percentage of each behavioural state exhibited by all ducks in our samples for all sites, and compared for each of the four time periods. For Pacific Black Ducks the highest proportion of time was spent either moving or resting while social interactions took up the least amount of time in all periods (Table 4). Interestingly, the time spent naturally feeding was significantly greater in all time periods than that for bread feeding (Table 4). In all cases, the difference in time spent feeding on bread was less than 10 per cent of the time foraging naturally.

For the domestic duck taxa the highest proportion of time was engaged in either preening or resting and the lowest proportion of time engaged in social activities (Table 4). Again, the proportion of time spent in natural feeding was far greater than that spent in bread feeding for all time periods (Table 4).

DISCUSSION

Concern over the feeding of anthropogenic foods to wild animals is widespread, with a wide range of impacts being suggested as a result of sustained feeding (Skira and Smith 1991; Jones and Reynolds 2008). Due to its ubiquitous use in wildlife feeding, bread has been especially prominent in such discussions in relation to a wide range of species (Rollinson *et al.* 2003; Wilson and Lawler 2008). However, despite the attribution of a number of medical conditions to the ingestion of bread, relatively little information is available. In relation to the general frequency of duck feeding, it was speculated that the sheer quantity of bread that is typically provided at urban lakes (Chapman and Jones 2009) could alter the normal patterns of foraging. Specifically, we predicted that the provision of bread would lead to ducks decreasing the amount of time spent in natural foraging. We also predicted that anthropogenic feeding would occupy a larger proportion of the foraging activities of domesticated ducks.

Species abundance

The abundance of the Pacific Black Duck was consistent with previous studies as it is the most abundant native species present in urban areas of South-east Queensland (Sinden *et al.* 2003; Chapman and Jones 2009). Given earlier studies (Sinden *et al.* 2003), we expected domestic ducks to be numerous, although even larger numbers of these taxa than expected were detected during the present study. The previous study (Chapman and Jones 2009) found 39 individual domestic ducks across eight locations whereas the same sites supported 55 individuals a year later. These situations, almost certainly resulting from releases of adult birds rather than reproduction, suggest a need for management of domestic ducks and the need for research into the potential

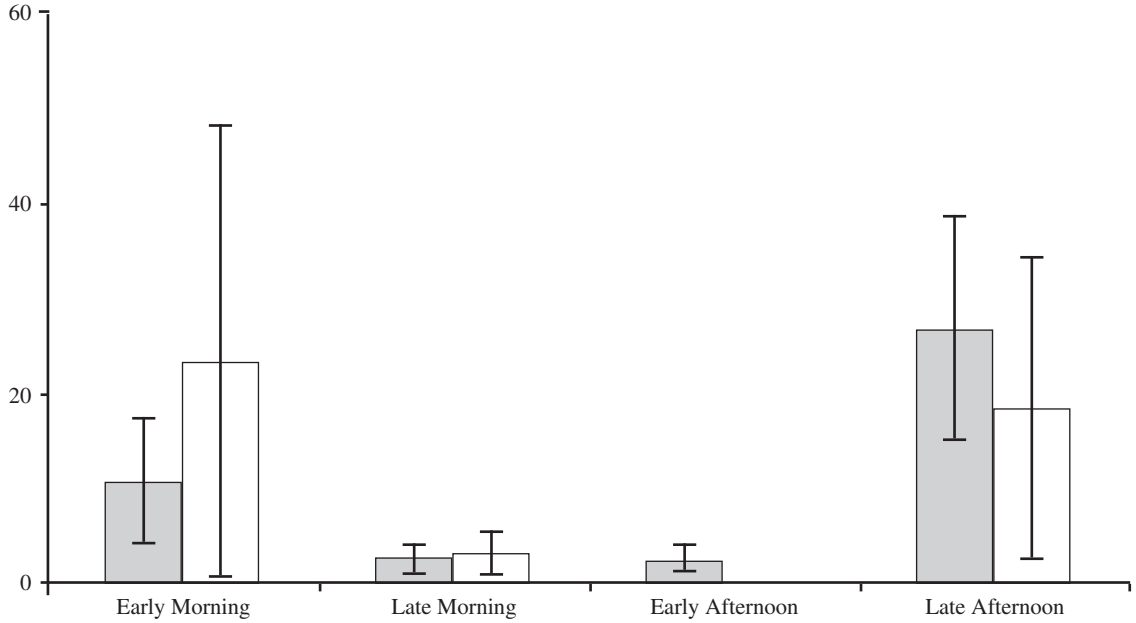

Figure 2. *Mean bread feeding (per 5 minutes period) of the Pacific Black Duck (grey bars) and domestic duck taxa (open bars) in each time category.*

Table 4

Proportions of behaviors undertaken by Pacific Black Ducks and domestic duck taxa in four different time categories in urban lakes in South-east Queensland.

