

Biodiversity and urban design: birds, 'burbs and Brisbane's bushland



A significant centre for birds and biodiversity

The Brisbane region lies at the centre of one of Australia's biodiversity "hotspots", supporting a notably high concentration of species. For example, about half of Australia's birds occur in Brisbane (about 330 out of 650 species, two-thirds of which are land birds) within a tiny fraction of the continent's total area. However, this is also the centre of Australia's fastest growing region in terms of human population size. The combination of these two factors poses unprecedented challenges for the city and its surrounding region. Will rampant urbanisation spell doom for this rich natural heritage or can patterns of human settlement and land use be managed in a way that enables the diversity of birdlife and its associated ecosystems to persist alongside the city's human occupants?

Development and change: taking a birds-eye view

Development in urbanising areas involves a series of transformations in the landscape. Urbanisation often goes hand in hand with deforestation, as native vegetation is cleared for housing developments. On the other hand, when developments are placed in areas previously cleared for pasture or cropland, garden plantings may offer an increased diversity of habitats for wildlife. Watering of gardens or direct provision of food may buffer the extremes of drought and provide a reliable supply of resources for some species. Seen from the air, urbanising regions are large-scale mosaics in which residential areas are interspersed with business and industrial domains, grassy parkland or pasture areas, and remnant native forest of different types. Residential areas also vary in type - some are very built-up whereas others have large gardens and many trees. These differing elements of the mosaic support different combinations of species. As people move into the region, there is a risk that the patches of native vegetation will progressively disappear, and much more land will become covered with housing and simple gardens of a more uniform style.



Studies of urbanisation in other parts of the world have highlighted the phenomenon of 'biotic homogenisation', in which a limited suite of urban-adapted species is spreading around the globe, while the much larger number of original and distinctive native species declines or disappears. For example, a handful of birds such as the house sparrow, common starling, and rock dove (domestic pigeon) can be found in city areas worldwide, while crows (albeit of various species) are also on the increase in many urban regions. However, most of these findings come from studies in temperate cities of the northern hemisphere. Australia, and Brisbane in particular, is different in many respects; our wildlife are more diverse and distinctive, we are more tropical in location, our history of urban settlement is much briefer, and yet we have cleared native vegetation much faster. We are only beginning to find out what that will mean for the persistence of native wildlife.

By studying the combinations of bird species that occur in the different habitat elements that make up the urban mosaic, we can get an idea of what could happen to bird diversity if we remove some of these elements (remnant bushland for example). This assumes that each habitat type supports a characteristic composition of species. For example, we assume that a conserved area of native bushland will in future support the mix of species that were originally present before the surrounding land was cleared and developed. However, in rapidly-urbanising areas such as Brisbane, it is quite plausible that some species are in the process of decline even within conserved bushland, because of a range of direct and indirect effects of past habitat loss and change (termed the "extinction debt" in scientific ecology). Simultaneously, other species that benefit from urban development in unanticipated ways may still be in the process of increasing and spreading. This means that we also need to study the changes that are occurring over time. The resulting knowledge can be applied to help design a kind of city where there is less risk of dooming many bird species and their habitats to catastrophic decline.

Here we describe some of the preliminary findings from such a study. In 2006 Griffith University and Brisbane City Council entered into a four year Biodiversity Research Partnership to assess recent changes in Brisbane's birds, and develop useful indicators for assessing the quality of their habitats. The partnership grew to include James Cook University, Logan City Council, and SEQ Catchments. The research team, led by Carla Catterall, counted birds at 124 sites in Brisbane and surrounding areas, including different types of suburb and different sizes of bushland remnants. Each site was an area 100 m long by 30 m wide, carefully placed within a larger patch of the specified habitat, and surveyed on six occasions in the early 1990s and again in the mid 2000s. This provided two "snapshots" of what bird species were present and how abundant they were, so that both the bird species of different habitats and their changes over the last 15 years could be quantitatively analysed. Looking just at the suburbs and larger patches of forest provided some interesting and not entirely expected results, based on a total of 102 recorded bird species from 74 sites.



