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Research note

Dingoes at the doorstep: Preliminary data on the ecology of dingoes in urban areas

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HIGHLIGHTS

- Dingoes are present in most large cities and towns in Australia.
- Dingoes regularly traverse backyards, school grounds, parkland and green zones.
- Urban dingoes may present significant social, economic and environmental impacts.
- Urban dingoes may contribute to human health and safety risks in urban areas.
- Urban planners and wildlife managers need more information on urban dingo ecology.

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ABSTRACT

Wild carnivores are becoming increasing common in urban areas. In Australia, dingoes exist, in most large cities and towns within their extended range. However, little empirical data is available to inform dingo management or address potential dingo–human conflicts during urban planning. From GPS tracking data, the nine dingoes, predominately juvenile and female, we tracked lived within 700 m of residential homes at all times and frequently crossed roads, visited backyards and traversed built-up areas. Home range sizes ranged between 0.37 km^2 and 100.32 km^2. Dingoes were mostly nocturnal, averaging 591 m/h between dusk and dawn. Juvenile and adult dingoes spent up to 19% and 72% of their time in urban habitats. Fresh scats from most areas surveyed tested positive to a variety of common zoonoses. These data suggest dingoes are capable of exploiting peri-urban areas and might contribute to human health and safety risks, the significance of which remains unknown.

1. Introduction

Wild, generalist carnivores 5–20 kg in size are becoming increasingly common in and around urban areas throughout the world (Gehrt et al., 2010). 'Ideal' urban carnivores are typically 'highly adaptable in terms of diet, movement patterns and social behaviour' (Bateman & Fleming, 2012, p. 14). Dingoes (10–20 kg; *Canis lupus dingo*) and hybrids (see Supplementary material for definitions and discussion of genotypes) were introduced to Australia from Asia around 5000 years ago, subsequently naturalising across the mainland within a few hundred years of their arrival (Fleming, Allen, & Ballard, 2012). Dingoes are presently distributed across about 85% of the continent (Allen & West, 2013) and are likely to be present in or adjacent to most cities and towns within their extended range (DEEDI, 2011). The frequency and intensity of human conflicts with dingoes in urban areas has reportedly increased in recent years, creating a potentially significant human health and safety issue for many residential communities (Allen, 2006b; DEEDI, 2011; Jenkins, Allen, & Goullet, 2008; O'Keefe & Walton, 2001; Rural Management Partners, 2004). Concern regarding the presence of dingoes in urban areas is not solely due to the risk of dingo attacks on humans or domestic pets and livestock, but also the increased risk of zoonoses and the fouling and subsequent underuse of recreational amenities (DEEDI, 2011; O'Keefe & Walton, 2001).

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The extent of published knowledge on urban dingoes is presently limited to general acknowledgement of their presence and potential risks (Allen, 2006b; DEEDI, 2011; O'Keefe & Walton, 2001), opportunistic observations of the parasites and pathogens they can carry (Brown & Copeman, 2003; Henderson, 2009; Jenkins et al., 2008), case studies discussing their impacts (Rural Management Partners, 2004), and limited information on their diets (Allen, Goullet, & Palmer, 2012) and genetic identity (Elledge, Allen, Carlsson, Wilton, & Leung, 2008). There has been little directed study of urban dingoes; much of what is known has been derived from local government control programmes where dingoes and other wild dogs were trapped and euthanized. There are presently no published studies on the home range sizes, activity patterns or habitat use of urban dingoes.

In this preliminary study, we use fresh scat and GPS tracking data to investigate aspects of the fine-scale spatial ecology of urban dingoes, with Supplementary information on zoonoses. Our primary objective was to explore the level of association dingoes have with humans in urban areas. Based on the characteristics typical of other urban carnivores (reviewed in Bateman & Fleming, 2012; Gehrt et al., 2010), we expected urban dingoes to have small home ranges, live in close proximity to humans and use the more densely vegetated habitat fragments within the urban matrix.

