



Protecting Powerful Owls in Urban Areas

Powerful Owls benefit people



Powerful Owl Coalition

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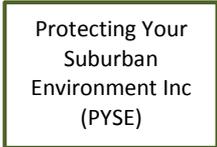
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Powerful Owl Coalition

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Powerful Owls can fly for tens of kilometres if there are sufficient trees in their habitat

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Front cover: photo of Georgie by Michael Bianchino

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PREFACE

Powerful Owls are listed as vulnerable in NSW and therefore require protection under Schedule 1 Threatened Species of the *Biodiversity Conservation Act 2016* [1]. They are listed as threatened in Victoria [2] and vulnerable in Queensland [3]. Their numbers are declining and they face a high risk of extinction in the medium-term future.

It is up to all of us to help ensure that Powerful Owls survive and thrive. To this end the Powerful Owl Coalition (a group of concerned community environmental groups in northern Sydney) has produced this position paper in cooperation with BirdLife Australia's Powerful Owl Project.

In NSW, Powerful Owls are managed under the Saving our Species program as landscape-managed species, species best assisted by addressing threats such as habitat loss or degradation within a landscape [4]. This position paper addresses landscape issues within the urban area. It also supports recovery objectives outlined in the Recovery Plan for the Large Forest Owls [5]:

- to ensure the impacts on large forest owls and their habitat are adequately assessed during planning and environmental assessment processes;
- to minimise further loss and fragmentation of habitat by protection and more informed management of significant owl habitat (including protection of individual nest sites); and
- to raise awareness of the conservation requirements of ... large forest owls amongst the broader community, to involve the community in owl conservation efforts.

This position paper is designed to educate and encourage all levels of government, professionals, groups, communities and individuals to protect and increase the number of Powerful Owls in urban areas. It is divided into three parts: part 1 gives an overview of the threats to survival, part 2 describes Powerful Owls and part 3 gives practical information on the actions specific stakeholders can do to improve habitat and thereby ensure the protection and long-term survival of Powerful Owls.

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PART 1. WHY PROTECT POWERFUL OWLS?

Legal Protection

Powerful Owls are listed as vulnerable in NSW and therefore require protection under Schedule 1 Threatened Species of the *Biodiversity Conservation Act 2016* [1]. They are listed as threatened in Victoria [2] and vulnerable in Queensland [3]. Their numbers are declining and they face a high risk of extinction in the medium-term future.

Powerful Owls are **not** currently listed under the Australian Government *Environment Protection and Biodiversity Conservation Act 1999*.

In NSW the *Biodiversity Conservation Act 2016* [1] legally dictates requirements to manage threatened species and threatened ecological communities. This act controls clearing, impact assessment and offsetting on public and private land.

Threats to Survival

Suburban areas and fragmented bushland in urban areas provide essential habitat for Powerful Owls outside national parks and represent a key ingredient in the success of this species. Unfortunately, rapid changes due to expanding development, and the removal of old growth trees, foraging habitat and green corridors, means that Powerful Owls are experiencing a rapid decrease in numbers. Gardens are shrinking and becoming simplified whilst trees are being removed. All of this will harm our Powerful Owls, and by extension, the many other species that live within the areas that owls also use.

Powerful Owls are listed as vulnerable in NSW because of their small population, restricted distribution and a decline in distribution [5]. Habitat loss and fragmentation are the primary causes of permanent regional decline and local extinctions [5]. Keeping large intact areas of core habitat and maintaining an all-important mosaic of urban forest patches in suburban areas is the way we can include owls in our urban areas.

Loss of hollow-bearing trees is also a threatening process as it reduces the availability of suitable nest sites and prey habitat [6].

Urban sprawl and intensified development reduce the density of trees and shrubs in suburban areas and hence reduce roosting and foraging possibilities for Powerful Owls. Even lawns and grass playing fields need to be included in suburban areas as they provide foraging areas for prey such as Magpies and Cockatoos. Synthetic ovals reduce foraging opportunities for these birds and hence reduce a potential food source for Powerful Owls.

Individual Powerful Owls face many threats to their survival. The absence of suitable hollows is a limiting factor affecting their ability to breed [7], increased competition for remaining nesting hollows by Sulphur-crested Cockatoos and exotic bees [8], and predation of eggs and nestlings by goannas and other animals [5]. Fledging owls are vulnerable to attack by Red Foxes, dogs, cats and other birds. [5].

However, the greatest threat to successful breeding in both the city and rural areas is expanding urbanisation and tree loss.



Synthetic ovals allow year round sporting use but prey birds such as Magpies, Sulphur-crested Cockatoos and Galahs are deprived of a large area to forage



Sulphur-crested Cockatoos compete with Powerful Owls for nest hollows

Car strikes cause more than half of all recorded mortalities for Powerful Owls in the greater Sydney Basin, killing an estimated 8% of the population per year [8]. An increase in the use of large expanses of glass in houses and apartment buildings, as well as pool and verandah surrounds, is also a threat.

Other incidents recorded during the Birdlife Australia study [8] included predation by feral animals, disease, electrocution, weather/ environmental injury and misadventure.

