

Parrots of the Sydney region: population changes over 100 years

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ABSTRACT

With European settlement, the landscape of Australia changed dramatically due to clearing for agriculture, forestry and urban development. These changes have impacted on the diversity and abundance of many Australian native fauna. The avifauna provides a conspicuous example. Despite their generally striking colours, strident call and large body size, the status of parrot populations in urban regions have been largely ignored. We reviewed three bird data bases to determine trends. The two species, recorded within 10 km of Sydney's General Post Office pre-1900, are no longer present, although 15 species are now known from this area. Populations of the five most common of these species have continued to increase in the last 20 years, one appears to have remained unchanged and others are present in insufficient numbers to comment. No species appears to have declined in numbers. Escapees or deliberate releases from aviaries are major sources of birds that establish viable populations, although even in these populations, numbers may also have been supplemented by vagrants. We suggest that supplementary feeding, and changes in the vegetation in the city landscape, are major contributing factors to the current diversity and abundance of parrots within Sydney.

Key words: range extension, urban wildlife, feral birds, urban birds, aviary escapees.

Introduction

With European settlement of Australia, extensive clearing occurred for agriculture, forestry, and urban development. The associated landscape changes have impacted on the local wildlife in ways different to those imposed by Aboriginal management (Burgin 2004). The outcome has been the widespread removal of endemic vegetation, and associated wildlife habitat fragmentation. Subsequently, there have been altered patterns of wildlife usage and ecosystem dynamics (eg. changes in wildlife abundance and species composition, vegetation structure, floristic composition); together with the introduction of feral animals and their parasites; more effective hunting regimes (i.e. guns instead of spears) that have resulted in additional species being targeted; and changed grazing regimes (Recher *et al.* 1993).

These post-European changes have culminated in a highly urbanised country, with most of the population clustered between the Great Diving Range and the eastern seaboard. With an area of approximately 3,000 km², the Sydney region is one such location (White and Burgin 2004). With the development of the urban/peri-urban landscape, a mosaic of new habitat types have been continuously formed and reformed. Within this highly modified and dynamic landscape, there have been species that have benefited with resulting increased abundance, others have declined and some species have become locally extinct. There have also been species whose abundance has apparently been unaffected (Catterall 2004).

The avifauna provides a conspicuous example of a taxon that continues to be affected by urbanisation (Parsons and Major 2004), and a large number of bird communities (e.g. Tomialojc and Profus 1977, Suhonen and Jokimaki 1988, Catterall *et al.* 1991, Ferrier *et al.* 1993, Sewell and Catterall 1998, Catterall 2004, Parsons and Major 2004, Recher 2004), and individual species (eg. Buchanan 1989; Low 1994; Major *et al.* 1996, Parsons and Major 2004) have been studied within urban boundaries. However, while the dynamics of a range of the larger bird species have been investigated (eg. ibis - Ross 2000, 2004, Perry 2001; gulls - Smith and Carlile 1993, Belant 1997, Temby 2004; currawongs - Buchanan 1989, Major *et al.* 1996), despite their often striking colours, strident call, and large size, parrots have attracted less attention.

The catalyst for reviewing the changes in residency of parrots in the Sydney region over the past 100 years resulted from a chance discussion with Dr Richard Major (Australian Museum). He commented that only two parrot species had been recorded within 10 kilometres of the Sydney's General Post Office (GPO) prior to 1900: the turquoise parrot *Neophema pulchella* and the ground parrot *Pezoporus wallicus*.

The turquoise parrot is now classified as a 'vulnerable' species on Schedule 2 of the NSW *Threatened Species Conservation Act 1995* (<http://www.nationalparks.nsw.gov.au/npws.nsf/content/turquoise+parrot+vulnerable+species+listing>), and no longer occurs within this 10 kilometre radius. The nearest contemporary sightings to

Sydney's core urban area are in the Wisemans Ferry and North Richmond areas, both in excess of 50 km from central Sydney. The nearest confirmed sighting of ground parrots is at Barren Grounds, near Robertson in southern New South Wales, considerably further from Sydney's centre than the sightings of the turquoise parrot. These two endemic species are, therefore, now locally extinct within the city centre, although the turquoise parrot is still present in peri-urban Sydney (Cumberland Bird Observers' Club Database, accessed October 2005). Based on this revelation, we decided to investigate the current trends in parrot populations in the Sydney region.

Methods

To determine the current species diversity and abundance of parrots in Sydney, information was sought from three organisations: Birds Australia (<http://www.birds.australia.com.au/>), Cumberland Bird Observers' Club (<http://www.cboc.org.au/wattlebird.html>), and Field Ornithologists Club – Birding New South Wales (<http://www.birdingsw.org.au/>).

Birds Australia conducted two nation-wide atlas surveys, one between 1977-1981 (Blakers *et al.* 1984), and another across 1998-2001 (Barrett *et al.* 2003). The bird species encountered during the survey period were checked off on a list by volunteers. There was no measure of abundance made. Barrett and Silcocks (2002) adjusted the results of the two census datasets and used probability of encounter with a species as the basis of comparison between the two datasets.