Species	Time Category	Movement (%)	Resting (%)	Social (%)	Preening (%)	Bread Feeding (%)	Natural Feeding (%)
Pacific Black Duck	Early Morning	36.7	34.9	0.9	6.2	4	17.6
	Late Morning	29.7	53.9	0.9	5.5	0.9	8.9
	Early Afternoon	39.7	24.2	0.6	9.3	0.8	25.5
	Late Afternoon	26.2	37.1	1.2	6.3	9.6	19.6
Domestic duck taxa	Early Morning	28.7	9.7	0.07	32.6	7.8	21.1
	Late Morning	26.4	34.1	1.3	12.2	1	25
	Early Afternoon	20	20.4	0.7	29.9	0	29
	Late Afternoon	20	30.4	0.07	19.3	6.1	24.1

impacts such as hybridization, competition and dominance (Rhymer and Simberloff 1996; Munoz-Fuentes *et al.* 2007).

Foraging activities of Pacific Black Ducks

The natural foraging behaviour of the Pacific Black Duck, in the absence of bread, was hypothesized to be distributed relatively evenly throughout the day, as suggested recently by Hamilton *et al.* (2002). However, our results were consistent with the pattern found in the earlier literature with feeding taking place early in the early morning and late in the day (Frith 1959; Norman *et al.* 1978; Marchant and Higgins 1990). We were, however, unable to comment upon the incidence of night feeding.

Bread feeding by the Pacific Black Duck occurred significantly more in the late afternoon compared to the rest of the day, a result largely related to increased visitation rates by people. However, even during these periods, the mean time spent in bread feeding for all ducks samples was unexpectedly low. An examination of the raw data indicated that these results were due almost entirely to the monopolization of the bread by a small number of individual ducks. This strongly suggests the potential for a subset of behaviourally dominant birds controlling access to this major anthropogenic food source. If so, and this was found to be a common situation among bread-feeding ducks, the distribution of the resource may be strongly biased towards a small proportion of the birds present. This may have several important consequences, including the concentration of potential costs and benefits in a few individuals. For example, the dominant birds may accrue fitness and reproductive advantages associated with their exploitation of a major food resource. On the other hand, such individuals may suffer from the health and nutritional complaints hypothesized to be associated with a heavy use of anthropogenic foods. Clearly, this is an issue deserving of further research (Wilson and Lawler 2008).

Foraging activities by domestic ducks

The assumed anthropologic relationships of the domestic ducks suggested that these birds would be more likely to respond to human-provided food sources resulting in a pattern of feeding in the morning and late afternoon in association with the feeding times by people. Moreover, we predicted that domestic ducks would engage in less natural foraging that native ducks. However, we found that domestic ducks also fed naturally relatively evenly throughout the day and that the total amount of bread feeding by the domestic duck taxa was also found to be far less than expected with no significant differences found between the time categories. As with the Pacific Black Duck, a much greater proportion of domestic ducks were observed to be engaged in natural feeding behaviours than that of bread feeding. This could also suggest that domestic duck taxa are not overly reliant on bread as a food source.

As with the Pacific Black Duck, relatively few individual domestic ducks were engaged in bread feeding, suggesting the possibility of behavioural dominance. Further investigation is recommended involving marked individuals of both species to gain an understanding of the potential dominance that could occur in natural feeding and feeding on anthropogenic food sources.

Foraging patterns

Although the feeding patterns of both species differed somewhat, there was no significant variation in the type of natural feeding modes of the Pacific Black Duck and domestic races. Dabbling, dipping and up-ending were all frequently used by both species, consistent with the typical foraging behaviour of dabbling ducks (Johnsgard 1965).

In conclusion, this modest study suggests that the practice and implications of the widespread and popular past-time of duck feeding is far more complex that is usually assumed. First, this study found that both Pacific Black Ducks and domestic races continue to forage on natural food items and employing typical foraging behaviours even in locations where significant amounts of bread are provided regularly. Although this preliminary finding requires further investigation, it does suggest that the individual birds involved are apparently not dependant upon this form of anthropogenic food, an important concern (O'Leary and Jones 2006). However, there is also some suggestion that access to the bread distributed by people is far from even and that a small number of behaviourally dominant individuals may be monopolising this resource.

Finally, the apparently permanent and growing populations of a wide variety of domesticated duck taxa throughout the region may be cause for concern from a number of perspectives. As well as the well-known capacity and risk associated with hybridization (Braithwaite and Miller 1975; Sinden *et al.* 2003; Guay and Tracey 2009), the presence of large numbers of these larger and socially dominant birds may lead to ecological impacts on native species through competition for food and nesting sites as well as the potential for disease transfer. We strongly encourage further research into these issues.

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