Birdlife Australia [8] has noted that inappropriate hazard reduction burning has the potential to threaten key habitat features. Habitat is further removed or modified for fire mitigation purposes through the implementation of asset protection zones and in NSW the Rural Fire Service 10/50 Vegetation Clearing Code of Practice [9].

Heat is a particular stressor for Powerful Owls. In NSW, heatwaves are projected to occur more often and last longer than currently, up to 3.5 days more on average and across most of NSW there will be more days over 40°C [10]. The retention of forest patches and the planting of trees in urban areas help reduce temperatures and provides suitable habitat for Powerful Owls and people [11].

Fortunately we don't need to worry about genetic diversity as the ability of the owls to disperse over tens of kilometres through a mosaic of forested and cleared land suggests that there are unlikely to be any barriers to gene flow within NSW [5].

Benefits of Protection

Powerful Owls are a top predator and help maintain the ecological balance in our bushland.

If we manage the bushland and suburban landscape for the leafy, complex habitat owls need, we will preserve ancient trees full of hollows and give ourselves shade and a diversity of shrubs of all heights, colours and textures. This will enrich our lives with the sound and sight of birds by day and the rustles, squeaks, grunts and hoots of possums and owls at night.



Car strikes are a major cause of death



Hazard reduction burns can be a threatening process unless they are conducted with habitat protection in mind



Clearing for asset protection zones near houses is a major cause of habitat reduction



As the east coast of Australia has more hot days due to climate change, cool shady roosting sites will become more important

The protection of our top nocturnal predator and its habitat will enhance biodiversity, and inform us about the health of the natural world around us. Urban bushland is already fragmented and clearing for residential development is continuing. However, if we design and expand our green spaces to support Powerful Owls their presence will in turn keep our natural world in balance.

Viewing the world through the eyes of Powerful Owls will enable us to see trees and habitat as an investment for decades and centuries, as 'green infrastructure' [12].

PART 2. POWERFUL OWLS

Description

A detailed description of Australia's largest owl is given in *The Australian Bird Guide* [13]. A simpler description is given in the *Recovery Plan for the Large Forest Owls* [5].

The adult is 60 cm long with the male weighing up to 2.5 kg.

The female is lighter at up to 1.6 kg and has a narrower head with a more rounded crown.

They have very prominent orange-yellow eyes in a flat face with fine bars on their head and coarse brown chevrons on their breast and belly.

Their powerful legs are fully feathered and they have large orange feet.

The wing span can be up to an enormous 140 cm [8].

Juveniles are downy white, have a grey mask around their eyes, less barring on their chests and much shorter tails than the adults [14].

Their call is a deep double hoot and can be heard on *Birds in Backyards* [14], *Birdlife Australia* [15] and the YouTube video, *Profile of Australia's Largest Owl – the Powerful Owl* [16].

They are long lived with an estimated lifespan of up to 25 years in the wild [5].

They have long and strong partner bonds.

They are sedentary (remain in one area).

Territory size varies enormously depending upon the size and connectivity of green spaces and often exceeds 1000 ha, with a range of 2 to 10 km radius from the nest site [8].



Powerful Owls are the largest owl in Australia and are clearly recognisable by the dark chevrons on their front – the young may stay with their parents for many months

Breeding

The age at first breeding is estimated to be 2 to 4 years [5] and the social unit is an adult pair and one to two dependants.

Breeding is over the cooler months of the year with egg laying from May to June [13]. In Sydney pair bonding commences in early May and most of the chicks fledge from their tree hollows by September with a few appearing as late as the end of October [8].

One to two young are generally fledged [8] and the fledged juveniles are dependant for 6 to 7 months [5]. The young then survive by remaining within the parental territory or possibly dispersing 10 to 20 km. The barriers to dispersal are extensive treeless country on route [5] and a lack of suitable habitat to disperse to.



Powerful Owl young are recognisable by their white fronts and grey masks

Distribution

Powerful Owls occur from north of the Sunshine Coast down the east coast to far western Victoria and the corner of South Australia. They occur as far inland as Canberra, the Bathurst area and central Victoria, including the Bendigo district.

Habitat

Owls (and most of their prey) use a variety of habitat types for roosting, sleeping and foraging. Structural and spatial features of an individual plant and the plant community are more important than plant species. The amenity that plants offer in terms of hollows, perching, position of roosting spots in the patch micromatrix, staying cool, providing cover from day birds, attracting prey species, and allowing access to the broader flight path within a patch are all important.

To keep Powerful Owls in urban areas we need to ensure the protection, conservation and ongoing improvement of three types of habitat: nesting, roosting and foraging.

Nesting sites

The ideal nesting site is not dependent on the species of Eucalyptus or Angophora but is dependent on the location and size of the tree. It is clearly described in the Recovery Plan [5]:

... old hollow eucalypts in unlogged, unburnt gullies and lower slopes within 100 m of streams or minor drainage lines, with hollows greater than 45 cm diameter and greater than 100 cm deep; surrounded by canopy trees and subcanopy or understory trees or tall shrubs. Hollow entrances are greater than 6 m above ground, commonly more than 20 m where the forest permits, in trees of at least 80 cm diameter at breast height.

