3.4.5 Garden Island (northern end)

Biodiversity values

The high biodiversity values of this site (Figure 15) are attributable to the following:

- Remnant trees of the Coastal Sandstone Foreshores Forest community, along with potentially naturally occurring shrubs, grasses and groundcovers;
- High diversity of indigenous flora species (more than 40 species);
- The presence of one of only two known populations of the Bar-sided Skink in the LGA;
- The onsite tunnel network may provide roosting habitat for microbats;
- High potential to continue bush regeneration works commenced in 2011, to increase the diversity of locally indigenous flora species and to undertake fauna habitat enhancements; and
- Relatively well protected from disturbance as public access is limited – only part of the site can be accessed during the day, and only by ferry or tour bus.

Site constraints

Site constraints affecting the above biodiversity values include:

- Its small size (approximately 2.7 hectares);
- The primary function of the site as the main base for the Royal Australian Navy fleet on the east coast of Australia, which is not necessarily compatible with biodiversity conservation;
- Heritage values of existing gardens, landscape and buildings, which are likely to pose restrictions on the expansion of bush regeneration and other habitat enhancement works;
- Remaining infestations of environmental and noxious weeds including Asparagus Fern, Madeira Vine, Potato Vine, English Ivy and Morning Glory; and
- Steep terrain poses access, safety and cost issues for bush restoration works.

Possible remnant trees of Coastal Sandstone Forest at Garden Island.

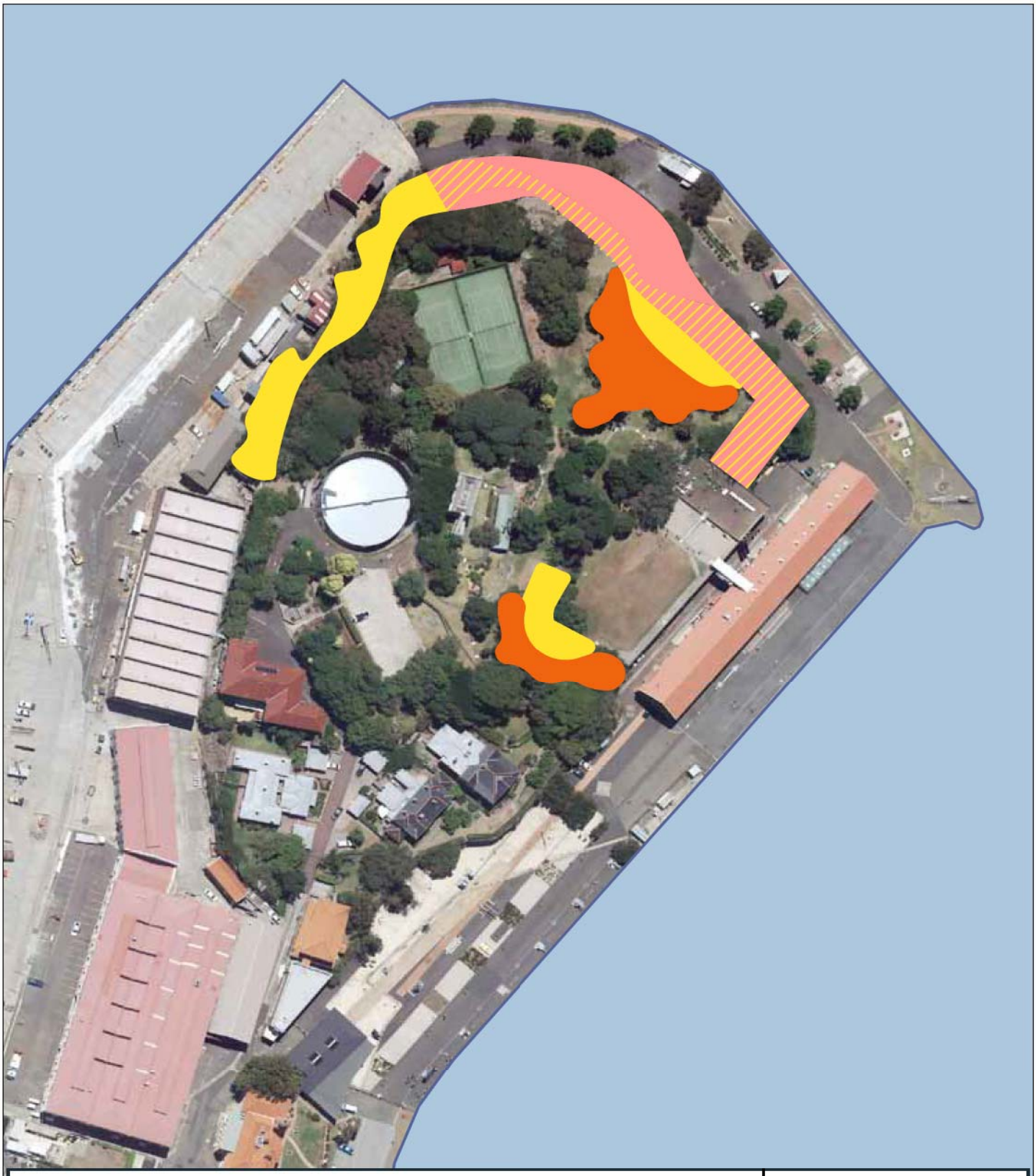

FIGURE 15
Garden Island

- Bush Restoration Sites
- Sandstone Outcrop/Bush Restoration
- Coastal Sandstone Outcrop Complex
- Indigenous/Mostly Indigenous Plantings

N

20 10 0 20 m

1:1,500 at A4

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3.4.6 Moore Park (Mt Steel, Moore Park Golf and Lake Kippax)

Biodiversity values

The high biodiversity values of this site (Figure 16) are attributable to the following:

- Its large size (approximately 64 hectares);
- Good range of planted indigenous trees and shrubs with some indigenous grass and groundcover species in the vicinity of Mt Steel and Moore Park Golf;
- The only site at which two epiphytic fern species, Elk Horn (*Platycerium bifurcatum*) and Rock Felt Fern (*Pyrrosia rupestris*), were recorded in the LGA (growing in mature planted fig trees);
- The presence of a large freshwater pond (Lake Kippax), located at the site of the former Billy Goat Swamp swamp (Centennial Parklands, undated);
- The only site at which Gould's Wattled Bat and the Eastern Freetail Bat were recorded;
- High potential to undertake bush restoration works and increase the diversity of locally indigenous flora species, and to undertake fauna habitat enhancements without compromising the existing range of land uses; and
- Its existing connectivity to habitat within Centennial Parklands and other sites in the Randwick LGA, and potential to contribute to a habitat linkage to Sydney Park via landscaping associated with future redevelopments at Green Square and other precincts in the southern part of the LGA.

Site constraints

- Disturbance created by high levels of public use, including regular large events, in the vicinity of Lake Kippax in particular; and
- The primary function of most of the site as a golf course and driving range.


Existing indigenous plantings at Moore Park (left), with potential for infill planting and other habitat enhancements, and possibility for establishing understorey beneath existing indigenous trees on parts of Mt Steel (right) without compromising existing range of uses (photos K. Oxenham)


Australasian Grebe nesting at Lake Kippax, Moore Park (left) and Nankeen Kestrel foraging over Moore Park Golf (right) (photos K. Oxenham)

FIGURE 16
Moore Park

- Bush Restoration Sites
- Indigenous/Mostly Indigenous Plantings
- Ponds

N

150 75 0 150m

1:10,000 at A4

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3.4.7 Supporting sites

There are many sites in the LGA that have important biodiversity values in their own right and/or have the potential to support the priority sites. These include small, City-managed parks as well as sites managed by others. A selection of these sites is briefly described below; details for other surveyed sites are provided in the identification of biodiversity values (Appendix 5):

- Embarkation Park and McElhone Stairs, Potts Point – sandstone cliffs, high diversity of locally indigenous species (>40 species), including four that are likely to be naturally occurring.
- Arthur McElhone Reserve, Elizabeth Bay – moderate-high indigenous species diversity (30–40 species), a sandstone outcrop with potentially naturally occurring species including the only known potentially natural Dwarf Apple (*Angophora hispida*) within the LGA, and freshwater habitat (constructed ponds and wet depressions/seepage along rock outcrop).
- Arthur (Paddy) Grey Reserve, Glebe – sandstone outcrop with some potentially naturally occurring species plus high diversity of locally indigenous shrubs and groundcovers planted by volunteers from the Glebe Society's Blue Wren Group and the broader community.
- Bannerman Crescent Reserve, Southern Cross Drive Reserve, and Kimberley Grove Reserve, Rosebery – diverse indigenous plantings with some connectivity to indigenous vegetation along Southern Cross Drive and the Australian and Eastlakes Golf Courses, and high potential for existing biodiversity values to be enhanced.
- Woolwash Park, Zetland – small, constructed freshwater wetland associated with a natural aquifer and vegetated with a good variety of macrophytes; good example of a habitat type that is very limited in the LGA.
- Rail corridors – sections of both the light and heavy rail corridors feature long grasses, thick weed infestations and ground-level debris that provide suitable habitat for a range of fauna species. Fencing along these corridors and restricted public access add to their habitat value.
- University of Sydney, Camperdown and Darlington – the university campus features a mix of long-established exotic and indigenous plantings that support one of few known Superb Fairy-wren populations in the LGA. Recent capital works onsite have incorporated a high proportion of indigenous plantings as well as a small freshwater wetland vegetated with a good variety of macrophytes and fringing vegetation.
- Chinese Gardens, Darling Habour – the freshwater ponds and substantial rocky areas in this landscaped garden support populations of the Eastern Water Dragon and Eastern Water Skink. While these species may originally have been introduced to the garden, which is isolated from other habitat areas, they appear to be flourishing.
- Victoria Barracks, Paddington – bush restoration works are in progress in the south eastern part of this site managed by the Department of Defence, with significant weed control undertaken and hundreds of local provenance seedlings planted to date.