2. Methods

2.1. Dingo capture and tracking

Urban dingoes were captured with soft-catch foot-hold traps ('Jakes' and Victor #3s), fitted with GPS datalogging collars, released and then intensively monitored from 5 to 43 successive days between October 2005 and June 2006 in the Pine Rivers Shire (PRSC) and Maroochy Shire (MSC) of sub-tropical southeast Queensland, the latter being the primary study area (Fig. 1; Allen, 2006a). Over one million people live within these study areas. Collars were programmed to record GPS points at 5 min intervals from 17:00 to 09:00 and hourly intervals outside these times (in order to conserve battery life). Each collar weighed ~450 g and automatically detached at a pre-programmed date to avoid the need for recapture. Collars had VHF radiotracking functionality which was used to obtain observations of individual dingo behaviour during the collaring period. The accuracy of GPS points was assessed using the horizontal dilution of precision (HDOP) values recorded with each GPS point; lower HDOP values being indicative of a more accurate GPS point (Matthews et al., 2013). Ground-truthing was undertaken post hoc through fixed collar tests at key focal points used by each dingo, and subsequent comparison of observations with GPS tracking data further verified the accuracy of GPS points at identifying the fine-scale location of dingoes (Allen, 2006a). The age of dingoes was estimated visually at capture from an assessment of tooth wear, body size and breeding status, while noting the date of capture and the annual breeding cycle of dingoes (Corbett, 2001). After retrieval of the collars, the calculation of home range sizes, activity patterns and habitat use were all performed in ArcGIS v9.1 using all recorded GPS points (i.e. non-independent points of all HDOP values). Annotated maps for each dingo monitored are provided in Figs. S1–S10 (Supplementary material).

2.2. Home range size, activity patterns and habitat use

Home range sizes were estimated using 95% adaptive kernels (AK; h1; Seaman & Powell, 1996). Core area sizes were estimated using 50% AKs. Activity levels were assessed by estimating each dingo's movement rate, velocity or speed of travel (m/h) between two consecutive GPS points, followed by calculating the mean speed of travel for each hourly period (similar to Grinder & Krausman, 2001). All areas within the home range were classified into one of three habitats: bushland, caneland or urbanland. Bushland was mainly comprised of eucalypt-dominated forest, closed rainforest or other 'natural' or remnant habitats. Caneland was mainly agricultural cropland (predominantly sugarcane or abandoned sugarcane fields), identified by its linear features. Urbanland included residential suburbs, open and/or grassed areas (e.g. recreational parks, sports fields and hobby farms) and some small bushland fragments not large enough to be classified as 'bushland' (e.g. powerline easements, narrow riparian areas, etc.).

Habitat utilisation was estimated by calculating the actual minutes/hours spent in the habitat and not the proportion of GPS points recorded in a particular habitat. However, results using the 'proportion of GPS points' were also recorded for comparative purposes. Critical habitat was assumed to be those habitats used as daytime resting places. Utilisation of critical habitat was calculated as the proportion of daytime GPS points (i.e. those between 09:00 and 17:00) in a given habitat because hourly GPS points were insufficient to calculate actual time spent. Further description of study sites, capture and collaring techniques, data quality validation and spatial analyses can be found in Allen (2006a). Data and discussions of habitat use and zoonoses detected in scats can be found in Table S1 (Supplementary material).

3. Results

Nine urban dingoes (seven juvenile and six female) were collared, released and monitored between October 2005 and June 2006 (Table 1). In PRSC, one adult male (Dingo5) was collared and monitored for 22 days. This dingo lived within 3-km radius of −27.37894 latitude, 152.93621 longitude (adjacent to a domestic refuse facility in the Brisbane suburb of Arana Hills; Fig. S6) during the monitoring period. The remaining dingoes were from MSC (Fig. 1). Body weights of collared dingoes ranged from 10 to 27 kg (Table 1).

The mean home range size of all captured animals was 17.72 km^2 (range 0.37–100.32 km^2). Overall mean activity levels were inconsistent between individuals, which may be related to differences in the duration of monitoring or their age, body size or the habitat they utilised (Table 1). Collared dingoes were primarily nocturnal, and activity levels rose and fell sharply at dusk and dawn, respectively. Activity peaked at 742.2 (SE 124.0) m/h just after dusk, and slowly declined throughout the night to 490.9 (SE 47.3) m/h at 08:00. Nighttime activity averaged 591.2 (SE 18.0) m/h, whereas, daytime activity averaged only 219.6 (SE 85.3) m/h. Collared dingoes regularly spent time in all habitat types (Table 1; Figs. S1–S10, Supplementary material). All juvenile and sub-adult dingoes monitored spent no more than 19% of time in urban areas (Table 1). In contrast, the two adult dingoes spent 62–72% of their time in urban areas. Each GPS point from each dingo was within 700 m of residential homes at all times, and was often within 200 m of homes (Figs. S1–S10). At night times, some collared dingoes often visited residential backyards and individual houses (e.g. Dingo3, Dingo7 and Dingo8; Figs. S4, S8 and S9). Observations and the fine-scale GPS data indicated that at least one dingo 'went from house to house' during the night (e.g. Dingo8; Fig. S9), presumably in search of rubbish bins, pet food, pets or perhaps just exploring her surroundings. No consistency in habitat utilisation was apparent for the nine dingoes we monitored (Table 1). Analysis of critical habitat also showed no consistencies between dingoes. No more than 16% of daytime GPS points were recorded in urbanland for juvenile dingoes, whereas, up to 74% of daytime GPS points were recorded in urbanland for Dingo5, an adult male.