The Field Ornithologists Club - Birding New South Wales has undertaken regular bird counts that encompass the Greater Sydney area, for over 20 years. These counts have been taken in an area that extends north to Wyong on the central coast of New South Wales, west to Leura in the Blue Mountains, and as far south as Shellharbour in the south. In the Sydney area, the counts were based on 10 regions, and a team of 10 volunteers sampled each of these regions for two days each year. Species observed were recorded and individual birds were counted during these surveys.

Cumberland Bird Observers' Club has maintained a database since 1986 that members contribute to on an on-going basis. Volunteers are asked to qualitatively record the maximum number of birds within a survey (5-10, 6-20, 21-50, 51-100, >100), for each species that they encountered. Along with this information, behavioural traits (e.g. habitat, stage of breeding) are noted.

Information obtained from the databases was current in October 2005. In addition, information was also gleaned from the literature to complement the data obtained from the databases.

Results

Between 2000 and 2005, 15 parrot species were recorded from within a 10 kilometre radius of Sydney's GPO (Table 1). These included species that are considered to be endemic to Sydney (eastern rosella *Platycercus eximius*, scaly-breasted lorikeet *Trichoglossus chlorolepidotus*) and

Table 1. Parrots sighted within 10 km of Sydney General Post Office since 2000 (Source: Cumberland Bird Observers Club records).

Common name	Scientific name
Yellow-tailed black-cockatoo	<i>Calyptrorhynchus funereus</i>
Galah	<i>Cacatua roseicapilla</i>
Long-billed corella	<i>Cacatua tenuirostris</i>
Little corella	<i>Cacatua sanguinea</i>
Sulphur-crested cockatoo	<i>Cacatua galerita</i>
Cockatiel	<i>Nymphicus hollandicus</i>
Rainbow lorikeet	<i>Trichoglossus haematodus</i>
Scaly-breasted lorikeet	<i>Trichoglossus chlorolepidotus</i>
Musk lorikeet	<i>Glossopsitta concinna</i>
Australian king-Parrot	<i>Alisterus scapularis</i>
Crimson rosella	<i>Platycercus elegans</i>
Eastern rosella	<i>Platycercus eximius</i>
Swift parrot	<i>Lathamus discolor</i>
Red-rumped parrot	<i>Psephotus haematotus</i>
Orange-bellied parrot	<i>Neophema chrysogaster</i>

those that are not local endemics (eg. galah *Cacatua roseicapilla*, long-billed corella *Cacatua tenuirostris*, and little corella *Cacatua sanguinea*; Table 2). Other species (eg. orange-bellied parrot *Neophema chrysogaster*, swift parrot *Lathamus discolor*) were infrequently sighted and were probably vagrants.

The status of the more common species that were surveyed between 1977-1981 and 1998-2001 are presented in Figure 1. These data indicated that five of the seven species presented in Table 1 have increased in probability of being recorded over time, while only one (crimson rosella *Platycercus elegans*) that was commonly encountered in the earlier survey, has maintained its numbers. Budgerigar *Melopsittacus undulatus* numbers were low in both surveys.

Annual survey data collected between 1978 and 1987 (Figure 2) indicated that, as would be expected, species abundance has tended to fluctuate. However, there was a sustained rise in the abundance of parrots between 1978 and 1983. Between 1983 and 1987 the numbers were maintained at lower levels than observed between 1982 and 1984, although they were substantially higher than in earlier survey years. The flock size data obtained in another survey for two of the species presented in Figure 2 (sulphur-crested cockatoo *Cacatua galerita* and rainbow lorikeet *Trichoglossus haematodus*) indicate that flock sizes have increased. There were more flocks with >20 and >50 birds in 2005 than in 1986 (Figure 3).

Discussion

Change in status of Sydney's parrots

There has clearly been a major shift in the diversity and abundance of parrots in the Sydney region over the last 100 years. Since the two species that were historically recorded (turquoise parrot and ground parrot) are