Roosting sites

Powerful Owls roost in riparian zones (creek valleys) during the breeding season, May to October. Dense canopies of shady trees with bare horizontal branches [13] form ideal places to sleep, shelter and cool off.



Powerful Owls live on the eastern coastal strip of Australia from north of Brisbane to west of Melbourne (simplified from Atlas of Living Australia)



Old growth Eucalyptus and Angophora trees have many hollows suitable for owls, other birds and possums



Powerful Owl young peering from their nest hollow in a eucalypt

Along much of the east coast Turpentine (*Syncarpia glomulifera*), Cheese Tree (*Glochidion ferdinandi*), Coachwood (*Ceratopetalum apetalum*), Lilly Pilly (*Acmena smithii*), Sassafras (*Doryphora sassafras*), Black Wattle (*Acacia melanoxylon*), Grey Myrtle (*Backhousia myrtifolia*) and Black She-oak (*Allocasuarina littoralis*) are all favoured tree species. Some of our weed trees and large shrubs, particularly Camphor Laurel (*Cinnamomum camphora*) and Large-leaved Privet (*Ligustrum lucidum*) can also provide roosting sites.

Gardens with shady trees and horizontal branches can provide ideal roosting sites for young or non-breeding birds outside the breeding season.

Foraging sites

Whilst foraging habitat includes nesting and roosting sites, prey species are also found in a range of urban and rural habitats. The key foraging habitat characteristics, dense shrubs and trees with a connective canopy and hollows are present in bushland, parks and gardens on private and public lands [8].

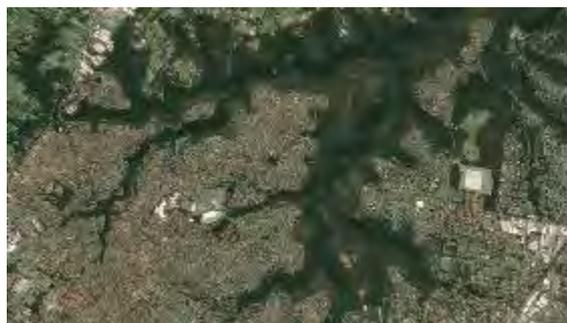
Bushland edges

We need to preserve and enhance the narrow fingers of bushland that penetrate into suburbia. They are important corridors for Powerful Owls and they have the highest chance of including both nesting and roosting habitat. Nesting rarely occurs in urban gardens but generally occurs in these narrow corridors within 50 m of the urban boundary.

The vegetated edges of bushland adjoining suburban areas are essential for Powerful Owl breeding, roosting and foraging. These interface areas are often undervalued as habitat for local fauna and compromised by edge effects from surrounding human disturbance and urban expansion. Suitable habitat does not begin or end on a property boundary but may extend across multi-tenured lands, whether national park, local government park, public or private bushland and needs to be managed cooperatively.



Powerful Owls roost in dense mid-canopy



Fingers of bushland along valleys penetrating suburbs are very important as they provide ideal nesting and roosting sites as well as ideal flight ways – they must be kept in a healthy condition (© Google Earth 2018)



Foraging habitat may not include roosting and nesting sites for Powerful Owls but is just as vital



Complex garden vegetation provides ideal sites for prey and for foraging Powerful Owls

Diet

The Powerful Owl is a predator of arboreal marsupials, particularly the Common Ringtail Possum in coastal forests and the Greater Glider in escarpment and tableland forests. A combination of these two mammals comprises more than 80% of the diet for this owl in most territories in NSW [5].

Powerful Owl diets in urban spaces are a little different. Greater Gliders are less common and owls dine upon fewer Ringtail Possums (just over 50% of diet) and more Brushtail Possums, insects and birds [8].

Powerful Owls will eat any worthwhile meal exposed on a roof, in a tree or on the ground at night. Prey recorded in their diet includes Ringtail Possum, Greater Glider, Brushtail Possum, Flying-fox, Black Rat and Christmas Beetle [8], Sugar Glider, Pied Currawong, Rabbit and many parrot species [5], Magpies and Cockatoos [13]. Domestic cats, snakes, koalas and unsuspecting Brush Turkeys have been known to end up as dinner for an opportunistic Powerful Owl.

The typical dietary requirement for a Powerful Owl is equivalent to one possum per night [17] which may increase during winter.

Large birds such as Magpies and Cockatoos are caught when they roost in trees at night.



Ringtail and Brushtail Possums are favoured food



Flying Foxes can be a useful source of food



Large birds such as Magpies and Pied Currawongs are favoured food



One of the Powerful Owl prey items, the Magpie, needs lawns to survive in urban areas

PART 3. STAKEHOLDERS IN THE CONSERVATION OF POWERFUL OWLS

All people living and working in urban areas are stakeholders in the survival of Powerful Owls. We all need to contribute to strategies for tackling the multiple environmental factors that are causing a reduction in their numbers.

This section provides information for stakeholders. You are encouraged to read all sections to gain a greater understanding of the impacts of a range of disciplines on different habitats in urban areas.

At the very least we need to work together with skilled professionals (see table) to ensure we are aware of issues facing Powerful Owls and current best practice strategies to protect them. Habitat managers should consult members of professional associations and other experts with proven local skills and knowledge in their area of expertise.