Project Leader Carla Catterall and colleague Scott Piper



The suburbs: bare and boring versus diverse and dynamic



The Kookaburra is a "generalist", common in both bushland and leafy suburbs

Suburbs in and around Brisbane have a much more diverse and interesting mix of bird species than would be expected from studies of urbanisation conducted in the northern hemisphere. From 38 suburban sites that were surveyed in both the early 1990s and the mid 2000s, 62 native and 7 introduced bird species were recorded. Averaged over both time-periods, the species recorded at the most suburban sites were rainbow lorikeet, spotted dove, crested pigeon, noisy miner, Australian magpie, magpie-lark and Torresian crow. In both time-periods, most suburban species were native and most were of larger body size compared with the common birds of bushland. In the early 1990s, "bare" suburbs without much tree and shrub cover had a simpler and less diverse bird community, with more introduced species (such as the house sparrow) than better-vegetated suburbs.

By the mid-2000s there had been many changes (see Table 1). First, some previously-common species had declined greatly in numbers, whereas others had increased. Overall, of the 36 species that were sufficiently common for statistical assessment, 58% changed significantly in abundance over time. Among native species, 10 of 31 (32%) increased significantly whereas 7 (23%) decreased. Increases included the noisy miner, crested pigeon, pied currawong, Torresian crow and Australian brush-turkey; decreases included the scaly-breasted and little lorikeets and magpie-lark or "pee-wee". Among the 5 testable introduced species there was an even balance between significant increasers (two species - common myna, rock dove) and decreaseers (two species - house sparrow, common starling). Some of the increasers have attracted the attention of many Brisbane residents; sometimes appreciated, sometimes disliked.

The conclusion is that there is no trend for decreasing bird diversity in the suburbs over time. Rather, the net trend was for increases in a range of species. Neither was there a net increase in numbers of introduced species – there was more change in introduced species than for native species, but changes were both positive and negative. On the other hand, the suburban sites did become more homogeneous (similar to one another), being increasingly dominated by a particular suite of native species, including rainbow lorikeets, noisy miners, crested pigeons and Torresian crows. These are all birds that respond positively to the presence of trees and shrubs, and it is likely that the increased homogeneity among suburban sites is due to an increase in vegetation cover within the previously "bare" suburbs. Current work is testing this idea by measuring the cover of vegetation, lawn, and impervious surfaces at the study sites, using aerial photography from both the 1990s and 2000s.

Table 1. Numbers of species that showed statistically significant changes in numbers in either suburbs or bushland during a 15 year period (early 1990s to mid 2000s).

Habitat	No. of testable species*	Native species		Introduced species	
		Increased	Decreased	Increased	Decreased
Suburban areas (38 sites)	36	10	7	2	2
Large bushland areas (29 sites)	38	2	4	0	0

*To be testable, a species needed to have been recorded from at least 5 sites

The bush: why keeping all that's left (and recovering more) is critical

Within the larger patches of forest (bushland), the study revealed the expected high total diversity of native bird species: from 29 sites in large tracts (over 100 hectares) of native eucalypt forest that were surveyed in both the early 1990s and the mid 2000s, 77 native and no introduced bird species were recorded. Averaged over both time-periods, the species recorded at the most bushland sites were yellow-faced, white-throated and scarlet honeyeaters, rainbow lorikeet, grey fantail, rufous whistler and striated pardalote. While a few species were common in both forest and suburbs, there were large and consistent differences in community composition between forest and suburb in both time-periods. Bushland sites had a distinctive set of bird species, most of which were uncommon in the suburbs. There was also less homogeneity among bushland sites than was the case for suburban sites – bushland areas showed more local variation in their bird species composition. Nevertheless, species that contributed to among-site homogeneity (typical "bushland" species) included the yellow-faced, white-throated and scarlet honeyeaters, the grey fantail and the rufous whistler. Other typical "bushland" species that occurred at many sites included the golden whistler, white-throated treecreeper, spotted pardalotes, and variegated fairy-wren – a large proportion are small-bodied foliage-feeders.

The bushland bird communities showed much less change over time than the suburban bird communities (see Table 1). Overall, of the 38 species that were sufficiently common for statistical assessment (all of which were native), six (16%) changed substantially in abundance over time. Two species increased (rainbow lorikeet and grey butcherbird) and four decreased (varied sittella, weebill, eastern yellow robin and dollarbird). Thus, in the bushland areas there were twice as many decreases as increases, whereas birds in the suburbs showed the reverse - nearly twice as many increases as decreases. Furthermore, the suburban increases did not offset the bushland decreases because a different set of species was involved. This means that, while the birds of large bushland reserves have in recent years retained their diversity reasonably well, there is a worrying trend towards species' declines exceeding increases. Some of this may have been associated with the effects of recent drought, but increasing frequency of drought in the future is expected as a result of climate change.