Recent landscaping works at the University of Sydney have incorporated indigenous plantings (left) and a vegetated pond (right). (photos K. Oxenham)

Woolwash Park wetland in Zetland (left) and Embarkation Park in Potts Point (right) are among a number of other supporting sites. (photos K. Oxenham)

3.5 Priority fauna species

The following fauna species were identified as priorities in the LGA for this Strategic Action Plan:

- Green and Golden Bell Frog and other frogs;
- Grey-headed Flying-fox;
- Powerful Owl;
- Long-nosed Bandicoot;
- Microbats;
- Small birds;
- Wetland birds; and
- Reptiles.

Most of these species occur at one or more of the sites discussed in Section 3.4, although some occur at other sites, including residential backyards. Most are dependent on particular habitat features that are limited within the LGA, such as dense shrubby vegetation, rock crevices, ground-level features such as rocks and fallen timber, tree hollows, and freshwater wetlands/ponds.

The following sections provide a profile of each priority species/group.

3.5.1 Green and Golden Bell Frog and other frogs

The Green and Golden Bell Frog (GGBF) was once abundant in Sydney and elsewhere across its range – it was described in 1863 as being "the most common of all Australian frogs" (Lemckert 2010), and remained very common until about 30 years ago, when it underwent a dramatic decline. This decline is thought to have been largely due to a combination of habitat loss, fragmentation and degradation; disease caused by the chytrid fungus (which has led to worldwide frog declines); and predation by the introduced Mosquito Fish (DEWHA 2009; DECCW 2008b; DECC 2005; White & Pyke 2008). GGBFs are now limited to a small number of isolated populations, and the species is listed as threatened under both the EPBC and TSC Acts.

In the City, GGBFs are limited to a very small population (estimated at less than 20 individuals) in Rosebery. This population is centred on a residential backyard in which the frogs colonised a disused, above-ground swimming pool in the mid-1990s, from a larger area of nearby habitat that has since been destroyed by a residential apartment development (DECCW 2008b).

When the pool became dilapidated, the Rosebery residents enlisted the help of the NSW Frog and Tadpole Study Group (FATS) who replaced the pool in 2005 with two small, purpose-built habitat ponds. The City provided funding to FATS for these works.

Peron's Tree Frog (photo K. Oxenham)

Green and Golden Bell Frog (photo K. Oxenham)

Although GGBFs bred in the ponds in large numbers every year until the 2009–10 season, the residents have reported an ongoing decline in the population. They have not observed any tadpoles in the past two years, and have also observed predation by Laughing Kookaburras on adult frogs. Without action, this population faces extinction in the very near future.

Translocation of GGBFs from Rosebery to Sydney Park was identified as a priority action by DECCW (2008b) in the management plan for the Lower Cooks River 'key' GGBF population. However, past translocations of this species have been largely unsuccessful (White & Pyke 2008) and translocation would in any case be difficult given that this is usually undertaken with tadpoles, which do not appear to have been produced in the last two years. Better outcomes may be achieved by establishing more breeding habitat, i.e. freshwater ponds, in the Rosebery area where GGBFs could colonise them naturally.

There are several City parks in Rosebery in which ponds could be constructed, and most backyards in Rosebery are large enough to readily accommodate ponds. There is also a relatively large number of of backyard swimming pools in Rosebery, which could easily be converted to ponds – conversion of just a small number could save the local GGBF population from extinction. A successful 'Pool to Pond' conversion program run by Ku-ring-gai Council has demonstrated the conversion is simple and effective, and Woollahra Council has also recently commenced a 'Pool to Pond' program.

The other frog species recorded in the LGA were the Striped Marsh Frog, Common Eastern Froglet, Perons Tree Frog and Eastern Dwarf Tree Frog. The Striped Marsh Frog and Common Eastern Froglet are more flexible in their habitat requirements and are consequently more widespread in the LGA than the latter two species: Perons Tree Frog was recorded at a small number of sites in the LGA and the Eastern Dwarf Tree Frog at only one site. While tree frogs in general have declined throughout the more densely populated and developed parts of Sydney (White & Burgin 2004), these two species are still common elsewhere throughout their range (Tyler & Knight 2011), including parts of adjoining LGAs, so it should be possible to achieve an increase in their distribution and abundance in the city.

Like the GGBF, all of these species would benefit from the construction of more freshwater ponds and pool conversions, as well as improvements to the habitat value of existing ponds and water features – particularly through increasing the complexity of adjacent terrestrial habitat features (Hamer & McDonnell 2010). This can be achieved by providing a diverse range of fringing vegetation along with ground-level features like rocks around ponds. Improving habitat connectivity between ponds, improving water quality, minimising pond shading, controlling predatory fish – particularly the Mosquito Fish – and providing aquatic vegetation are also important in encouraging a range of frogs (Hamer & Parris 2011). Restrictions on the use of chemical herbicides in and around frog habitats is also critical.

Attempts are currently being made to re-establish populations of similar frog species to those that occur in the city at unoccupied ponds in Melbourne (A. Hamer, *pers. comm.*); if successful, this could potentially be replicated in Sydney.

Frog and Tadpole Study Group working bee (left) to replace dilapidated swimming pool with purpose-built GGBF ponds in a Rosebery backyard; and the main pond today (right) (photo K. Oxenham)

3.5.1 Grey-headed Flying-fox

The Grey-headed Flying-fox has experienced substantial declines across its range as a result of the destruction and development of its natural habitat, particularly along and near the coast. Its range also appears to be contracting in the north and expanding southwards (DSEWPaC 2012). It is listed as threatened under both the EPBC and TSC Acts.

Grey-headed Flying-foxes forage at night over extensive areas, feeding primarily on the nectar, flowers and fruit of a wide variety of trees – mainly *Eucalyptus, Corymbia, Angophora, Melaleuca* and *Banksia* species – and supplement this diet with leaves (DECCW 2009b). They also feed on *Ficus* species and on introduced trees. Their diet varies throughout the year depending on which trees are flowering or fruiting (DECCW 2009b). They play an important ecosystem function in terms of seed dispersal and pollination of many indigenous tree species (NSW Scientific Committee 2001).

During the day, Grey-headed Flying-foxes roost communally in trees, usually in large numbers. Until mid-2012, a large camp comprising thousands of individuals was present at the Royal Botanic Gardens. Despite the relocation of the camp by the Royal Botanic Gardens and Domain Trust, the Grey-headed Flying-fox is likely to remain relatively abundant in the LGA, since individuals from other nearby camps (for example at Centennial Park) are likely to continue to forage throughout the area at night.

Existing tree maintenance practices in the LGA will contribute to their conservation. In Melbourne, at least 87 street tree species and more than 315,000 individual street trees provide a food source for Grey-headed Flying-foxes (Williams *et al.*, 2006), and it is likely that there would be a similar number in Sydney.

Increasing winter-flowering tree species such as Swamp Mahogany and Forest Red Gum in City parks would assist to ensure a year-round food supply (other winter-flowering species such as Spotted Gum and Broad-leaved Paperbark are already common in streets and parks across the LGA). Reducing the potential for Grey-headed Flying-fox electrocutions on overhead power lines, a common occurrence in urban areas, is also likely to benefit the species.

3.5.2 Powerful Owl

The Powerful Owl is Australia's largest owl species and like most large predators, it has a large home range, with a single pair usually occupying a given territory (DECC 2006). It is a forest-dwelling and hollow-nesting species, and has been listed as threatened under the TSC Act mainly due to loss of habitat, including hollow-bearing trees, through logging and clearing for urban development and agriculture.

Powerful Owls have historically occurred in the outer suburbs of Sydney, particularly where there are substantial adjoining bushland areas (Kavanagh 2004), but in recent years there have been numerous records much closer to the city, presumably due to the abundance of prey such as possums and flying-foxes (Birds in Backyards website). A pair now appears to be resident in the Royal Botanic Gardens, where they can often be seen roosting in a leafy tree during the day, usually holding the remains of the previous night's prey in their talons. They have also been recorded in other parts of the LGA on occasion.

Although prey is abundant in the gardens, it is unlikely that there are any tree hollows that are large enough for nesting. As Powerful Owls have successfully nested in a purpose-built nest box in Melbourne (McNabb & Greenwood 2011), Royal Botanic Gardens staff installed a similar nest box in early 2012 ahead of the breeding season, which extends from mid-May to mid-July. It has not been used to date, but will continue to be monitored. Installation of additional nest boxes may increase the likelihood of the owls nesting.

BirdLife Australia's Birds in Backyards program is currently running a Powerful Owl Project, which aims to identify the critical roosting and breeding requirements of the species in the Sydney region, identify important areas requiring protection, and improve awareness of the public and land managers about Powerful Owls and issues affecting their conservation (Birds in Backyards website).

Powerful Owl in the Royal Botanic Gardens. (photo C. Tomkinson)

3.5.3 Long-nosed Bandicoot

The Long-nosed Bandicoot is very common in bushland around Sydney and elsewhere throughout its range, but like most other indigenous ground-dwelling mammals, it has disappeared from most highly urbanised areas and is considered extinct from most parts of inner city Sydney (Leary *et al*. 2004). In 2002, however, numerous reports from residents led to the discovery of a small population around the inner-western suburbs of Dulwich Hill, Marrickville, Lewisham and Petersham. This was surprising given that it was considered extinct from the area by the 1970s; there is no known source population nearby; and it is very vulnerable to predation from foxes, cats and dogs, as well as threats posed by traffic and limited habitat availability and connectivity. This inner-western population has subsequently been listed as endangered under the TSC Act.