List of professional organisations

Organisation	Website
Regional planners and designers	
Australian Institute of Landscape Architects	www.aila.org.au
Local planners and designers	
Australian Institute of Landscape Architects	www.aila.org.au
Australian Institute of Landscape Designers and Managers	www.aildm.com.au
Australian Institute of Architects	www.architecture.com.au
Builders	
Master Builders Association	www.mbansw.asn.au
Housing Industry Association	hia.com.au
Outdoor workers in natural areas	
Australian Association of Bush Regenerators	www.aabr.org.au
Outdoor workers in parks and gardens	
Australian Institute of Horticulture Inc.	www.aih.org.au
Master Landscapers Association	www.landscapenswact.com.au
Arborists	
Arboriculture Australia	www.arboriculture.org.au
Tree Contractors Association Australia	www.tcaa.com.au
Institute of Australian Consulting Arboriculturists	www.iaca.org.au
Fire managers	
Fire Protection Association Australia	www.fpaa.com.au
Schools	
Australian Association for Environmental Education	www.aaee.org.au
Sustainable Schools NSW	www.sustainable-schools-nsw.org.au
Ecologists	
Ecological Society of Australia	www.ecolsoc.org.au
Ecological Consultants Association of NSW	www.ecansw.org.au
Soil specialists	
Soil Science Australia	www.soilscienceaustralia.com.au

Community Groups

Includes trusts, civic trusts, progress associations, conservation groups, friends of, neighbourhood groups, resident associations, Landcare, park care, local land services, bushcare, street care, community nurseries, arboretums, garden clubs, native plant societies, community gardens, botanic gardens, environmental centres, catchment committees, foundations, action groups, residents coalitions, preservation societies, community associations, protection associations, wildlife carers, schools.

Powerful Owls face a high risk of extinction (see p 1). It is up to all of us to protect and improve their habitat to ensure their survival.

The participation of community groups is vital for the protection of Powerful Owls in urban areas. Community groups can take action at multiple levels including:

- lobbying all levels of government;
- ensuring regional and local planning is suitable for the conservation of Powerful Owls;
- ensuring local planning, including development applications, incorporates maximum tree protection, tree planting and suitable gardens;
- defending current Powerful Owl and possum habitat;
- educating the general public, children and all levels of planning and government about the specific requirements of Powerful Owls;
- enhancing habitat in bushland areas, parks, schools and gardens;
- participating in bush regeneration and revegetation projects;
- lobbying land managers to maintain a register of nesting sites and request they inform all services, transport, fire authorities, arborists and bush regenerators of nesting sites when required;
- notifying the local land manager of nesting sites; and

- signing up to Birdlife Australia's Birddata app at <https://birddata.birdlife.org.au> to provide them with up-to-date information about Powerful Owls.

It is therefore strongly recommended that office bearers of community organisations become familiar with this position paper to ensure that they are aware of everyone's responsibilities and impacts.

As well as being a threatened species, Powerful Owls make an excellent flagship species, a species chosen to increase awareness of conservation issues [18].

Who can forget the gasp of awe when sighting one of these majestic birds, their prey dangling from their claws clearly indicating the Powerful Owl's position in the social hierarchy – the very top. The fluffy chicks are unforgettable. The haunting deep double hoot echoing up a valley on a cold winter's night brings images to mind of large, wild and lonely spaces.

Powerful Owls need us and we need them.



Powerful Owls often hold their prey during the day

Regional Planners and Designers

Includes town planners, landscape architects, local government.

Powerful Owls face a high risk of extinction (see p 1). It is up to all of us to protect and improve their habitat to ensure their survival.

Regional planning needs to provide the three components of habitat in the right ratio in urban areas:

- nesting trees – but if there is insufficient foraging area, breeding will fail;
- roosting canopy – but if there are no hollow-bearing trees there will be no breeding; and
- ideal foraging areas – but if there are no trees for roosting, owls cannot persist in an urban environment.

In Sydney, these habitat components can be provided within the framework of the district plans by the Greater Sydney Commission [19]. The Draft Northern District Plan outlines several planning priorities relevant to the conservation of Powerful Owls. Planning priority N16 seeks to protect and enhance bushland and biodiversity by supporting landscape scale biodiversity conservation and restoration of corridors; N19 seeks to increase the urban tree canopy cover and deliver Greater Sydney Green Grid opportunities.



If a Powerful Owl pair nested in this upper valley, much of their foraging habitat would be in urban areas
(© Google Earth 2018)

Ideal nesting and roosting habitat is often found in long unburnt gullies and lower slopes frequently associated with streams or minor drainage lines [5]. These areas support mature canopy trees containing large hollows and fully structured forest vegetation providing habitat suitable for both predator and prey species.

Urban sprawl and development intensification has led to a reduction in the extent and quality of potential habitat on private and public lands. This has resulted in Powerful Owls expanding their foraging range into urban parks and gardens, in particular those that are adjacent to bushland reserves and national parks [20]. These smaller areas are still capable of supporting suitable prey species and provide stepping stones for Powerful Owls to travel between larger core habitat areas.