Table 2. Changing Status of Some Parrots in the County of Cumberland since 1900

Common name	Status
*Galah <i>Cacatua roseicapilla</i>	No records <1920 when released by Taronga Park Zoo. 1st breeding Richmond 1955 (Hoskin 1991).
*Long-billed corella <i>Cacatua tenuirostris</i>	1 st record Centennial Park 1970. 2 birds Cobbitty 1983, 65 birds 1986 (Hoskin 1991).
*Little corella <i>Cacatua sanguinea</i>	1st breeding record Riverstone 1954. Few earlier records of aviary escapees (Hoskin 1991, Keast 1995).
Sulphur-crested cockatoo <i>Cacatua galerita</i>	Found western edges of County about 1800 (Hoskin 1991). 'Few pairs' in Royal National Park 1945 (Keast 1995). 1000 Camden Park, 1952. Moved into coastal sandstone areas, 1960s (Hoskin 1991). Now widespread and abundant, even pairs over city (Keast 1995).
Rainbow lorikeet <i>Trichoglossus haematodus</i>	'Well known' in early days of European settlement, numbers may have been depressed by cage-bird industry. 'Rare' in 1940s, coincident with exceptional flowering of eucalypts (Keast 1995). 1 st breeding record, 1947, East Lindfield (Hoskin 1991). Now one of Sydney's most common birds (Keast 1995)
*Red-rumped parrot <i>Psephotus haematonotus</i>	Not recorded in County list in North (1889). 20-30 birds Centennial Park 1920 (Hoskin 1991).
Eastern rosella <i>Platycercus eximius</i>	Some shrinkage of range by 1995, remains common along Hawkesbury (Keast 1995)
Crimson rosella <i>Platycercus elegans</i>	Become more urbanized, accepting food from feeding trays (Keast 1995)

*Introduced to Cumberland County (Keast 1995 definition 'in effect, the region about 50km around Sydney') from aviary escapees.

relatively inconspicuous, compared with some of the more strident, conspicuous species now present, it is likely that most were not previously resident or, if they were, they were probably in very low numbers.

At least 6 of the 15 species recorded have extended their range into urban Sydney. Five of these six species are well established, and four continue to have a sustained increase in numbers over time. None appears to be in decline.

Many of the parrots that are common in Sydney are species that have therefore been introduced to the city landscape. For example, the galah populations of Sydney resulted from a release from Taronga Park Zoo in the 1920s (Table 2) probably boosted over time by influxes during drought, as has been observed for other species (e.g. rainbow lorikeets into Melbourne; Shukuroglou and McCarthy 2006). The galah is now one of the four most likely species to be encountered within the Sydney region (Figure 1).

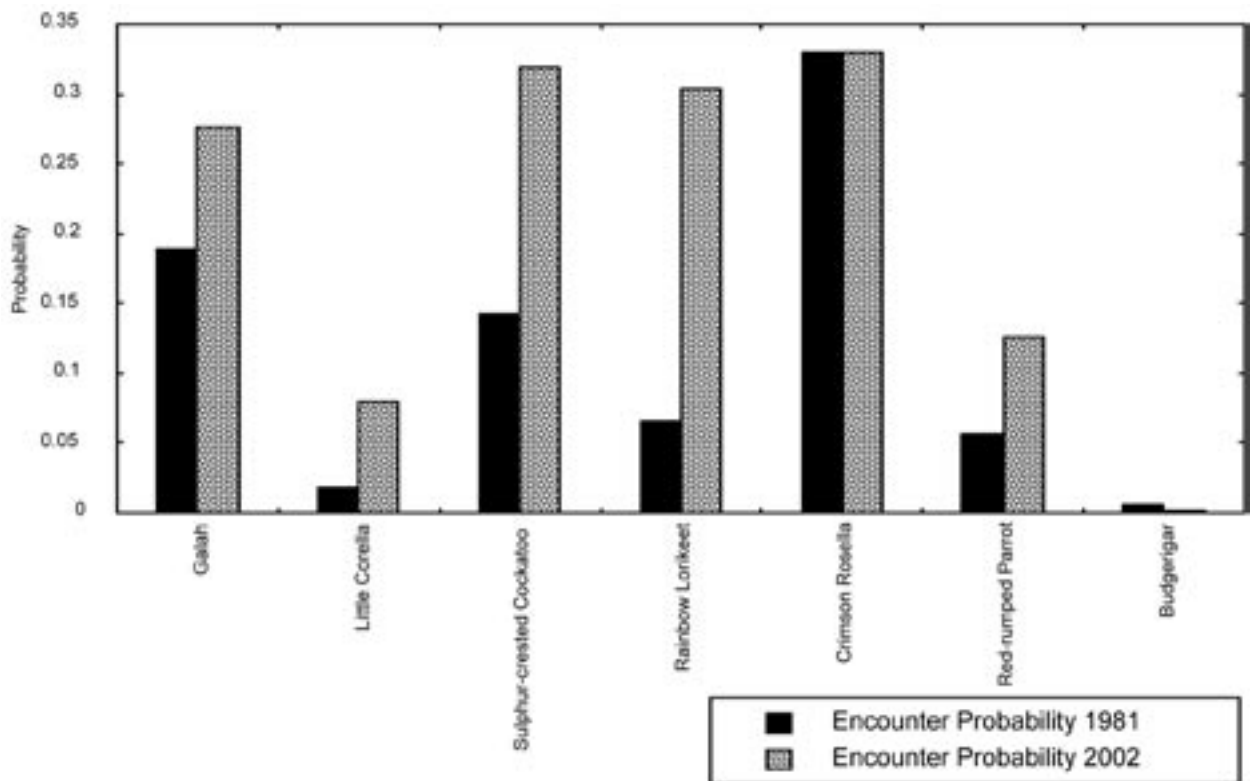


Figure 1: Changes in reported parrot numbers in the Sydney region between 1977-1981 and 1998-2001 (Source Barrett and Silcocks 2002).