A radio-tracking study found the bandicoots forage almost exclusively in urban backyards and shelter by day under old buildings (Leary *et al*. 2004). It is considered possible they may have persisted at industrial sites in the inner west (such as old flour mills and warehouses), and redevelopment of such sites may have forced them to relocate to urban backyards (Leary *et al*. 2004).

Three Long-nosed Bandicoots have since been recorded in the LGA, at Alexandria and Camperdown. The first of these was photographed by a motion-sensitive camera in a community garden in April 2011, while the second (reportedly a juvenile) was found injured in January 2012 in the adjacent Alexandria Park and had to be euthanased. While no further sightings of bandicoots or their diggings have been reported since that time, it is possible that other individuals are present in the area, particularly in and around the many industrial sites in the southern part of the LGA. The third bandicoot record was from the University of Sydney's Camperdown campus, where a dead individual was discovered in November 2012.

Hughes & Banks (2010) found Long-nosed Bandicoot foraging activity was greater in areas with moist, soft soils close to dense vegetation cover, and suggest artificial watering and the provision of additional cover may assist in the conservation of urban bandicoot populations through increasing foraging opportunities.

3.5.4 Microbats

Microchiropteran bats (microbats) are small-bodied, generally insectivorous species which locate their insect prey by echolocation, usually above dense vegetation or waterbodies. In urban areas, they can also sometimes be seen foraging around street lights. By day, they normally roost within the hollows of live or dead trees, under bark, or within caves. Within urban areas where tree hollows and other natural habitat is less available, some microbats have adapted to roosting in man-made structures such as roof and wall cavities of buildings, stormwater drains, and tunnels, but most still depend on tree hollows for refuge and breeding.

There are about 17 microbat species in the Sydney metropolitan area (Threlfall *et al*. 2012a). Only three species – Gould's Wattled Bat, the Eastern Freetail Bat, and Little Forest Bat were confirmed in the City during the surveys, although there were possible records of two additional species, the Southern Forest Bat and threatened Eastern Bent-wing Bat. Several other species may also be present, but were not detected.

Most of the microbat species in Sydney are urban-sensitive (Threlfall *et al*. 2012a). The species detected in the LGA were only recorded from a small number of sites. A recent study (Threlfall *et al*. 2012b) found that only one microbat species – Gould's Wattled Bat, which is the most widespread species in NSW and the ACT (Pennay *et al*. 2011) – can routinely tolerate life in the highly urbanised inner city. A related study also found habitat enhancement efforts for microbats in urban areas should focus on maintaining and restoring bushland and riparian habitat, particularly in areas with fertile, shale-influenced soils (Threlfall *et al*. 2012b). Shale-influenced soils in the LGA are largely limited to the inner west and Surry Hills (the Blacktown soil landscape indicated in Figure 5).

Provision of roost boxes may be another means of encouraging microbats in urban areas, although their use of roost boxes is poorly understood and is likely to be influenced by numerous factors including box design and placement. Rhodes & Jones (2011), however, found five microbat species used roost boxes installed in tall *Eucalyptus* trees in Brisbane parks and backyards, and the boxes were more likely to be used if clustered in groups of at least six within 50 metres of each other, in areas with high grass cover within one kilometre and in areas with high forest cover within five kilometres. Evans & Lumsden (2011) found that Gould's Wattled Bat used roost boxes as well as natural tree hollows in the suburbs of Melbourne, and there was no apparent preference for either roost type. This species has also readily colonised roost boxes recently installed at Sydney Olympic Park.

As well as microbats, roost boxes may also be used by other species, including several that are likely to exclude or prey upon microbats, such as ants, introduced honeybees, and introduced rats (Rhodes & Jones 2011), so it is important that boxes are designed to prevent or minimise potential for this.

3.5.5 Small birds

Given birds are currently the most diverse and prominent vertebrate group within the LGA, the general absence of small woodland bird species was particularly notable in the survey results. The current bird assemblage is dominated by large indigenous honeyeaters, parrots, carnivores and introduced species.

Most of these larger species were not originally resident in the Sydney area (Major 2010; Major & Parsons 2010), or at least not in large numbers – populations of all increased dramatically in the 20th century as Sydney's human population and associated development increased markedly (Recher 2010). Many of the small bird species that did once occur here, such as the Red-browed Finch, Grey Fantail, Eastern Spinebill, and Spotted Pardalote (Major & Parsons 2010), were not recorded in the survey and no longer appear to be present in the LGA. Some of these smaller species still occur in other parts of Sydney, however, including adjoining LGAs, but many have declined in general across their range (Major 2010; Major & Parsons 2010; Recher 2010; Parsons 2009).

Apart from the Willie Wagtail, which is reasonably well-adapted to urban environments and is found across the LGA, the only small woodland birds that appear to be resident in the LGA today are the Superb Fairy-wren, Silvereye and New Holland Honeyeater. Other small birds recorded in the LGA were the White-plumed Honeyeater and Rufous Whistler – each at one site on only one occasion. Several other species, including rainforest species such as the Rufous Fantail and Black-faced Monarch which migrate through Sydney, may also occur in small numbers from time to time.

The Superb Fairy-wren appears to be limited to small populations at Sydney Park, St Peters; Erskineville; the University of Sydney, Camperdown; and possibly Glebe. Lesryk Environmental Consultants also reported it from the Royal Botanic Gardens in 2005, but it no longer occurs there. It lives in small, territorial groups and is a weak flier, unlike the Silvereye and New Holland Honeyeater which are more mobile and capable of moving around the landscape in response to availability of food. Small numbers of New Holland Honeyeaters have been recorded recently at Erskineville and Rosebery. Silvereyes have been recorded at a greater number of locations and appear to be more abundant and widespread across the LGA, though still not particularly common.

Small birds that once occurred in the LGA but no longer appear to be present: Red-browed Finch (left) and Spotted Pardalote (right). (photos N. Lazarus)

The decline of small birds is mainly attributable to the loss of habitat that has occurred with increased urbanisation, along with an associated increase in larger, aggressive birds, especially the Noisy Miner, as discussed in Section 3.7.8. Nest predation by introduced rats may also be a factor.

Most small woodland birds are dependent on dense understorey vegetation comprising a mix of different indigenous shrubs, grasses and groundcover species, which provide the food and shelter they require (Parsons 2009; Debus 2008). Ground level features like fallen logs are also beneficial habitat features. These characteristics are missing from most urban parks and gardens, which tend to be characterised instead by trees over mown lawn, mulch or paved surfaces. This type of environment favours many of the larger bird species that have consequently become abundant in Sydney and other urban areas, and several of which are aggressive towards or prey on small birds (Section 3.7.8).

Concern over the decline of small birds led to the formation of The Glebe Society's Blue Wren Group, a group of residents who for several years have led community education and habitat enhancement initiatives, with a particular focus on the Superb Fairy-wren. With grant funding from the City, the Blue Wren Group commissioned a study to investigate the status of Superb Fairy-wrens in Glebe and Forest Lodge, and to provide recommendations to promote the conservation of wrens and other small birds. The resultant report (Stevens 2008) identifies potential habitat corridors in the Glebe and Forest Lodge area, and particularly stresses the importance of small parks, backyards and the light rail corridor in providing habitat for small birds, given they are generally more protected from disturbance than most City parks.

While some small birds will use a range of indigenous and exotic species as habitat, and weeds like Lantana can be particularly important (Parsons *et al.*, 2008), Parsons & Major (2004) found that several small birds, including the Superb Fairy-wren, were more likely to be encountered in backyard gardens dominated by indigenous vegetation, whereas Noisy Miners dominated gardens with a mix of exotic and indigenous plants.

Several studies (for example Ashley *et al.* 2009 and Catterall 2004) have also shown that plantings of small eucalypt-dominated urban strips and patches are unlikely to provide useful habitat for many small birds, due to their tendency to be colonised by Noisy Miners. Hastings & Beattie (2006), however, found that incorporating acacias, preferably bipinnate species such as the locally indigenous Sydney Green Wattle *Acacia decurrens* and Parramatta Green Wattle *Acacia parramattensis*, along with a dense shrubby understorey was effective in promoting the abundance and diversity of small birds, as Noisy Miners were not resident in plantings with these characteristics.

3.5.6 Reptiles

Based on records from the Australian Museum, there were originally 45 reptile species within the Sydney metropolitan area – most have declined and some, particularly larger species, have disappeared altogether from suburban environments and adjacent small bushland areas (Shea 2010; White & Burgin 2004).

Four of the 11 species recorded in the LGA – the Eastern Water Skink, Bar-sided Skink, Eastern Water Dragon and Gully Skink – are considered 'suburban battlers' in Sydney (Shea 2010), because although they are still present, they are generally uncommon. This certainly seems to be the case in the LGA, although the Bar-sided Skink seems relatively abundant in foreshore locations where suitable rocky habitat is present, and has also been recorded from nearby trees. The occurrence of the Gully Skink in the LGA is of interest in that it is only known in Sydney from a small number of sites in the eastern suburbs and on the north shore (Shea 2010).

Five of the other reptile species recorded in the LGA are considered to be long-term 'suburban survivors' (Shea 2010) as they appear to have adapted well to urbanisation. However, two of these – the Weasel Skink and Eastern Blue-tongue – were recorded from one and two sites respectively and do not appear common in the LGA.

The only known reasonable Eastern Blue-tongue population in the LGA appears to be at Sydney Park, where it is vulnerable to dog attacks and other disturbance.