Recommendations for maintaining populations

Most of the following recommendations have been adapted from The Powerful Owl Project [8] and Lake Macquarie Large Forest Owl Planning and Management Guidelines [21].

Preserve mesic (moist) vegetation along ephemeral and perennial drainage lines and gullies where tree species provide a dense canopy (including individual trees) for roosting. This includes all areas of rainforest and wet sclerophyll forest.

Maintain corridors of suitable habitat, particularly riparian corridors, of at least 200 m wide between large remnants and corridors as wide as possible between smaller remnants.

Maintain and plan forest, woodland and complex urban vegetation suitable for arboreal prey species such as possums.

Maintain and plant habitat patches greater than 1 ha where the patch is any contiguous area of foraging vegetation separated by gaps less than 50 m.

Retain a minimum of 450 ha of good quality foraging habitat (complex trees and shrubs) in a maximum of four patches within the territory (2 km of nest site).

Prevent proposals to remove >1 ha (including staged proposals) of foraging habitat within 2 km of a nest site.

Preserve and improve habitat in a radius of 2 km around a nest site.

Preserve and improve breeding territory and adjacent territories within 5 km.

Provide a buffer of 100 m around nest sites and 50 m around roost sites.

Do not rely on Powerful Owl nest boxes as offsets for hollow loss as anecdotally these are usually unsuccessful.

Develop suitable prescriptive measures in local environment plans and development control plans that support conservation of habitat:

- retention of mature and hollow bearing trees;
- retention of hazardous trees as habitat stags [22];
- retention of canopy connectivity; and
- provide natural buffers between development sites and local reserves and other habitat.

Prevent damage to conserved nesting and roosting habitat by:

- maintaining suitable buffers by not designing walking tracks, bike ways and other facilities along riparian habitat and other core habitat areas to avoid noise and disturbance;
- avoiding public lighting that illuminates the full height of trees as this will impact both Powerful Owls and their prey; and
- keeping lighting, particularly bright artificial sports lighting, away from riparian areas, other core habitat and nesting sites [21] and [23].

Employ a practising ecological consultant as defined by the Ecological Consultants Association of NSW for surveys of flora and fauna.



Trees in golf courses, schools, parks and along streets form vital foraging habitat for Powerful Owls in urban areas



Avoid bright lights near riparian and nesting sites

Design corridors of local indigenous trees along streets to support prey populations and allow movement of Powerful Owls and prey above roads and through the landscape.

If continuous corridors of trees cannot be created, aerial pathways (for example ropes and cables) between trees, especially across roads are vital as this helps keep prey off the road and reduces the risk of car strike for both possums and Powerful Owls.

Be aware of problems with street trees, for example:

- Fire – do not create a path for bushfires to penetrate urban areas. Local indigenous trees with smooth bark may be preferable to trees with stringy or fibrous bark. Less flammable exotic trees may need to be selected [24].
- Power lines – both above and below ground.
- Other underground services.



Trees form a safe passage across the road for possums – keeping prey off the road also keeps Powerful Owls off the road



Planting trees in local centres can be an expensive operation; advanced trees are protected by the local development control plan and are less likely to be vandalised; tree protection and support need to be substantial; these trees need to be linked by more street trees to the nearby bushland



Cables sometimes provide safe aerial crossings for possums



Street trees need to be carefully assessed for fire management near bushland. Smooth barked trees with a close mown nature strip are the best option

Local Planners and Designers

Includes architects, builders, landscape architects, landscape designers, local government.

Powerful Owls face a high risk of extinction (see p 1). It is up to all of us to protect and improve their habitat to ensure their survival.

Design to minimise tree and large shrub removal during construction.

Design buildings and gardens to prevent damage to the tree root zones of actual or potential nesting trees. The tree protection zone (an area above or below ground) should be within: 9 m of a tree with a diameter at breast height of 800 mm or greater, 7 m of a tree with a diameter at breast height of between 400 and 800 mm, and 4 m of a tree with a diameter at breast height of 400 mm or less [25]. This includes no change to soil level, soil structure and moisture content.

Design the landscape plan with new or existing potential hollow bearing trees further than 3 m from the main dwelling so that damage to the dwelling is limited and trees are less likely to be removed in the future.

Design area(s) of dense large shrubs/small trees approximately 2 to 10 m high in each park or garden for prey habitat and as roosts for Powerful Owls. These must form part of contiguous dense vegetation corridors.

Native shrubs and small trees such as Tea-trees and Paperbarks should be included in all landscape designs as they provide suitable shelter and extra food for prey species, such as possums and small birds.

Design minimal areas of hard landscaping to provide the space needed and deep soil required for trees and shrubs.

Design windows and glass fences, including pool fences, to reduce bird strike. Birds tend to fly into glass if they can see straight through or if there are reflections of shrubs and trees. Use stickers and stripes and other techniques to make the glass obvious [26].