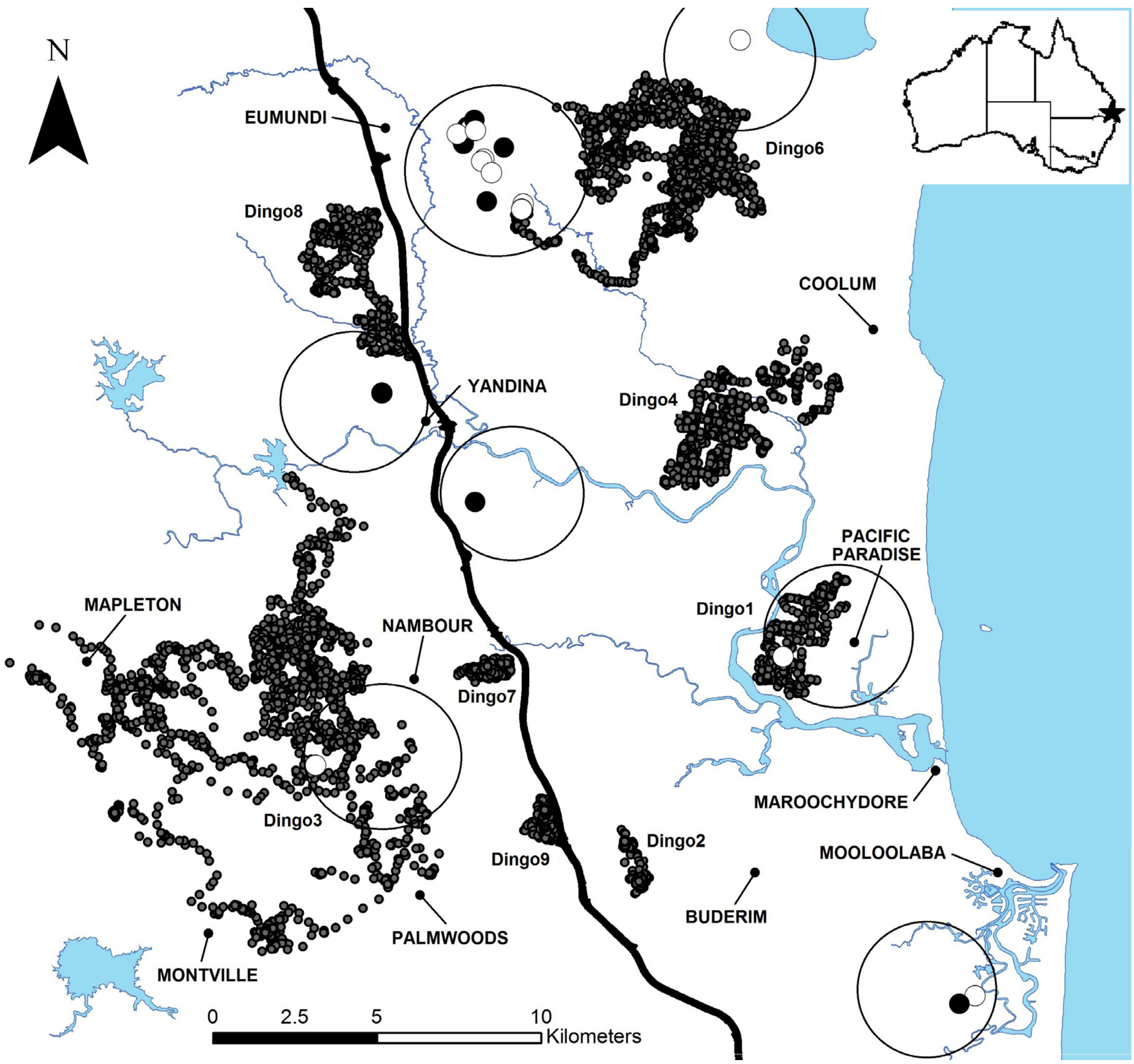

Fig. 1. Overview of the MSC study area, showing the location of major townships, the Bruce Highway (black line), sequential GPS points (small grey dots) of the eight urban dingoes monitored in the area, the primary areas searched for dingo scats (large circles), and the fresh scats ($n = 30$) testing positive (hollow marks) and negative (solid marks) for zoonoses (see Supplementary material). Inset: location of the study site in Australia.

4. Discussion

Our results suggest that dingoes have biological traits typical of ideal urban exploiters, such as flexible resource requirements (see also Corbett, 2001; Newsome, Ballard, Dickman, Fleming, & Howden, 2013). However, we recognise that intensive monitoring of nine mostly juvenile animals for only a few weeks allows only tentative insights into the ecology of urban dingoes.

The home range sizes of most dingoes we monitored were relatively small (typically < 15 km^2) when compared to those of rural dingoes, which can be over 1000 km^2 (Newsome, Ballard, Dickman, Fleming, & van de Ven, 2013). Such small home range sizes probably reflect the age and social status of the majority of the dingoes we monitored and/or the limited duration that collars remained on them. For example, juvenile dingoes may remain close to the immediate area surrounding their birthplace, expanding their range as they get older (Allen, 2009, 2010). Given that the annual birth peak of dingoes occurs in late winter (July–August; Corbett, 2001), the juveniles or sub-adults in our study were probably 6–10 months old, and their restricted movements and home range sizes may simply be attributable to their age and associated vulnerability. Additionally, it is possible (and perhaps probable) that not all of the home range area may have been traversed by dingoes during their 5- to 43-day monitoring periods. The only adult collared during the high-activity breeding season (Dingo3) had a home range of 100 km^2 at this time.