More than 2,000 Eastern Blue-tongue rescues were recorded by WIRES over a three-year period in Sydney (Koenig *et al*., 2002); vehicles and dogs killed many adults in spring (the breeding season) when adult males move about more frequently, while domestic cats killed mainly juveniles. However, in highly urbanised areas such as the inner city, habitat loss rather than domestic pets was found to be the most important cause for lizard rescue (Koenig *et al*., 2002).

This illustrates the importance of maximising habitat for Eastern Blue-tongues and other reptiles, and improving connectivity between habitat patches to enable them to move safely across the landscape. Koenig *et al*. (2001) found for example that Eastern Blue-tongues actively avoided crossing roads and instead used corridors of dense vegetation to move between shelter sites. Hamer & McDonnell (2010) also stressed the need to maintain structural complexity in habitat patches – for example through providing ground-level habitat features such as rocks and logs – and to protect habitat patches and corridors.

As well as parks, residential backyards can also provide valuable reptile habitat, and reptiles in return play a useful role in controlling garden pests – Eastern Blue-tongues for example prey on garden snails. They and other species readily inhabit backyards in Sydney provided suitable shelter sites are present (Koenig *et al*., 2001) – these can comprise rock retaining walls and other rock features, logs and other ground-level features including artificial structures. However, domestic pets and the use of chemical pesticides such as snail baits, which are likely to be fatal to Eastern Blue-tongues that eat poisoned snails, pose threats to reptiles in backyards, and it is important to improve community awareness about this.

Ideal habitat for the Eastern Water Dragon at the Chinese Gardens, Darling Harbour: rocks, water, long vegetation; and a Weasel Skink. (photos K. Oxenham)

3.5.7 Freshwater wetland birds

Given the freshwater swamps and creeklines that were once present in what is now the LGA, it is likely that a range of freshwater wetland birds was once common. Large numbers and a great variety of bird species, including 'red-bills' (probably Purple Swamphens), 'water hens' (probably Dusky Moorhens), bitterns, many kinds of duck, snipe, and rails, were reported from Lachlan Swamp in the early-mid 1800s (Doran 2004), to the east of the LGA in what is now Centennial Park. It is likely that swamps and other freshwater bodies in the LGA supported a similar assemblage.

Filling of these swamps and channelisation of creeks that took place with the development of Sydney would have led to the disappearance of many of these species. Hunting was also likely to have contributed; large species like the Black Swan were reportedly hunted to local extinction by the mid-19th century (Doran 2004). Many wetland birds have similarly declined overall across Australia (Birds Australia 2008), although there have been recent increases after three years of inland wetland flooding (Porter & Kingsford 2011).

Although no natural freshwater wetlands remain in the LGA, several duck species, the Purple Swamphen and Dusky Moorhen are still reasonably abundant where wetlands and ponds have been constructed. Most other freshwater wetland birds, however, now only occur in very small numbers. These include the Black Swan, Buff-banded Rail, Australian Reed-warbler, Black-fronted Dotterel, Royal Spoonbill, Eastern Great Egret, and Black-winged Stilt.

The four latter species do not appear to be resident in the LGA but appear from time to time, mostly at Sydney Park. They are all waders that forage in shallow water and/or on muddy banks created by fluctuating water levels. Some are also very sensitive to disturbance, for example from recreational activities including dog walking.

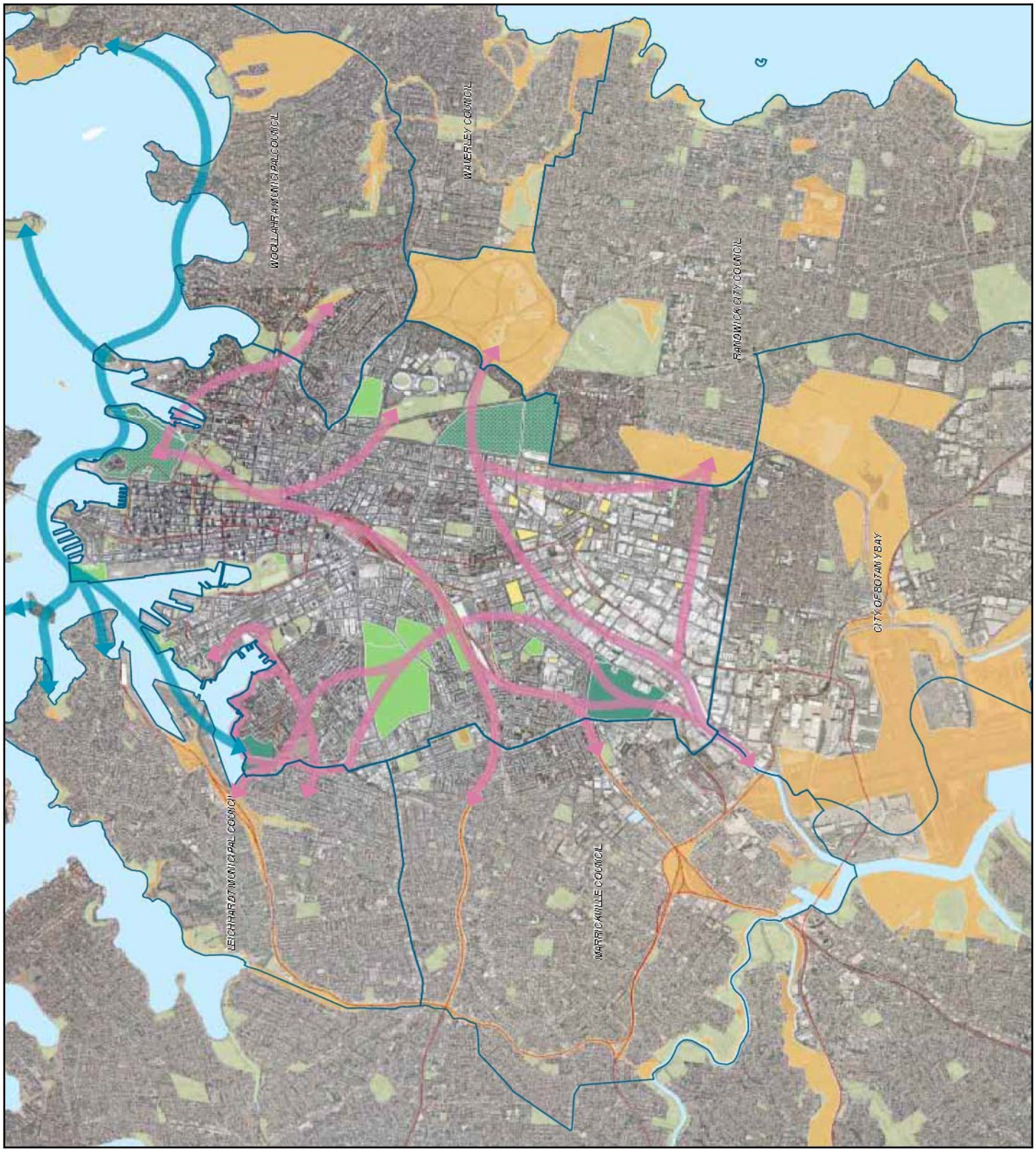
Other species such as the Australian Reed-warbler inhabit dense reed beds and are reliant on the maintenance of this habitat type, while species like the Buff-banded Rail generally require thick long grasses and sedges. Increasing the availability of these habitat types is likely to benefit these species, and could encourage other similar birds, including the Golden-headed Cisticola, Little Grassbird, Baillon's Crake and the migratory Latham's Snipe to inhabitat the LGA.

Black Swan adults and cygnets at Sydney Park (left) and Eastern Great Egret (right, photo J. Irvine)– wetland birds that are uncommon in the LGA.

3.6 Potential habitat linkages

Indicative locations of potential habitat linkages identified within the LGA and between known or potential habitat areas in adjoining LGAs are shown in Figure 17. The mapped linkages do not relate to a defined area or specific properties, but the general vicinity in which linkages may be achievable. While it is unlikely that continuous habitat 'corridors' can be created along their full length, there is considerable potential on public land and through large redevelopments to at least create 'stepping stones' of habitat along or in the vicinity of these potential linkages to facilitate the movement of species across the landscape. These stepping stones would be created within the current planning requirements and would not increase the area of landscaping for new development.

Figure 17
Potential Habitat Linkages



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3.7 Threats

Current threats to biodiversity in the LGA are outlined below.

3.7.1 Limited habitat availability

Arguably the main threat to biodiversity in the LGA today is the limited availability of habitat. The LGA has been almost completely modified from its natural state and is now dominated by the built environment. The habitat features upon which many species rely are consequently very limited.

Many of the species that have disappeared from or are scarce in the LGA require structurally complex habitat comprising a mix of trees with a dense understorey of shrubs, grasses, groundcovers, and/or other features like rock crevices, fallen logs, tree hollows and wetlands. Many species moreover require large areas of habitat that have a minimal perimeter to area ratio, i.e. large, round or square rather than narrow linear areas, as the former have a 'core' that is protected from disturbance at the edges. Studies have shown for example that a minimum area of more than 10 hectares is required to conserve many small birds (Piper & Catterall 2003), although habitat complexity can be more important than area for frogs and reptiles in urban areas (Jellinek *et al*. 2004; Hodkison *et al*. 2007).

Given that vegetation in most parks and gardens in the LGA comprises trees over mown lawn or mulch, with understorey vegetation sparse or absent; areas of structurally complex habitat are scarce and small; no large areas are available for bush restoration; fallen logs have generally been removed as part of site maintenance; most natural creeks have been modified and swamps filled; and trees with hollows are generally removed for safety reasons, many species that once occurred in the LGA are unlikely to return, particularly given the other challenges of surviving in a highly urbanised environment.