Trees in urban areas should be saved wherever possible; a carport has been added over existing hard landscaping and the tree has been incorporated in the design



Dense trees and shrubs provide habitat for Powerful Owls and their prey while the lawn provides space for recreation and prey birds such as Magpies and Sulphur-crested Cockatoos

Part 3. Stakeholders in the Conservation of Powerful Owls



This fence has been designed to preserve this magnificent habitat tree rather than cut it down



These units have been located on the block to preserve this stand of native trees; time will tell how successful this has been as soil disturbance has been too close to the trees



An opportunity lost; a small native tree, Tuckeroo, has been planted in an area where there are no overhead wires; species such as the tall local native trees visible in the background would have been more useful to possums, birds and Powerful Owls

Natural Area Managers

Includes local government, Bushcare staff and volunteers, bush regeneration contractors, Landcare groups and employees (who carry out assisted natural regeneration, weeding, revegetation, water management, track construction and tree management), fire managers (in NSW Fire and Rescue, Rural Fire Service, National Parks and Wildlife Service) and owners of private bushland and rural holdings.

Powerful Owls face a high risk of extinction (see p 1). It is up to all of us to protect and improve their habitat to ensure their survival.

Register of nesting sites

Maintain a register of Powerful Owl nesting sites and inform all services, transport, fire authorities, arborists and bush regenerators of nesting sites when required.

Check and update records in the Atlas of Living Australia [27] and (in NSW), BioNet [28].

Maintain and enhance the native vegetation structure

Don't damage or alter the root environment of actual and potential nesting trees. The tree protection zone (an area above or below ground) should be within: 9 m of a tree with a diameter at breast height of 800 mm or greater, 7 m of a tree with a diameter at breast height of between 400 and 800 mm, and 4 m of a tree with a diameter at breast height of 400 mm or less [25]. This includes no change to soil level, soil structure and moisture content.

Don't over clear weeds such as Large-leaved Privet and Camphor Laurel as these are important roosting sites for Powerful Owls and nesting sites for Ringtail Possums. Remove these weeds in a mosaic pattern [29] so that habitat is protected while weeds are gradually removed.

Encourage natural regeneration of trees as well as planting upper storey trees to provide a succession of tree hollows over the next 100 to 200 years.

Encourage natural regeneration and plant a middle layer of native trees with dense canopy foliage but low mid-layer development along the riparian zone of creeks to provide roosting sites. Suitable species include: Coachwood, Turpentine, Lilly Pilly, She-oak, Sweet Pittosporum, Cheese Tree, Black Wattle and New South Wales Christmas-bush. Use nearby reference sites for species and species composition [30].

Repair and create linkages and corridors of suitable vegetation along creeks and reserves that penetrate urban areas to enlarge the potential area for foraging.

Maintain and enhance habitat for the main prey species. This includes gum trees for food and a dense lower tree/shrub layer, including vine tangles, for nesting and protection.

Preserve large trees at the interface of bushland and built up areas as these are favourite roosting sites for Powerful Owls when hunting through urban areas.



Think about the roosting requirements of Powerful Owls before you remove large areas of Privet



Planting at bushland boundaries can be very important to strengthen bushland habitat



Large trees at the interface of bushland and built-up areas make it easy for Powerful Owls to fly into suburban areas



Construction work near or in bushland should be well away from possible nesting sites during the breeding season

Work ethics

Build tracks 100+ m away from possible Powerful Owls nesting and roosting sites to ensure they are not disturbed during track construction or when used for recreation.

Bush regeneration, weeding, planting and any construction work, for example storm water management structures, should not take place within 100 m of possible nesting or roosting sites during breeding season.

Work quietly near nesting or roosting sites and limit work to hand tools only during the breeding season, early May to late October.

Fire management

Identify habitat trees and implement appropriate control measures (such as clearing leaf litter from the base of the tree) prior to undertaking hazard reduction burns.

No burning around known nesting sites at any time [31]. The Powerful Owl Project [8] recommends an exclusion zone of 50 m around nesting sites and the adjacent roosting habitat and to burn outside the breeding season of early May to late October.

No slashing, trittering or tree removal of or around known nesting sites [31].

Carefully observe recommended fire thresholds, for example those for Hornsby and Ku-ring-gai [32] in Sydney include:

- avoid fire in rainforest;
- for the local shrubby wet sclerophyll forest a fire interval of a minimum of 25 years in strategic fire management zones and a minimum of 30 years in land management zones and overall maximum of 60 years;
- crown fires should be avoided in the lower end of the interval range for wet sclerophyll forest; and
- ensure pile burns are well away from the base of trees [33].

Garden and Park Managers

Includes horticulturists, landscapers, golf clubs, home gardeners, garden clubs, strata managers, bodies corporate, local government.

Powerful Owls face a high risk of extinction (see p 1). It is up to all of us to protect and improve their habitat to ensure their survival.

Trees

Plant and preserve gum trees (Eucalyptus, Angophora, Corymbia) and, in parts of Sydney, Turpentines (*Syncarpia*) as these are the main nesting trees for Powerful Owls and a food source for prey animals.

Don't damage or alter the root environment of actual and potential nesting trees. The tree protection zone (an area above or below ground) should be within: 9 m of a tree with a diameter at breast height of 800 mm or greater, 7 m of a tree with a diameter at breast height of between 400 and 800 mm, and 4 m of a tree with a diameter at breast height of 400 mm or less [25]. This includes no change to soil level, soil structure and moisture content.