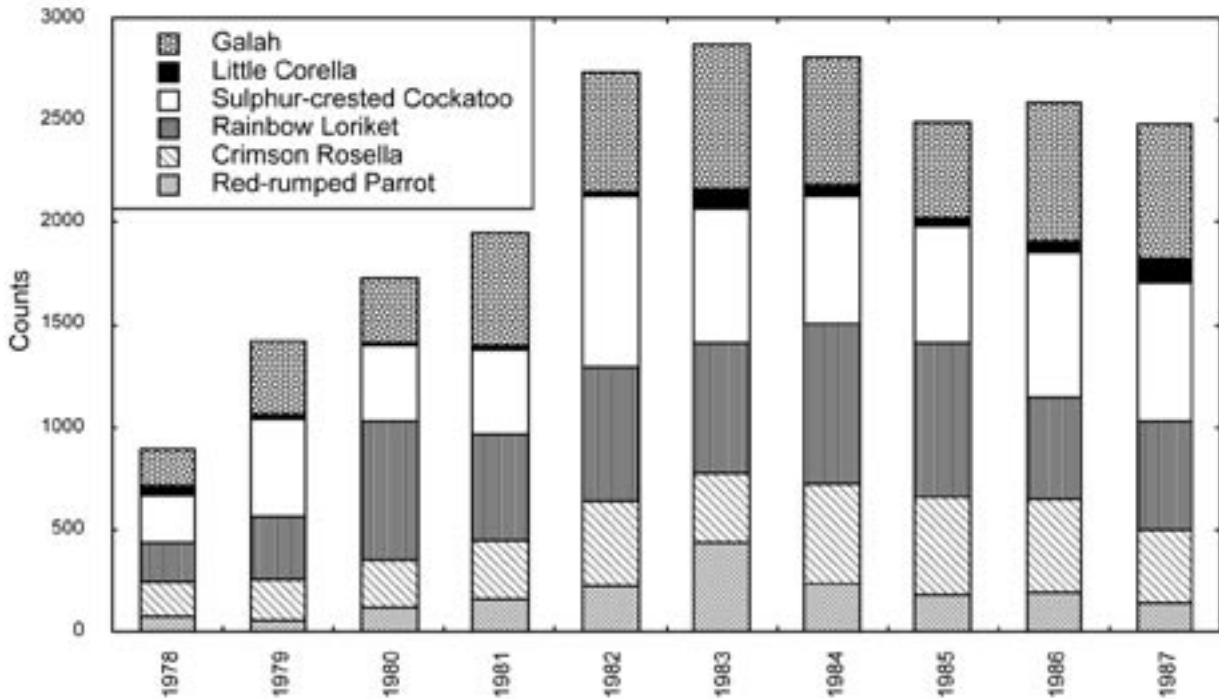


Figure 2: Greater Sydney spring bird counts between 1978 and 1987 (Source: Birding NSW)