There is consequently a clear need to maximise, to the extent possible, the availability of suitable habitat to prevent the loss of species that currently remain in small numbers, and to encourage the species that can (for example, those that still occur in surrounding LGAs) to recolonise the area.

Aerial photos of part of Surry Hills (left) and Pyrmont (right) illustrate the limited availability of habitat within the LGA due to its highly urbanised nature

3.7.2 Lack of habitat connectivity

While canopy connectivity is relatively good across much of the LGA, habitat connectivity at the understorey level is very poor. As discussed above, many species are reliant on this type of habitat, which as well as providing food and shelter enables them to move and disperse across the landscape.

The lack of connectivity means that the existing small patches of structurally complex habitat are generally isolated from each other by intensively developed urban areas and roads, as well as paths, lawns, sportsgrounds and other recreational features associated with most areas of public open space.

The isolated nature of habitats within the LGA, in combination with their limited extent, further limits the potential for many species to survive in the LGA, particularly ground-dwelling species and other less mobile species, since it limits recruitment and gene flow (discussed further in Section 3.7.4). Species particularly at risk include the endangered Green and Golden Bell Frog, which is restricted to one site at Rosebery where it is isolated from the nearest population at Arncliffe in the Botany Bay LGA, and the Superb Fairy-wren, which is a poor flier, and remaining populations of which are isolated from each other and from populations in adjoining LGAs.

While narrow strips of habitat and small 'stepping stone' habitats can improve connectivity between larger areas, recommended widths for functional habitat corridors vary from 25–500 metres, since narrow corridors lack the protected 'core' area required by many species. Corridors of such widths are obviously not achieveable in the city context given the extent of development and competing demands for open space. Neverthless, numerous species are likely to benefit from maximising connectivity of understorey vegetation and ground-level habitat features across the LGA.

3.7.3 Destruction and fragmentation of remaining habitat

Destruction and fragmentation of habitat within the LGA can result from maintenance practices that are incompatible with biodiversity conservation, for example inappropriate use of herbicide, lawnmowers and brushcutters; excess application of mulch leading to smothering of habitat and/or excessive nutrification of waterbodies; misidentification of indigenous plants as weeds (and vice versa); and removal of other important habitat features such as fallen timber and hollow-bearing trees (the latter of which is often required for safety reasons).

Habitat destruction and fragmentation can also result from construction works associated with new developments, redevelopment, and infrastructure maintenance, for example through the unstaged removal of habitat features such as thick long grass and dense shrubs (including weeds, which can provide important habitat for some species as discussed in Section 3.7.5), rock retaining walls, rock piles and debris including rubbish piles, scrap metal and similar.

Clearing of indigenous vegetation is listed as a Key Threatening Process under both the EPBC Act and TSC Act. The loss of hollow-bearing trees, removal of dead wood and dead trees, and bushrock removal are also all listed as Key Threatening Processes under the TSC Act.

3.7.4 Low genetic diversity

The limited habitat availability and poor habitat connectivity characteristic of the LGA has resulted in small isolated populations of numerous species. This is likely to lead to decreased genetic diversity, resulting in reduced resilience of many flora and fauna species to factors such as environmental change, disease, and predation, further limiting their availability to persist in the LGA.

There are similar risks associated with low genetic diversity if vegetation used in bush restoration and other habitat creation/enhancement works is not sourced from a variety of locations.

3.7.5 Weed invasion

Noxious and environmental weeds can suppress and out-compete indigenous flora species. Some weeds also provide a food source for aggressive/predatory bird species that have been implicated in the decline of small birds (as discussed in Section 3.7.8).

Examples of weeds in the City include:

- Fountain Grass and exotic vines such as Asparagus Fern, Madeira Vine, Potato Vine, English Ivy and Morning Glory that are invading sandstone cliffs and outcrops and possible forest remnants;
- Exotic grasses including Kikuyu and other turf species that are outcompeting indigenous groundcover and wetland species;
- Chinese Hackberry (*Celtis sinensis*), which is invading bush restoration sites, parks and railway corridors;
- Dense thickets of African Olive in the Yurong Precinct of the Domain and of Lantana and other weeds in the light rail corridor at Pyrmont that are likely to be inhibiting the germination and growth of indigenous flora;
- Noxious aquatic weeds Ludwigia at Wetland 2 in Sydney Park and Salvinia at Woolwash Park wetland, that can proliferate to adversely affect wetland health; and
- Soft-fruiting species such as Privet and Chinese Hackberry that are increasing the food supply of the Pied Currawong, which also preys on the eggs and chicks of small birds.

The loss and degradation of indigenous plant and animal habitat by invasion of escaped garden plants, including aquatic plants, is listed as a Key Threatening Process under the EPBC Act, while the invasion of numerous species including exotic vines and scramblers, Lantana, exotic perennial grasses, African Olive and Bitou Bush are listed as Key Threatening Processes under the TSC Act.

Despite the threats posed by weed invasion in general, it should be noted that dense thickets of some weeds can be an important habitat resource for small birds, the Long-nosed Bandicoot and other species that occur within the LGA in small numbers/at a small number of sites, particularly given that indigenous vegetation and other habitat is limited in the area.

Infrastructure maintenance works damaging habitat at Orphan School Creek, Forest Lodge (left) and off-site removal of fallen logs and branches at Sydney Park (right). (photos K. Oxenham)

The noxious weed Fountain Grass and other weeds on the foreshore at Pyrmont (above left), annual weeds can outcompete native species if not controlled (below left) and the noxious weed Salvinia infesting Woolwash Park wetland (right).

3.7.6 Use of chemical herbicides and pesticides

The use of chemical herbicides and pesticides, while effective in controlling weeds or pest fauna, can also be detrimental to indigenous species. For example, overspray of herbicide can lead to the death of non-target indigenous plants, and can also impede their germination. Herbicides can also be fatal to aquatic species, and species like frogs and some reptiles that can absorb chemicals through their permeable skin.

Chemical snail baits, which are effective in controlling garden snails, can unfortunately also kill indigenous species like the Eastern Blue-tongue, which preys on snails, and is ironically an excellent natural control for them. Similarly, chemical pesticides can lead to the death of frogs, which prey on numerous insect pests, and use of rat baits can be fatal to raptors, owls or other birds that may prey on poisoned rats.

3.7.7 Introduced fauna

A number of introduced species, including domestic pets, pose a threat to indigenous fauna in the LGA, mainly through predation but also in some cases through competition or disturbance.

Predation by introduced species including the European Red Fox and feral cats are listed as Key Threatening Processes under both the EPBC Act and TSC Acts, and predation by Mosquito Fish and competition from feral honeybees are also listed as Key Threatening Process under the TSC Act.

Examples of the impact of introduced fauna in the City include:

- Predation of frogs, reptiles, birds and potentially Long-nosed Bandicoots by foxes, feral cats, rats and domestic pets; and
- Predation of frog eggs and tadpoles by the Mosquito Fish at freshwater wetlands in Sydney Park and Woolwash Park.

While the impact of cats and dogs may be minimised by increased owner awareness as well as strategic fencing of habitat areas, control of the European Red Fox and feral cat are very difficult in publicly accessible urban areas. Both are also resource-intensive and unlikely to be particularly effective, since removal of one animal generally results in arrival of another to take its place. Within the LGA, both are more likely to be scavenging on garbage or preying on introduced rodents, given these are more abundant than the indigenous species upon which they could potentially feed.

The introduced Black Rat and Brown Rat are both common across Sydney, and while both can impact adversely on indigenous fauna through competition and predation (Banks & Hughes 2012), and may have contributed to the decline of small birds, the majority in the LGA are likely to currently be scavenging on garbage or other waste. Introduced rats do however affect humans through their potential to carry disease (Banks & Hughes 2012). The City therefore undertakes a regular program of monitoring, baiting and control of rat populations on public land and ensures any severe rat infestations creating unhealthy conditions on private property are controlled by education, regulation and/or enforcement.

The Mosquito Fish has been implicated in the decline of the endangered Green and Golden Bell Frog and other frog species. It produces up to 300 young several times a year, and can therefore quickly proliferate to infest a wetland. It is a difficult species to eradicate from large waterbodies, but periodic wetland draining can be effective in reducing numbers.

Despite widespread public perception about the Common Myna (also known as the Indian Myna), which has become common and widespread in the City and other urban areas, numerous studies (eg Haythorpe *et al*. 2012; Taylor 2011; Lowe *et al*. 2010; Parsons *et al*. 2006) have shown it does not appear to have any adverse impact on indigenous bird species in Sydney, and efforts to control it would be better directed to habitat enhancement works for the small bird species which have declined in many urban areas. Even in the ACT, where a recent study has shown a negative impact on some bird species, habitat enhancement for indigenous birds has still been recommended over myna control (Grarock *et al*. 2012). The only potentially effective control method for Common Mynas – cage trapping – is extremely resource intensive, and its effectiveness in terms of reducing overall myna numbers is uncertain (Tidemann 2010).

3.7.8 Indigenous fauna

A number of aggressive and predatory indigenous birds that have proliferated in the LGA and other urban areas have been implicated in the decline of small birds. In particular, aggressive exclusion by the Noisy Miner – rather than the introduced Common Myna – as well as predation by species such as the Pied Currawong, Australian Raven, Grey Butcherbird and Laughing Kookaburra are likely to have contributed to reduced diversity and abundance of small birds (Parsons *et al.* 2006; Bayly & Blumstein 2001), as well as resultant decrease in the ecosystem services such as pollination and predation of insect pests that small bird species provide.