Prevent damage to tree trunks near soil level:

- avoid bark damage by line trimmers;
- mulch with coarse bark mulches around tree trunks
- apply mulch to 100 mm deep;
- ensure mulch is not piled up against the tree trunk [34];
- in areas of high fire risk use coarse gravels as mulch [35]; and
- avoid raised garden beds around tree trunks as they are built up over tree roots and are often over-watered, both of which can cause harm to the bark [36], increase the risk of insect attack and crown root rot – these will eventually reduce tree health.

Remove dense vines on trees, particularly from gum trees, as they cover the tree foliage, cause decay of the bark and eventually tree death.

Use a professional consultant, for example a member of the Institute of Australian Consulting Arboriculturists [37] for any reports and a registered professional practicing arborist [38] for any tree work.



In parts of Sydney Turpentines are important habitat trees for prey and Powerful Owls as the dense canopy provides shade and shelter



Mulch is useful around trees as it suppresses weeds and helps retain moisture in the soil but make sure it is not piled against the trunk



Changes in soil level have damaged the root system and the bark – severe insect attack at the base and an unhealthy tree is the result



Raised beds and dense plantings can damage the bark and roots and hence reduce the life of a tree so it may not live long enough to form a hollow



Dense vines can damage bark and foliage and reduce the life of trees



Arborists must be qualified

Food for the main prey species

Ringtail Possums need abundant gum tree leaves to eat as well as shrubs in the Myrtaceae family, for example Tea-tree (*Leptospermum*) [39] and fine-leaved Paperbarks such as Snow-in-Summer (*Melaleuca linariifolia*).

Common Brushtail Possums like a wide range of leaves and fruit from different trees and shrubs [39].

Sugar Gliders feed on a diverse range of foods from different trees; kino producing trees, for example in Sydney, Red Bloodwood (*Corymbia gummifera*) and gum producing trees such as Sydney Green Wattle (*Acacia decurrens*) and Parramatta Green Wattle (*Acacia parramattensis*) as well as nectar, pollen and insects [40].



Tea-trees provide shelter and food for possums



Sugar Gliders are not normally seen on the ground but in trees feasting on kino, gum, nectar, pollen and insects



Gum oozing from wattle trunks provides food for Sugar Gliders

Grey-headed Flying-foxes feed on the nectar and pollen of native trees, in particular Eucalyptus, Melaleuca and Banksia, and fruits of rainforest trees and vines [41].

Large birds, for example Sulphur-crested Cockatoos and Magpies need lawn where seed and insects are eaten [13].

In summary, our gardens need eucalypt trees, some wattles, a diversity of shrubs and a lawn to provide food for prey.

Shelter and roosts for Powerful Owls and their prey

Wherever possible rely on large trees for hollows. Powerful Owl nest boxes are available [42] but there is only one recorded successful breeding in a nest box [43] which suggests owls are reluctant to use them. Providing suitable roosting sites in gardens, particularly those adjacent to gullies or natural waterways will offer greater benefits than nest boxes.

Common Brushtail Possums and Sugar Gliders both need hollows. Ringtail Possums will use hollows or build dreys (football sized nests of sticks, bark, leaves and grasses) [39].

Without hollows, Common Brushtail Possums will find cavities in houses but nest boxes offer a much better solution. Boxes may be bought on-line, for example Nest Boxes Australia [42] and plans to build your own are also available, for example Local Land Services [44] and Office of Environment and Heritage [45].

Ensure nest boxes are mounted with a rough north-easterly to south-easterly aspect providing protection from the worst of the weather. The mount should not damage the tree; generally a large bugle head batten screw or coach screw is suitable [46].

Grey-headed Flying-fox will generally not roost in gardens as they commonly roost in gullies, close to water, in vegetation with a dense canopy [41]. They will however feed on fruit, pollen and nectar in suburban gardens.

Large birds simply need large trees to roost in overnight.



Fleshy fruit (for example figs) and pollen and nectar producing gums (such as Sydney Red Gum) are needed in urban areas to attract Flying-foxes for Powerful Owls to eat



Grass, whether on lawns, nature strips or playing fields, is needed to provide food for prey species, for example Galahs, Magpies and Sulphur-crested Cockatoos



A rounded Ringtail Possum drey below leaves caught in the vines at the top



Brushtail Possums appreciate a nest box



Flying-foxes roost in favoured camp sites

Possums as pests

If you have favourite plants, particularly roses and fruit trees, that you want to protect from possums, isolate the plants so possums find it difficult to climb into them. Also use scent, light, sound and fencing barriers to deter them. More detail is provided in a Garden Australia fact sheet [47].

Plant selection

Local native trees and shrubs are the best selection as they are most likely to provide the required food and shelter for Powerful Owls and their prey.

Another option is a native garden with a few long-flowering nectar bearing shrubs such as hybrids and cultivars of Grevilleas and Bottlebrushes. Do not overplant these as they will encourage Noisy Miners to dominate gardens [48]; a garden without small birds and where even the Ringtail Possums are harassed. The best way to discourage them is to increase structural diversity by planting more shrubs and groundcovers and increasing shrub density for small insect-eating birds.