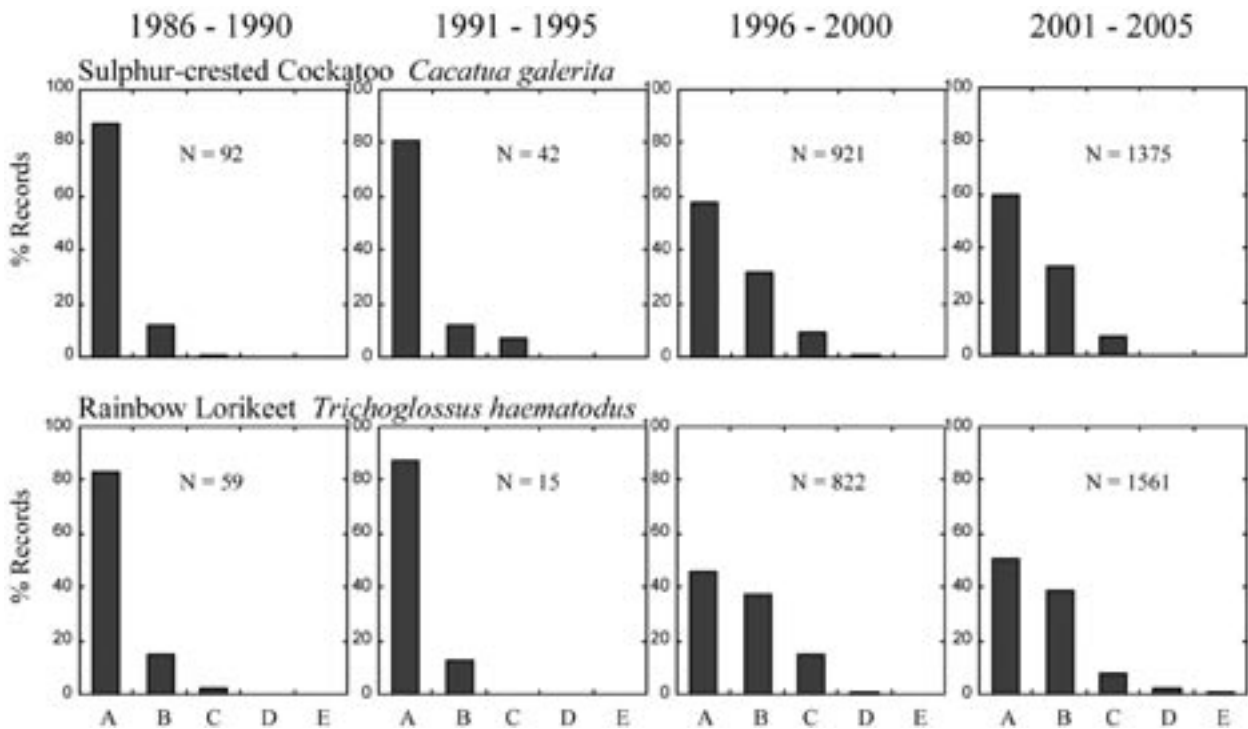


Figure 3. Changes in reporting abundance over time for two species of parrot based on records in the County Bird Database (A = 1-5, B = 6-20, C = 21-50, E > 100).

The more recently introduced corellas continue to increase in number, and now form mixed species (little corella and long-billed corella) flocks. In the Richmond area of north-west peri-urban Sydney, the size of these flocks appear to have dramatically increased in the past decade (Cumberland Bird Observers database).

The red-rump parrot is another species that has been inadvertently translocated by humans. Since first recorded in 1920 (Table 2), there are now several well established

populations associated with parkland (e.g. Homebush Bay), and golf courses, near the city centre. It is also relatively common in many of the marginal grazing areas in peri-urban western Sydney (Cumberland Bird Observers database).

Two species, sulphur-crested cockatoo and rainbow lorikeet, are arguable the most noticeable parrots across Sydney and its environs. The sulphur-crested cockatoo is a local endemic of the western fringe of the city. However, it has greatly expanded its range within the city, and has

had a sustained increase in abundance over time. This can be gleaned by the observation that the number of large flocks (>20, >50) has increased, and these larger flocks now make up a greater proportion of the flocks observed than smaller flock sizes (Figure 2). Hoskin (1991, see Table 2) provided support for an 'explosion' of sulphur-crested cockatoo numbers since 1800, and they are now widespread and common throughout Sydney.

Based on anecdotal reports, rainbow lorikeets were common until the late 1800s (Crome and Shields 1992). In the first half of the 1800s, numbers apparently declined dramatically (Hindwood 1939; Keast 1995; Waterhouse 1997) to the point where it has been recorded as first breeding within Sydney in 1947 (Hoskin 1991). However, despite being considered uncommon before 1950 (Table 2), rainbow lorikeet numbers have been dramatically increased (see Figure 1), and flock sizes continue to grow (Figure 3).

Not all species recorded appear to be showing the exponential increase in number of the rainbow lorikeet. However, the only 'abundant' species that has apparently not sustained a population increase is the crimson rosella. The probability of observing a crimson rosella has not changed between the surveys of 1977-1981 and 1998-2001, although in the earlier study, it was by far the most likely parrot to be recorded in surveys (Figure 1).

The probability of encountering budgerigars was very low in both the 1997-1981 and 1998-2001 surveys (Figure 1). However, this species is widely kept as a caged animal and releases occur. During extensive drought periods, they also migrate east from the drier inland. For example, during the recent prolonged drought in Eastern Australia, there was an influx of budgerigars from the west towards the east. Most of these birds congregated on the western side of the Great Dividing Range, however, over the last two to three years of the drought, they have been occasionally observed in the Sydney basin area. Although budgerigar numbers have remained low within the Sydney region, they continue to be recorded in surveys (Cumberland Bird Observers records). With the potential for natural colonisation, together with what is probably an on-going trickle of escapees, they are very likely to be a future feature of the city bird chorus.

The origin of some parrot populations is due to aviary escapees (Table 2), deliberate release, and/or vagrant flocks. During drought conditions some parrot species (eg., galah, long-billed corella, little corella) migrate into the Sydney region. However, the numbers of such vagrants are few, and only a sub-set of these have managed to establish breeding populations. The urban/peri-urban populations of little corella, long-billed corella, and the galah are considered to have been largely derived from avian escapees, or deliberate releases (Hoskin 1991).

There has been a single sighting (near the rifle range, Maroubra) of the orange-bellied parrot. Swift parrots have also been occasionally recorded. However, it is unlikely that they forage in the inner city area, but pass through on their winter migratory route. These data indicate that with appropriate habitat and conditions conducive to breeding in the area, there is the potential for additional species to become established.