Numerous studies have found a significant negative impact on small birds resulting from the Noisy Miner (Parsons 2009; Debus 2008; Parsons *et al.* 2006; Hastings & Beattie 2006; Parsons & Major 2004; Piper & Catterall 2003; Grey *et al.* 1997), and a nomination has been made to have 'aggressive exclusion of birds from potential woodland and forest habitat by over-abundant Noisy Miners' listed as a Key Threatening Process under the EPBC Act. Noisy Miners and other aggressive/predatory birds are well-adapted to the structurally simple habitat comprising trees and mown lawn, mulch or paved surfaces that characterises many parks, streets and backyards in urban areas.

The predatory Pied Currawong also benefits from the presence of soft fruit-bearing trees that are common in urban areas, such as the introduced Camphor Laurel, the environmental weed Chinese Hackberry, the noxious weed Privet, and the locally indigenous Lilly Pilly and Sweet Pittosporum, as their fruit provides it with an additional food source.

3.7.9 Nuisance fauna

A number of indigenous and introduced species are often considered 'nuisance' species because of their impact on public amenity, rather than any particular impact on biodiversity. Such species include the Australian White Ibis, Sulphur-crested Cockatoo, Common Brushtail Possum, Rock Dove (or feral pigeon), and Common Myna (or Indian Myna). Most indigenous species are protected in NSW under the *National Parks and Wildlife Act 1974*, which is administered by the NSW National Parks and Wildlife Service (NPWS). Any applications to cull indigenous species are processed by the NPWS. Introduced species are not protected under this legislation.

The Australian White Ibis is an indigenous species that was originally an inhabitant of inland wetlands. Large populations have however established in Sydney and other urban areas outside of its original distribution, presumably as a result of inland drought in combination with the abundance of food – large numbers forage at landfills and ibis also scavenge for food scraps in garbage bins, cafés, and parks (Martin *et al.* 2010 & 2007). Ibis populations have increased dramatically in Sydney in recent years (Martin *et al.* 2010). They are considered a nuisance for their scavenging habits, as well as due to noise and odour associated with their nesting colonies.

On City-managed land, nesting colonies have establishd in Phoenix Palms (their preferred nesting habitat in urban areas), in Cook + Phillip Park and Redfern Park, with a smaller colony in a single Phoenix Palm in Fitzroy Gardens in Kings Cross. The NPWS has issued conditional licences to cull eggs and chicks around Sydney in the past, but due to concerns about the overall conservation status of the species, culling is no longer permitted. The NPWS is preparing an Ibis Management Strategy for the Sydney region, and currently recommend the more effective, non-lethal approaches of either removing Phoenix Palms or heavily pruning them each year to prevent nesting.

Common Mynas tend to occur in and around built-up areas rather than bushland (left); the indigenous Noisy Miner (right) has been implicated in the decline of small birds. (photos K. Oxenham)

The Sulphur-crested Cockatoo is another species that has adapted well to urban areas and is now common in the city. It tends to be more fondly regarded than the Australian White Ibis, presumably due to its charismatic appearance and behaviour. Many Sydney residents feed cockatoos, as can be seen for example from a facebook page established for a cockatoo research project (see facebook.com/cockatoo.wingtag). However, this species is capable of causing substantial property damage by chewing through features such as timber window frames, timber decking, wiring, building facades, and roof tiles. Feeding may encourage this nuisance behaviour, and also lead to the spread of beak and feather disease (OEH 2011). The NPWS has issued licences to cull Sulphur-crested Cockatoos around Sydney in some cases, and is currently preparing a Cockatoo Management Strategy to guide the management of human-cockatoo conflicts in urban areas.

The Common Brushtail Possum is indigenous to Sydney, but has adapted well to urbanisation (Russell *et al*. 2011) and is a common species in the city. Like the Sulphur-crested Cockatoo, this species is charismatic and often fed by residents and park users, leading in some areas to unnaturally high populations of this normally fairly solitary species. Large concentrations of possums, for example at Hyde Park, have led to substantial tree defoliation, and this species also impacts on public amenity through feeding on backyard fruit, vegetables and other plants. Given that it is a hollow-dwelling species, and that tree hollows are scarce in most urban areas, its main impact on public amenity is its tendency to invade roof cavities where it can be noisy and cause property damage (Russell *et al*. 2011). It is considered a pest by many residents (Matthews *et al*. 2004). The NPWS has a policy on managing possums that cause this type of disturbance – it requires property owners to take all reasonable efforts to prevent access to roof cavities by possums. In some circumstances, NPWS issues conditional licences to authorise the relocation of possoms from roof cavities (OEH 2012).

The Rock Dove (or feral pigeon) is an introduced species that occurs in large numbers in many city parks. It impacts on public amenity through scavenging for food, although people often actively feed it. It often roosts in/on buildings where it can foul surfaces, cause property damage and potentially pose a health risk. It does not tend to occur in more 'natural' habitats or appear to have any adverse impact on other species.

Although the Common Myna, discussed in Section 3.7.7, does not appear to be adversely impacting on biodiversity in Sydney, it is very abundant in the city where it does impact on public amenity through noise, particularly at its communal roost sites.

Bird feeding (left) can encourage unnatural behaviour and encourage nuisance fauna such as cockatoos, ibis and pigeons. It can also lead to the spread of beak and feather disease, which is affecting this Sulphur-crested Cockatoo in Woolloomooloo (right). (photos K. Oxenham)

3.7.10 Diseases and pathogens

A number of diseases and pathogens pose a threat to indigenous flora and fauna in the LGA, including naturally occurring and planted locally indigenous vegetation and priority fauna species. Some are listed as Key Threatening Processes under the EPBC Act and TSC Act; those of relevance to the City are:

- Infection of plants such as Eucalyptus, Angophora, Paperbark, Bottlebrush, and Turpentine species by Myrtle Rust;
- Dieback caused by the root-rot fungus *Phytophthora cinnamomi*;
- Infection of frogs by amphibian chytrid fungus; and
- Beak and feather disease affecting endangered parrots (while this disease is affecting Sulphur-crested Cockatoos in the city, it should be noted this is not an endangered but a common and widespread parrot species).

3.7.11 Poor water quality and inappropriate hydrological regimes

Poor water quality can lead to the degradation of wetland ecosystems, as can inappropriate hydrological regimes, with consequent adverse impacts to wetland flora and fauna. Examples in the LGA context include nutrient enrichment and subsequent algal blooms and depletion of oxygen levels in the Sydney Park wetlands, at least partly as a result of mulch washing into the wetlands from adjoining slopes (Sainty & Associates 2009) and from excessive feeding of water birds; and the potential for degradation of wetland vegetation from the maintenance of constant water levels (to maintain wetland health, periodic water level fluctuations are required, i.e. periods in which they are allowed to partially dry out).

Natural germination of *Juncus* species at Wetland 1, Sydney Park (left) is assisted by water level fluctuations, which can also assist in minimising blooms of the floating fern Azolla, here covering the whole of Wetland 5, Sydney Park (right) and algae that can be detrimental to wetland health. (photos K. Oxenham)

3.7.12 Light, noise, traffic, and other disturbance

The normal behaviour of fauna can be altered by the presence and movement of people and dogs, and by other disturbance including artificial light, noise and traffic (e.g. Potvin & Parris 2012; Parris *et al.* 2009; Herrera-Montes & Aide 2011). Disturbance impacts vary between species and individuals, and can be more significant at particular times of the year – for example during breeding seasons it can lead to abandonment of young. Levels of disturbance in the LGA are obviously high given its highly urbanised nature.

Traffic is a particular threat to many fauna species, including priority species that are ground-dwelling such as frogs, reptiles, and bandicoots.

The establishment of habitat plantings is sometimes hindered by trampling by park users and dogs, and plantings are also sometimes vandalised.

3.7.13 Climate change

Climate change has the potential to alter the distribution, abundance and availability of habitat for both indigenous and exotic species, and this potential could exacerbate many of the other threats discussed above.

Potential impacts of climate change in the LGA also include loss of habitat for the endangered Coastal Saltmarsh community as a result of rising sea levels, and depletion of food resources for priority fauna species such as the vulnerable Grey-headed Flying-fox.

Loss of terrestrial habitat caused by human-generated emissions of greenhouse gases is listed as a Key Threatening Process under the EPBC Act, and climate change is also listed as a Key Threatening Process under the TSC Act.

Dog chasing birds in the Sydney Park wetlands (top); Eastern Blue-tongue with head injuries and a missing leg after a dog attack at Sydney Park (left); and Masked Lapwings adults with chick at risk from traffic in Glebe (right).

04 Urban Ecology Strategic Action Plan

4.1 Overview

This section provides an overview of the Plan. It first outlines the objectives and targets, then provides an introduction to the actions that are the basis of the Plan and to how they will be implemented. It also outlines how the City will assess and report on its performance in implementing the plan, and how and when the Plan will be reviewed.

4.1.1 Objectives, targets and monitoring requirements

The objectives and targets required to achieve the City's vision for the Plan have been grouped into the following three categories:

- Locally indigenous vegetation;
- Fauna; and
- Habitat connectivity.

Objectives and targets for each category are outlined in Table 5, along with the monitoring that will be undertaken in relation to each to assess the City's performance in implementing the Plan (performance is discussed further in Section 4.1.4).

While the objectives relate to both public and private land across the LGA, the targets relate mainly to City-managed land since it is not possible for the City to control or accurately monitor all activities that take place on land managed by others. Despite this, both public land managed by others and private property will play important roles in meeting the objectives of the Plan, and therefore many of the actions outlined in Sections 4.2–4.4 relate to such land.