All nine dingoes became active at dusk and remained relatively active throughout the night, significantly decreasing their activity within a few hours after dawn (see also Allen, 2006a). Our limited data suggests that urban dingoes may travel 10–15 km during the night within their home range. Minimal movement occurred throughout the day for all dingoes (Table 1). The causes for this polarised activity pattern were unclear, but higher levels after dusk might reflect more profitable foraging times in urban habitats. Alternatively, dingoes may face greater danger during daylight hours as increases in human activity (e.g. vehicular traffic) may become more hazardous to them, restricting their activity during these times. A variety of factors likely influence where and when a dingo moves about their home range in an urban area (such as the presence of aggressive pet dogs, vehicular traffic, or other civil events such as school start and finish times or sports events). Thus, major differences in activity levels may be expected between individuals and groups of individuals. For example, an experienced and resident adult may be much more familiar with their surroundings

Table 1
Details of collared dingoes, including GPS data quality, home range sizes (core area sizes in parentheses), activity levels and habitat use. HDOP = horizontal dilution of precision; AK = adaptive kernel; * = Caneland habitat not available.

Dingo ID	Dingo details				GPS data details						Home range size (km^2)
	Age class	Sex	Colour	Weight (kg)	Release date	Number of whole days monitored	Total GPS points obtained	GPS points with HDOP ≤ 3 (%)	Proportion of expected GPS points obtained (%)	Median HDOP	95% AK (50% AK)
Dingo1	Juvenile	Female	Sable	13	12-Feb-06	5	920	68.3	83.6	2.5	7.73
Dingo2	Juvenile	Male	Sable	10	5-Jan-06	12	1029	50.0	38.6	3.1	0.83
Dingo3	Adult	Female	Sable	27	21-Apr-06	40	6315	63.8	77.3	2.6	100.32 (5.62)
Dingo4	Juvenile	Female	Tan	15	9-May-06	30	4237	62.0	69.2	2.6	13.43
Dingo5	Adult	Male	Black	23	14-Oct-05	22	3898	65.2	85.4	2.6	0.37
Dingo6	Juvenile	Female	Black and Tan	14	2-Feb-06	43	6870	59.1	78.0	2.8	25.67 (1.89)
Dingo7	Juvenile	Male	Tan and White	10	5-Jan-06	21	3409	59.0	74.3	2.8	0.48
Dingo8	Juvenile	Female	Sable	14	21-Dec-05	22	3826	62.6	83.4	2.6	9.86
Dingo9	Juvenile	Female	Black and Tan	14	4-Apr-06	13	1197	55.4	33.5	2.8	0.81
Mean				**15.56**		**23**	**3522**	**61**	**69.3**	**2.7**	**17.72**