Comparison to other urban bird invasions

While not directly comparable, Recher (2004) reported on surveys that were undertaken in Perth's Kings Park. He observed that of the 61 bird species (excluding water birds) recorded between 1928 and 2002, 20% had increased in abundance, 40% decreased, and 16% had become locally extinct. He further observed that although the composition of species had changed, the abundance was probably equivalent to when surveys began in 1928. Although over the larger and more diverse Sydney landscape, the parrot assemblage has also dramatically changed, evidence from the last 20 years indicate that, in contrast, to the bird species that inhabit Kings Park, parrot abundance has increased substantially.

Four parrot species were recorded in both Sydney and King's Park: galah, little corella, rainbow lorikeet and the cockatiel. Two of these (little corella and rainbow lorikeet) are introduced species in both areas. While the rainbow lorikeet and galah have increased in numbers in both areas, little corella numbers were 'unchanged' in Kings Park, but have increased over time in Sydney. Cockatiel numbers remained 'unchanged' in Kings Park. This species is widely distributed across the inland 'dry country' of Australia, with habitat that includes woodlands (common across western Sydney), and it is nomadic and migratory in the southern part of its range (Macdonald 1992). It is also a popular aviary bird. While observed in the surveys of Sydney, it is not well established.

The pattern of increase in galah abundance in Sydney and Perth, has also been observed in the survey of Brisbane's birds. Over 20 years, between 1979-1980 and 1999-2000, this species went from being the 44th most common species (Woodall 1995) recorded in surveys of the Queensland Ornithologists Society, to the 24th most common (Woodall 2002).

As observed in Sydney, early anecdotal reports from Melbourne indicate that rainbow lorikeets were initially common, but by the 1920s sightings were sufficiently rare for them to be considered aviary escapees or vagrants (Veerman 1991). Also in parallel with the expansion of the Sydney population, since the 1970s numbers of rainbow lorikeets have increased 'spectacularly' in other cities including Melbourne (Fitzsimons *et al.* 2003; Shukuroglou and McCarthy 2006), Canberra, Adelaide (Shukuroglou and McCarthy 2006), and Brisbane (Woodall 1995). In the Melbourne landscape, White *et al.* (2005) considered that this species was now one of the four 'ubiquitous' bird species, while Forshaw (2002) suggested that the Perth a population, based on aviary escapees, where now out-competing some indigenous species for nesting resources. The pattern of exponential increase has also occurred in Brisbane. Based on surveys taken in 1979 – 1980, Woodall (1995) observed that scaly-breasted lorikeets and rainbow lorikeets were similarly recorded, and they were much less common than the pale-headed rosella *Platycercus adsittus*, the most common parrot species surveyed. Twenty years later, rainbow lorikeets had experienced the most dramatic increase of any bird (46%) in numbers and sites reported, and had gone from being the 22nd most common bird in Brisbane to the most common (Woodall 2002).

Scaly-breasted rosellas had also expanded their numbers from 21st most common to 11th most common, while the pale-headed rosella was less commonly reported than in the past (Woodall 1995, 2002). These data indicate that the pattern of increase in abundance of rainbow lorikeets is sustained across many of the capital cities.

Parrot species expansion into urban areas is not restricted to Australia, Chebez and Bertonatti (1991) reported that seven species of parrots visited urban areas of Buenos Aires (Argentina), and all may be breeding within the city boundaries. However, in contrast to Sydney's introduced parrot populations that tend to be derived mainly from aviary escapees or deliberate introduction, it was suggested that most introduced parrot populations of Buenos Aires were probably not escaped cage-birds.

In other parts of the Americas, parrots have become naturalised in urban areas. For example, Neck (1986) reported on the expansion of the red-crowned parrot *Amazona viridigenalis* in southern Texas. The monk parakeet *Myiopsitta monachus* has been in Chicago since 1973, and their numbers have continued to increase over that time. Colonies of this species are also present in other states. In eight of these (New York, Connecticut, Florida, Illinois, Massachusetts, Oklahoma, Rhode Island and Texas), they are sufficiently common to be placed on official bird lists (Moskoff 2003). Southern California also has naturalised populations of parrots (Garrett 1997).

Factors influencing parrot success in urban habitats

The complexity of urban habitats, and human - bird interactions (direct and indirect), influence the ability of species to colonise in the changed landscapes Europeans have created. Many of these factors are inter-related and synergistic, but some clearly impact on the diversity and/or abundance of some species (see eg. Recher 2004; Recher and Serventy 1991; Catterall 2004; Piper and Catterall 2003; Sewell and Catterall 1998; Howard and Jones 2004; White *et al.* 2004; Parsons *et al.* 2006). Factors identified as of importance include dietary requirements, breeding resources, adaptations to local climate, together with levels of predation, competition, and disease (Shukuroglou and McCathy 2006).