Table 5 Urban Ecology Strategic Action Plan objectives, targets, and monitoring requirements

Category	Objectives	Targets	Monitoring	Monitoring frequency
Locally indigenous vegetation	Protect, expand and improve condition of naturally occurring locally indigenous vegetation, including possible remnants	Area of naturally occurring vegetation maintained or increased from 2012 baseline of 2.7 hectares by 2023	Systematic flora surveys and vegetation mapping	Five-yearly
	Increase the extent of bush restoration sites across the LGA, and maintain sites in good condition	• Area of bush restoration sites increased by 100 per cent from 2012 baseline of 4.6 hectares by 2023 • Bush restoration sites characterised by well-established, structurally complex vegetation, free of weeds by 2023	• Mapping of bush restoration sites • Condition assessment	• As sites are established, with annual review • Monthly reporting, with annual review
	Re-establish representative patches of the likely original vegetation communities	Representative patches of at least three of the likely original vegetation communities established by 2023	Systematic flora surveys and vegetation mapping	Five-yearly
Fauna	Protect and enhance sites that provide habitat for priority fauna species	Indigenous fauna species diversity maintained or increased by 2023 based on 2012 baseline of 87 confirmed species, comprising: – 5 frogs – 11 reptiles – 63 birds – 8 mammals	Systematic spring bird surveys, with opportunistic reporting of all fauna groups at other times	Annual
	Increase the distribution and abundance of priority fauna species across the LGA	Priority fauna species recorded from greater number of locations and in higher numbers compared to 2012 baseline by 2023	LGA-wide systematic fauna surveys	Five-yearly
Habitat connectivity	Improve habitat connectivity across the LGA, particularly between priority sites, and between identified habitat areas in adjoining LGAs	Progressive increase in number of habitat features for priority fauna species established along potential habitat linkages by 2023	Mapping of habitat features	Annual

4.1.2 Actions

The actions identified for the Plan are based on the survey results and aim to address issues raised in the community consultation process and identified threats to biodiversity in the LGA. Two broad types of actions have been identified:

- General actions – actions that require implementation across the City of Sydney organisation and/or the LGA as a whole. These have been further grouped into the following five categories:
  - Park and streetscape maintenance
  - Planning controls
  - Staff and contractor engagement
  - Community engagement
  - Partnerships
- Specific actions – site-specific actions that relate to the six priority sites, and species-specific actions that relate to the priority fauna species, with some additional actions for other species.

General actions are outlined in detail in Section 4.2; site-specific actions are outlined in Section 4.3, and species-specific actions are outlined in Section 4.4.

4.1.3 Implementation

The Plan will be implemented over a ten-year period, from 2013–14 to 2022–23. The timeframe for implementation and status of each of the actions is indicated in Section 5. As indicated, numerous actions are already in progress, and many will be ongoing.

An annual implementation plan will be prepared and key projects incorporated into the City's annual Corporate Plan.

4.1.4 Performance assessment

In order to evaluate the City's performance in implementing the Plan, the overall number of actions implemented annually (in accordance with the annual implementation plan) will be monitored and recorded.

Monitoring will also be undertaken in relation to the targets as indicated in Table 5 – some monitoring will be undertaken annually, and some at longer intervals.

4.1.5 Reporting

An annual report on the implementation of the Plan, including an overview of actions implemented and monitoring results, will be produced at the end of each financial year, with a summary incorporated into the City's annual State of Environment Report. The City's quarterly Environmental Sustainability Progress Report will also include a summary of progress throughout the year.

4.1.6 Review

The Plan will be subject to the principles of adaptive management, i.e. Sections 4.2–4.4 and Section 5 will be reviewed annually and modified:

- Where monitoring results indicate this is necessary;
- To incorporate new advances or knowledge in the field of urban ecology;
- In response to any identified changes in priorities; and/or
- To take advantage of new opportunities that may arise in the City.

Recommendations for modification of the Plan will be incorporated into the annual report.

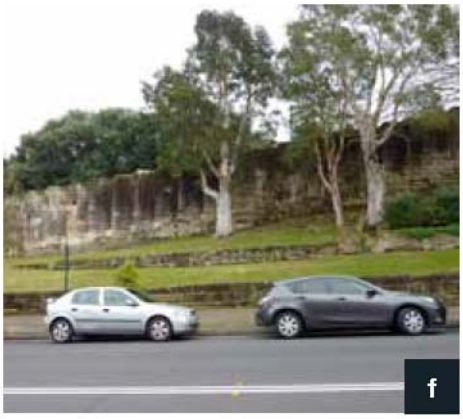
The Plan will also be subject to a full review after a ten-year period, i.e. in 2022–23.

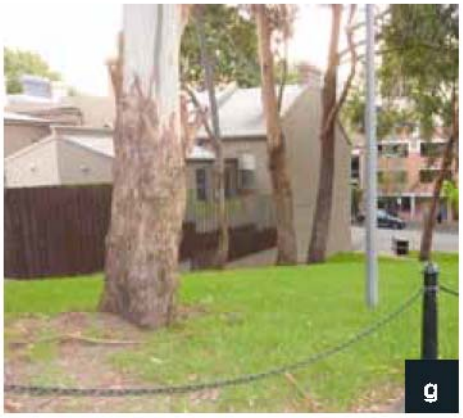
4.2 General actions

4.2.1 Park and streetscape management

The following actions will be undertaken to ensure that best practice bush regeneration and biodiversity management techniques are incorporated into the management of parks and streetscapes:

1. An annual bush restoration and habitat enhancement program will be implemented in City-managed parks. The program will incorporate the principles outlined in Appendix 6.
2. A Bush Restoration Management Plan will be prepared to outline the best practice bush regeneration and biodiversity management techniques that will be implemented in the maintenance of bush restoration and habitat enhancement sites. The requirements of the plan are outlined in Appendix 7.
3. The principles and requirements of both the above will be incorporated into:
   - Landscaping associated with park and streetscape upgrades, in-road plantings and other capital works within the LGA, wherever possible and compatible with existing site conditions and relevant City codes; and
   - All future park and streetscape maintenance contracts.
4. A qualified and experienced bush regeneration specialist will be appointed to fill an existing vacancy within the City's park and streetscape maintenance team.
5. Training in best practice bush regeneration and biodiversity management techniques will be given to existing park and streetscape maintenance staff.
6. Habitat protection fencing will be installed at strategic locations to reduce disturbance to habitats from dogs and park users.
7. Indigenous trees removed due to tree failure or other reasons will be strategically placed within parks to provide ground-level habitat features wherever possible.
8. Where new lighting is required in/near indigenous vegetation patches or other habitat features such as wetlands, lightspill will be minimised wherever possible by installing narrow spectrum bulbs, down lights, shields, embedded lights and/or motion-activated lighting.
9. The diversity of street plantings will be maximised to the extent possible.
10. Understorey species will be included in in-road tree plantings wherever possible.
11. Trials of additional indigenous tree species, particularly any that have recognised habitat value for priority fauna species, will be undertaken with a view to future inclusion in the next review of the City's *Street Tree Master Plan* and *Park Tree Management Plans*.





Examples of pocket parks and edges of larger parks at which habitat planting and other habitat enhancements could be undertaken without compromising existing uses.

a Clyne Reserve, The Rocks
b Pocket park in Erskineville
c Ernest Pedersen Reserve, Glebe
d Cooper Street Closure, Surry Hills
e Edges of Erskineville Oval, Erskineville
f Oatley Reserve, Paddington
g Pocket park in Woolloomooloo
h Pocket Park in Rosebery
i South Sydney Rotary Park, Alexandria

Habitat enhancement works incorporated into the first stage of a stormwater harvesting project at Wetland 4, Sydney Park:
a works in progress
b 18 months later

c & d Plantings and rock features incorporated into landscaping associated with the recent Johnstons Creek Canal shared path.

4.2.2 Planning controls

Landscaping can significantly contribute to the biodiversity of a development site that may be negatively impacted upon as a result of construction. The following actions will inform future planning policy and guide the development assessment process:

1. A reference to Figure 17, which identifies indicative potential habitat linkages, will be mentioned in the Landscape Code. A copy of Figure 17 will be available on the City's website.
2. Consideration will be given to this Plan, and particularly relevant principles of the Habitat Creation Guide (refer Section 4.2.4) in preparation of the City's Landscape Code.
3. A map layer based on Figure 17, Potential Habitat Linkages, will be added to the City's mapping tool, and updated from time to time as required.
4. Development assessment guidelines will be prepared which will address the following:
   - Guidance for development proponents on how landscape designs could enhance and support potential habitat linkages;
   - Managing and staging the removal and disturbance to vegetation and other habitat features particularly those that support priority fauna species;
   - Existing habitat features within and adjacent to larger development sites; and
   - Guidance for the engagement of an ecologist or wildlife rescue officer to check habitat features for the presence of fauna, and manage its relocation.

Removal of habitat features such as thick weeds, long grass and ground debris at this proposed development site at Green Square has the potential to adversely impact biodiversity (left), while a new apartment complex in Pyrmont (right) that has incorporated locally indigenous species into site landscaping is a good example of the potential for new developments to contribute to biodiversity (photos K. Oxenham & S. Golding).