Previous work has shown that small patches of bushland down to around 10 hectares in area retain most of the bushland-dependent bird species. Analyses of the changes that have occurred in such patches during the past 15 years indicate that they have so far done surprisingly well at retaining a diversity of native bird, although these analyses remain incomplete. Below a threshold of around 5 hectares, the bird community found in small forest patches becomes similar to that in well-vegetated suburbs: dominated by noisy miners and other large-bodied native species. While such areas do support a wide range of larger-bodied native birds, the presence of noisy miners contributes to the absence of small-bodied bushland birds, because the miners live in very aggressive family groups which gang up to attack many other bird species (with greatest effect on smaller species).



Hyper-aggressive noisy miners often establish colonies at forest edges, in small remnants and in well-vegetated suburbs. They exclude most smaller birds from these areas.

Disruptive species: miners, mynas and other delinquents

One of the ecological problems that we see in well-vegetated suburbs and tiny patches of bushland results from the way in which the species that benefit from the creation of these habitats interact with other birds. Among the increasers are a number of birds that are either aggressive competitors for key resources or predators on the nests of other birds (see Table 2). Increases in the native noisy miner (see above) result in the exclusion of almost all smaller-bodied species from the food and shelter provided by trees and shrubs. Another (unrelated) species, the introduced and recently-increasing common myna, aggressively excludes most other hollow-nesting birds from the limited number of nest sites (cavities in old trees) available in suburbs. Among other recent native increasers, the pied currawong, is well known for preying on the eggs and nestlings of birds in other areas, and the Torresian crow and noisy miner have both been implicated in studies of nest predators in this region. The grey butcherbird, an increaser within bushland areas, is also a significant nest predator.

These are all species that are most common in well-vegetated suburbs and tiny patches of bushland, rather than large bushland areas. And all except the butcherbird have shown recent increases in the suburbs. None of the decreaser species in either bushland or suburbs have this type of role as significant competitors or predators. The diverse small bird species that are typical of the Australian bush stand little chance when faced with this combination: even if they do succeed in running the gauntlet of noisy miner aggression, they are increasingly likely to be either excluded from nest sites by common mynas or have their nests preyed upon by currawongs, butcherbirds, crows, or noisy miners. This is also the situation at the edges of larger forest patches, so that a "typical" bushland bird community is often not seen within the first hundred metres or so from the edge.

Table 2. Changes in the prevalence of "disruptive" species (broad-spectrum competitors or nest predators) during a 15 year period (early 1990s to mid 2000s).

Habitat	Species that increased*		Species that decreased*	
	Total No.	No. of "disruptives"	Total No.	No. of "disruptives"
Suburban areas	12	4	9	0
Large bushland areas	2	1	4	0

*The number of species that showed a statistically-significant change in abundance (many other less common species may also have changed, but this would require more survey effort to detect)

Future prospects for biodiversity in the city

The broad picture revealed by this study can be used to make several recommendations for urban design. The patterns described above are statistical generalities, and a small proportion of sites will behave differently from these generalisations. However, such places are simply interesting exceptions. Given the trends revealed by this study, together with current scientific knowledge of ecological principles, it is clear that bird diversity in the Brisbane region is far from secure. Nevertheless, there is still room for actions to minimise further loss.



This work has shown that well-planted suburbs support a novel bird community, a new mix of species which is very different from that found in areas of native bushland, and which is still changing rapidly and whose future composition is therefore hard to predict in detail. Designs for urban villages that feature layered and dense plantings of trees and shrubs rather than lawns will encourage and sustain this interesting and diverse suburban bird community.

Since the bird diversity encouraged by even the "greenest" suburban designs is different from that in the remnant bushland, the only means of ensuring that the Brisbane region's bird diversity persists in future is to conserve or restore a sufficient total area of bushland habitat. Urban designs to sustain the city's bushland-dependent bird diversity need to incorporate sufficient total area of native bushland, in a range of possible patch sizes down to around 10 hectares. It is very difficult to calculate how much this should be, but the ecological literature suggests that 30-40% of the total land area may be a minimum needed to avert widespread declines.

Whatever actions are taken, the incomplete state of current knowledge and the unknown impacts of climate shifts mean that continued monitoring of long-term changes within the different habitats of the city's urban mosaic will also be important to enable further progress in maintaining the diversity of birds and other wildlife.

Further reading and acknowledgements

The references below provide further information about many of the issues discussed here:

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