A major influence on species present, and their abundance, is supplemental feeding (Howard and Jones 2004; O'Leary and Jones 2006). This practice is widespread across the more affluent countries including North America (Deis 1986; Petterson 2000; Knight and Anderson 1990; Elliot 1994), Britain (Cannon 1984, 1999) and Australia (Cannon 1999; Pizzey 2000; Howard and Jones 2004; O'Leary and Jones 2006). The practice is particularly popular during winter throughout temperate areas (eg. Cowie and Hinsley 1987; Brittingham and Temple 1992; Brittingham 1991; Cannon 1999, 2000; Wilson 2001). In Australia, 25 - 57% of urban households in some of the larger cities (Brisbane - Woodall 1995, Thomas 2000, O'Leary 2002, Rollinson *et al.* 2003, Howard and Jones 2004; Melbourne - McLees 2001; Sydney - Keast 1995). The general pattern for many species was that when food was supplied, breeding began earlier in the season, and

hence the breeding season was longer. This resulted in multiple broods, and higher hatchling survival rates. As a consequence, there were greater numbers of offspring each year when supplementary feeding was provided, in comparison with birds that did not receive additional human support.

The pattern of planting native species has changed over the last 20 years (see Burgin 2004). For example, many of the tree-scape plants of Sydney, together with those planted in parks, on golf courses and in gardens, include the native species of *Callistemon*. Before European settlement, these species were largely confined to areas around water, such as swamps, steam courses, and river banks. We estimate that the numbers of this one taxon could be a thousandfold the numbers before humans began planting and tending them in urban surroundings. The increase in the number of species in just this single plant genus, is likely to have provided more nectar for parrot species, particularly lorikeets.

Over the past decade it has become increasingly popular to plant 'wildlife friendly' garden plant cultivars, developed from native species. This has resulted in a rapid increase in the planting of *Grevillea* cultivars in the city landscape. These are frequently a hybrid of *Grevillea banksii* from south-eastern Queensland, crossed with inland desert *Grevillea* sp. The attributes that makes them attractive garden plants are their extended flowering period, and that the flowers project beyond the foliage. These attributes also provide an abundance of nectar. As a consequence, they provide some species, particularly rainbow lorikeets, with supplementary food.

Some species, such as the sulphur-crested cockatoo, also consume seeds from ornamental Italian pines, *Pinus radiata* in its early stages, liquidambar *Liquidambar styraciflua*, and many other species (Cumberland Bird Observers database). Indeed, many introduced plants of the urban landscape provide effective alternative food sources to the endemic plant species.

Less seasonality of food supply has probably resulted from planting of this greater diversity of species (often not locally endemic), that may supply suitable food resources across the year (Shukuroglou and McCathy 2006). In addition, such plants are frequently provided with supplementary water and nutrients, and it has been noted (e.g. Law *et al.* 2000) that activities, such as watering, can extend flowering times, and enhance nectar and fruit yields. Shukuroglou and McCathy (2006) suggested that the increased popularity of incorporating native plant species into the urban landscape may be an explanation for the expansion of rainbow lorikeet population in urban Melbourne. It is an equally valid explanation for the observed changes in the species in the Sydney urban landscape. Further support for this hypothesis can be gleaned from the observation that in Darwin, rainbow lorikeets were closely associated with the most abundant nectar sources (Franklin and Noske 1999) and these are likely to be in the urban landscape.

Urban climatic conditions differ from surrounding rural areas in terms of temperature, humidity, increased cloud cover and rainfall, and modified wind regimes, and may

influence plant phenology, together with the activity patterns of animals (Parris and Hazell 2005). Such changed climatic characteristics, particularly temperature regimes, may be substantial (Landsberg 1981), and the 'heat island features' of Australian cities have been acknowledged (e.g. Torok *et al.* 2001). The influence such changes may have on the introduction and/or changing abundance of any Australian parrot species has not generally been considered beyond comment of its potential impact (e.g. Shukuroglou and McCathy 2006), although the effect on flying foxes has received limited attention (e.g. Parris and Hazell 2005).

Changed opportunities and/or changed behaviour, may also influence comparative competitive ability among species in urban environments. For example, where the range of scaly-breasted and rainbow lorikeets overlap in the *Banksia* heath associations in northern New South Wales, scaly-breasted lorikeets are abundant and rainbow lorikeets are scarce. In Sydney's peri-urban gardens, the ratio is the reverse. At supplementary feeding stations, the rainbow lorikeet is much more aggressive than the scaly-breasted lorikeet, which indicates that the rainbow lorikeet may out-complete their congeners at favoured food sources (Cumberland Bird Observers database).