4.2.3 Staff and contractor engagement

Increased awareness and engagement of all relevant City staff and contractors regarding the actions outlined in this document is essential to ensure the effective implementation of this Plan. The following actions will be implemented:

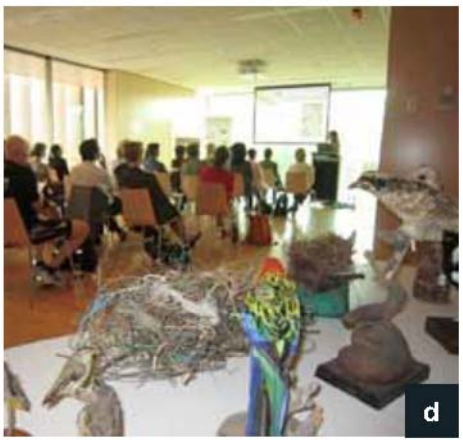
1. City staff in all relevant units will be briefed on the contents of this Plan, and made aware of their requirements under it.
2. An ecological induction process will be prepared and implemented for all new staff and contractors undertaking on-ground works that have potential to impact on indigenous vegetation and/or other habitat features.
3. Regular biodiversity-related stories will be included in the City's weekly internal email newsletter.

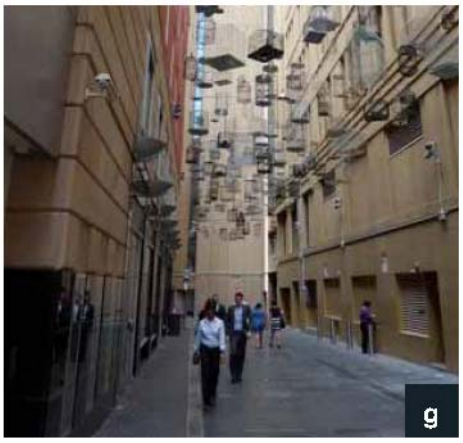
4.2.4 Community engagement

A great level of community engagement is required to assist in the implementation of this Plan, particularly given volunteer bush restoration groups and private properties will play an important role in achieving its objectives. Increased awareness of biodiversity in the LGA is likely to also lead to increased care and concern, not just on private property but on public land as well. The following actions will be implemented to promote community engagement:

1. A user-friendly Habitat Creation Guide will be prepared for the LGA. The guide will be made available on the City's website, with hard copies distributed to volunteer bush restoration groups and community gardeners, and at workshops and other events. The guide will:
   - Provide lists of species from the likely original vegetation communities (Appendix 8), as well as other species, both indigenous and introduced, that have recognised value as habitat for priority fauna species and invertebrates like butterflies;
   - Incorporate information from the *City of Sydney Native Plant List – Sydney Inner West Species* (RBCNN, undated), the suggested plant species list for Superb Fairy-wren habitat (Stevens 2008), and Birds in Backyards guidelines (Parsons 2009);
   - Provide information on the appearance of each species;
   - Provide information on the habitat value of particular species;
   - Distinguish species that are readily available and robust from those that are more difficult to obtain and/or grow;
   - Provide information on planting and maintenance requirements; and
   - Provide guidelines about incorporating other habitat features including frog ponds, rock features, and roost boxes.
2. A demonstration habitat garden will be created on City-managed, publicly-accessible land.
3. Ongoing support will be provided for existing volunteer bush restoration groups and other local community groups such as The Glebe Society's Blue Wren Group.
4. Targeted community consultation will be undertaken to encourage establishment of new volunteer bush restoration groups, particularly around Sydney Park, Moore Park, Green Square, Paddington and Potts Point (refer Section 3.7.2).
5. The potential for locally indigenous plant production at Sydney Park will be investigated as part of the proposed City Farm.
6. Community gardens will continue to be be encouraged to incorporate locally indigenous plants and other habitat features.
7. Permanent interpretive signage will investigated at City-managed priority sites as part of the existing parks signage program.

8. Information about the potential impacts of companion animals on wildlife and responsible pet management in and around habitat areas will be incorporated into:
   - Dog obedience training courses provided by the City;
   - The City's companion animal fact sheets; and
   - Sustainable pet care pages on the City's website.
9. Biodiversity will continue to be promoted through the Green Villages program by:
   - Ongoing workshops to increase community awareness of biodiversity and of how to incorporate locally indigenous vegetation and other habitat features into backyards, onto balconies, on common property including rooftops, in community gardens, at schools, and onto footpaths (in accordance with the City's Footpath Gardening Policy);
   - Including biodiversity-related stories when possible in the City's Green Village News monthly e-newsletter;
   - Providing information about existing biodiversity monitoring programs, such as the Australian Museum's BugWise, Web2Spider and Plant2Pollinator programs, on the Green Villages website;
   - Encouraging and supporting community-led social media initiatives relating to local biodiversity, such as the Sydney Park Swans facebook page; and
   - Other Green Villages initiatives whenever possible.
10. An online fauna database will be established to enable the community to report fauna observations and obtain information about the species that occur in the LGA.
11. Community participation will be encouraged in annual bird surveys (refer Table 5).
12. Grants for biodiversity-related projects will continue to be provided through the City's existing grant programs.
13. The potential to establish a program to encourage schools within the LGA to undertake habitat creation, enhancement and monitoring activities, and to involve students in these activities, will be investigated and implemented if practicable.
14. The potential to hold an annual competition for City residents around the theme of incorporating locally indigenous vegetation and other habitat features into small spaces will be investigated, and implemented if practicable.
15. Community planting events will continue to be held in conjunction with National Tree Day, with the Glebe Society's Blue Wren Group, volunteer bush restoration groups, and other organisations such as Conservation Volunteers Australia and Landcare.
16. Biodiversity-themed display materials will be developed for use at planting days and other events.
17. The potential to hold an annual volunteer planting weekend for City residents in rural NSW in association with Landcare or a rural Council (similar to the program run by North Sydney Council with Landcare at Boorowa in south-western NSW), to increase awareness of biodiversity issues on a broader scale, will be investigated.
18. Biodiversity-themed public art installations such as *Forgotten Songs* in the CBD and *What Bird Is That* in Surry Hills will continue to be encouraged through existing City art programs for their potential to increase community awareness of biodiversity issues.
19. Information about pest and nuisance fauna management will continue to be provided to local residents.
20. The tree management provisions of the Sydney Development Control Plan 2012 and the City's *Urban Forest Strategy* will be used to encourage environmental weed trees such as Chinese Hackberry *(Celtis sinensis)* to be removed from private property and replaced with suitable alternatives where appropriate.





Community engagement actions that will be ongoing and expanded throughout the LGA.

a Glebe Bushcare Group volunteers at a bush restoration site in Federal Park. (photo K. Oxenham)

b&c City residents participating in community planting days.

d Backyard biodiversity workshop at Surry Hills.

e biodiversity tour on the Glebe foreshore.

f A facebook page set up in mid-2012 by residents interested in Black Swans nesting at Sydney Park – a good example of social media being used to improve community engagement in local biodiversity issues.

g Biodiversity-inspired public art commissioned by the City: *Forgotten Songs* at Angel Place in the city centre.

h The *What Bird is That?* mural at Surry Hills. (photos K. Oxenham)

4.2.5 Partnerships

Several priority sites are not managed by the City but by other agencies. Other public land, including sites along or near potential habitat linkages, is likewise managed by others. Collaboration with these other land managers, which include the Royal Botanic Gardens and Domain Trust, the Department of Defence, the Centennial and Moore Park Trust, the University of Sydney, Sydney Water, Railcorp, the Sydney Harbour Foreshore Authority, Housing NSW and adjoining local government authorities (Leichhardt, Marrickville, Botany Bay, Randwick and Woollahra), is required to maximise the effectiveness of this Plan. Similarly, collaboration with other government departments, non-government organisations and research institutions will contribute to the successful implementation of the Plan. The following actions will be implemented:

1. Other land managers within and adjoining the LGA, particularly the managers of priority sites, supporting sites and sites along and near potential habitat linkages, will be briefed on the contents of this Plan to:
   - Create awareness of the existing or potential biodiversity value of land under their management;
   - Encourage the implementation of locally indigenous planting and other habitat enhancement works, adoption of the principles of the Bush Restoration Management Plan (Section 4.2.1), including staged weed control and habitat replacement programs, and implementation of site-specific actions where possible; and
   - Encourage provision of access to their land for volunteer bush restoration groups, for example:
     – By RailCorp to potential bush restoration sites identified near Erskineville and Newtown Stations (RailCorp 2006); and
     – By Sydney Water to weed-infested above-ground pipeline easements, such as adjacent to Perry Park in Alexandria.
2. Partnerships will be established with other land managers within and adjoining the LGA where possible, to facilitate implementation of actions outlined in this Plan.
3. Cooperation with the NSW Office of Environment and Heritage will be ongoing in relation to biodiversity management issues such as the management of threatened species, endangered ecological communities, and nuisance fauna species.
4. The City will continue to advocate with the NSW Department of Primary Industries for the declaration of Chinese Hackberry *(Celtis sinensis)* as a noxious weed under the *Noxious Weeds Act 1995*.
5. Collaboration with research institutions such as the University of Sydney, the Australian Museum and non-government organisations such as BirdLife Australia and Birding NSW will be ongoing in relation to research, monitoring and community education projects that are likely to assist in the ongoing implementation of this Plan.

Plantings undertaken by University of Sydney grounds maintenance staff in July 2011 (left) to provide habitat for the Superb Fairy-wren population at the Camperdown campus and the same plantings establishing habitat value in August 2012 (right).

Sulphur-crested Cockatoo on an inner-city balcony (left) fitted with wing tags as part of University of Sydney and Royal Botanic Gardens and Domain Trust research project, and Australian White Ibis in the Royal Botanic Gardens (right) fitted with leg bands as part of a University of Wollongong, Australian Museum and Royal Botanic Gardens and Domain Trust project. The City will continue to support such studies, which have potential to improve community awareness of biodiversity issues and provide useful information for fauna management.