Dingo ID	Mean activity levels (m/h)		Overall habitat utilisation: the proportion of total time spent (and the proportion of total GPS points) in a given habitat			Critical habitat utilisation: the proportion of diurnal GPS points in a given habitat		
	Nighttime 1700–0900	Daytime 0900–1700	Bushland	Caneland	Urbanland	Bushland	Caneland	Urbanland
Dingo1	794.7	184.3	8 (8)%	89 (89)%	3 (3)%	35%	57%	9%
Dingo2	473.2	148.9	58 (58)%	23 (30)%	19 (12)%	52%	48%	0%
Dingo3	921.5	122.0	38 (33)%	0 (0)%*	62 (67)%	38%	0%*	62%
Dingo4	443.6	364.9	23 (15)%	67 (75)%	10 (10)	17%	67%	16%
Dingo5	409.4	110.2	26 (25)%	0 (0)%*	74 (75)%	26%	0%*	74%
Dingo6	588.9	196.1	36 (32)%	46 (50)%	18 (18)%	33%	53%	14%
Dingo7	516.3	387.5	61 (62)%	21 (20)%	18 (18)%	61%	26%	14%
Dingo8	561.6	69.2	11 (10)%	85 (86)%	4 (4)%	2%	97%	2%
Dingo9	611.6	393.5	85 (79)%	7 (9)%	8 (12)%	94%	6%	0%
Mean	**591.2**	**219.6**	**38(36)%**	**38(40)%**	**24(24)%**	**40%**	**39%**	**21%**

and be more confident utilising them than a juvenile, transient or vulnerable (e.g. pregnant or lactating) dingo which may be more cautious around vehicles, under lights or in confined spaces (e.g. fenced yards with limited opportunities to flee). It might reasonably be assumed that observed movement patterns and activity levels would reflect the foraging strategies and nature of risks an individual urban dingo is prepared to face, and variable results for different individuals might be expected for such a highly adaptable species.

Densely vegetated bushland and caneland habitats appeared particularly important to the dingoes we monitored (Table 1; Figs. S1–S10). Vegetation density most likely influences the abundance of dingo prey populations in urban ecosystems, with more densely vegetated areas probably supporting a greater variety of prey species (May & Norton, 1996; O'Keefe & Walton, 2001). Densely vegetated areas may also offer refuge for dingoes where they are less likely to be disturbed or harassed. Resource availability typically determines the home range size of dingoes (Corbett, 2001; Newsome, Ballard, Dickman, Fleming, & Howden, 2013), which suggests prey availability influences the habitat use (and home range size) of urban dingoes to a greater degree than other factors. The occurrence of juveniles in such areas also suggests that dingoes can successfully raise litters in these places. We did find evidence of litter-raising in some instances where diurnal resting places were visited, with temporary dens located under dense *Lantana camara* stands and low-growing broadleaf palms within 200 m of houses and industry (B. Allen, personal observations).

4.1. Management and research recommendations

The presence of dingoes in urban areas presents substantial management challenges that may not be easily addressed using tools and techniques (e.g. poisons and firearms) commonly applied in rural areas (DEEDI, 2011). That individuals or groups of dingoes can traverse a variety of land tenures on a day-to-day basis also presents a practical challenge to policies which place the responsibility of pest animal control on the landowner (DEEDI, 2011). Urban dingoes are also known to carry multiple bacterial, protozoan and helminthic parasites and pathogens (Table S1), which may add further complexity to their management. Given public concern and the dearth of data on urban dingo ecology, future research priorities could include more detailed and longer-term information on their zoonotic disease ecology, genetics, distribution, density, dispersal patterns, diet and their economic, environmental and social impacts. The role of urban planning in minimising potential dingo–human conflict should also be explored. The sparse knowledge-base and practical challenges to urban dingo management may appear overwhelming but, on the positive side, there may be a greater level of community interest in a charismatic icon of the Australian outback living literally on their doorsteps.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at http://dx.doi.org/10.1016/j.landurbplan.2013.07.008.

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