Competition may also occur for nesting sites. Parrots tend to be tree-hollow nesters (i.e. they require hollows in tree trunks or large limbs of large trees), generally associated with *Eucalyptus* sp. (Gibbons and Lindenmayer 2002), and many species (eg. sulphur crested cockatoo) select nesting sites high in these trees (MacDonald 1992). Such resources are rare in Sydney (Waterhouse 1997). Shukuroglou and McCarthy (2006) calculated that the density of hollow-bearing trees in urban areas was approximately 1% of those found in natural forest and woodland patches beyond the city. Parrots may move long distances to forage, for example, rainbow lorikeets can move more than 100 km in a day (Schodde and Tidemann 1986). Waterhouse (1997) noted that while some rainbow lorikeets breed in urban tree-hollows, others breed elsewhere and forage in the urban landscape. The same behaviour has also been observed in Melbourne (Shukuroglou and McCathy 2006), and the pattern is assumed to occur for other parrot species. Despite their ability to seek nesting sites beyond the city fringe, with the increasing abundance of parrots in the Sydney basin, together with continued loss of mature trees to urbanisation and agriculture, competition for nesting sites has probably increased, with impacts on less assertive species.

The effect that the 'hyperaggressive' (*cf.* Piper and Catterall 2003) noisy miner *Manorina melanoccephala* has on other species is well documented (eg. Catterall 2004; Grey *et al.* 1998; Low 2002). We have observed them successfully excluding even the largest bodied parrots (eg. sulphur-crested cockatoos) from their habitat. Smaller, less assertive species are ultimately driven from such areas (Catterall 2004).

Most of the parrot species reported from Sydney in the last five years would fall within Catterall's (2004) definition of 'Aussi Icons', indeed she included the scaly-breasted

lorikeet and rainbow lorikeet as 'member species' of this group. A number of these species spend at least part of the time feeding at ground level (Macdonald 1992) which would increase their vulnerability to predation, compared to species that tend to be arboreal. However other behavioural characteristics, such as the habit of congregating to feed, the noisiness of most species and, some species (eg. galah), have well developed sentry systems (Macdonald 1992) that tend to protect them against predators such as cats, dogs and foxes.

Overall there is a dearth of data on predation on parrots. At least some of the smaller species, such as lorikeets, would be preyed upon by raptors although it may occur less frequently in urban areas, than in natural environments (Shukuroglou and McCathy 2006). Triggs *et al.* (1984) found that in Croajingalong National Park (South-eastern Victoria), foxes, dogs and cats did prey on birds, but 97% of scats contained mammal hair. Although there were no figures given for the number of scats with bird remains, all indications are that the numbers were low. Of the three predators, dogs and foxes had equivalent numbers (11%, dogs $n = 44$, foxes = 107) of non-mammalian items. Cats consumed more birds (27%, $n = 13$). Barratt (1977) observed that in urban Canberra, birds contributed the same percentage of prey items to the cat diet as in Triggs *et al.* (1984) study. A survey of prey items of the cats from 1400 households in Great Britain showed that 73% of cats that brought home at least one prey item, had preyed upon birds. Eggs and nestlings would also be preyed upon, however, because all of the parrots in the Sydney urban area tend to nest high in trees (most in tree hollows) and nests are guarded (Macdonald 1992), predation is likely to have less impact than for many other urban bird species (eg. Mathews *et al.* 1999).

Conclusion

The complexity and hierarchy of impacts that are associated with the dynamics of parrot populations are such that it is unlikely that knowledge will be gained in sufficient time to manage populations, even if the funds, government, and the attitudes within the broader community, were in agreement. For example, supplementary feeding is provided for a range of reasons (see e.g. Conover 2002; Howard and Jones 2004). Trees are planted and landscapes created for much more diverse reasons, and frequently without conscious concern for the wildlife that are associated with the area. It is, therefore, necessary to carefully consider species priorities (preferably before they are overabundant or in serious decline) and focus resources on research and management of such species. Realistically, however, the pragmatic view of Recher (2004) may be the only appropriate way forward. He observed that, although the composition of bird species in Kings Park had changed dramatically over the 80 years that the Park has been monitored, the bird abundance was probably equivalent. Over much of this time there has been clear evidence of the changing dynamics of the bird assemblage. However, Park management appear to have not considered this in their management strategies. Likewise, in western Sydney, we have observed that the mixed flocks of long-billed and

little corellas have increased dramatically in recent years. These population increases appear to have been largely ignored, maybe because the concept of culling native birds (albeit invasive species in the urban context) is simply not worth the political fallout, until disease that affect human or bird health occurs.

Ecosystems are dynamic, with changes in flora, fauna, and climatic conditions over time. With the major restructuring of the landscape that has occurred post-

European settlement, it is inevitable that there would be 'winners' and 'losers'. The two species of parrots that triggered this research (turquoise parrot and ground parrot) are 'losers', while at least most of those that have prospered could be defined as 'Aussie Icons' (cf. Catterall 2004). For different reasons these groups should be the focus of further research: the 'winners' because they are generally overabundant and the 'losers' because they tend to disappear, often without notice.

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APPENDIX I



Caption?
Photo?