The third option is a mix of native and introduced plants (see table on pp 20–21). Check with your local nurseries for suitable plants for your area that are not weeds. Also check web sites. Weeds in Australia [49] is a good option in all States. In NSW check NSW Weedwise [50] and PlantNET [51] and in Victoria look up Victorian Resources Online [52]. Do not be afraid to draw on old fashioned shrubs that have been used in your area for years but are no longer in vogue.

Consider the heritage value of the garden.



Local nectar producers such as this Banksia provide food for birds and mammals that form prey for Powerful Owls



Hybrid Grevilleas and Bottlebrushes encourage Noisy Miners to the exclusion of other birds and mammals



Camphor Laurels and other undesirable invasive trees can provide vital roosting and foraging sites for Powerful Owls, as well as being heritage items

Protecting Powerful Owls in Urban Areas

A variety of native and introduced trees and shrubs can provide habitat for Powerful Owls and possums

(N) indicates native plants but some may become weedy in your area – check with local nurseries and state weed lists
Also carefully assess plants from overseas for their potential to invade natural areas

Common name	Scientific name	Provides habitat for Powerful Owls due to the plant height	Provides habitat for possums
Lilly Pilly (N)	<i>Acmena</i>	Yes	Yes
Abelia	<i>Abelia</i>	No	Yes
Chinese Lantern	<i>Abutilon</i>	No	Yes
Wattle (N)	<i>Acacia</i>	Yes	Yes
Willow Myrtle (N)	<i>Agonis</i>	Yes	Yes
She-oak (N)	<i>Allocasuarina, Casuarina</i>	Yes	Yes
Apple Gum (N)	<i>Angophora</i>	Yes	Yes
Irish Strawberry	<i>Arbutus</i>	No	Yes
Myrtle (N)	<i>Backhousia</i>	Yes	Yes
Banksia (N)	<i>Banksia</i>	Yes	Yes
Orchid Tree	<i>Bauhinia</i>	Yes	Yes
Bougainvillea	<i>Bougainvillea</i>	No	Yes
Kurrajong (N)	<i>Brachychiton</i>	Yes	Yes
Yesterday, Today and Tomorrow	<i>Brunfelsia</i>	No	Yes
Ivory Curl Tree (N)	<i>Buckinghamia</i>	Yes	Yes
Butterfly Bush	<i>Buddleia</i>	No	Yes
Powder Puff	<i>Calliandra</i>	No	Yes
Blackwattle (N)	<i>Callicoma</i>	Yes	Yes
Bottlebrush (N)	<i>Callistemon</i>	Yes	Yes
Cape Chestnut	<i>Calodendron</i>	Yes	Yes
Camellia	<i>Camellia</i>	No	Yes
Christmas Bush (N)	<i>Ceratopetalum</i>	Yes	Yes
Flowering Quince	<i>Chaenomeles</i>	No	Yes
Oranges, lemons, limes	<i>Citrus</i>	No	Yes
Butterfly Bush	<i>Clerodendrum</i>	No	Yes
Dracaena Palm	<i>Cordyline</i>	No	Yes
Bloodwood (N)	<i>Corymbia</i>	Yes	Yes
Tuckeroo (N)	<i>Cupaniopsis</i>	Yes	Yes
Blueberry Ash (N)	<i>Elaeocarpus</i>	Yes	Yes
Gum Tree (N)	<i>Eucalyptus</i>	Yes	Yes
Euphorbia	<i>Euphorbia</i>	No	Yes
Fig (some N)	<i>Ficus (not elastica)</i>	Yes	Yes
Ash	<i>Fraxinus</i>	Yes	Yes
Fuchsia	<i>Fuchsia</i>	No	Yes
Cape Jasmine	<i>Gardenia</i>	No	Yes
Wilga(N)	<i>Geijera</i>	Yes	Yes
Spider flower (N)	<i>Grevillea</i>	Yes	Yes

Part 3. Stakeholders in the Conservation of Powerful Owls

Common name	Scientific name	Provides habitat for Powerful Owls due to the plant height	Provides habitat for possums
Silky Oak (N)	<i>Grevillea</i>	Yes	Yes
Hakea (N)	<i>Hakea</i>	No	Yes
Veronica	<i>Hebe</i>	No	Yes
Hibiscus	<i>Hibiscus</i>	No	Yes
Hydrangea	<i>Hydrangea</i>	No	Yes
Jungle Geranium	<i>Ixora</i>	No	Yes
Jacaranda	<i>Jacaranda</i>	Yes	Yes
Tickbush (N)	<i>Kunzea</i>	No	Yes
Golden Chain Tree	<i>Laburnum</i>	Yes	Yes
Crepe Myrtle	<i>Lagerstroemia</i>	Yes	Yes
Tea-tree (N)	<i>Leptospermum</i>	Yes	Yes
Tulip Tree	<i>Liriodendron</i>	Yes	Yes
Liquidambar	<i>Liquidambar</i>	Yes	Yes
Brush Box (N)	<i>Lophostemon</i>	Yes	Yes
Fringe-flower	<i>Loropetalum</i>	No	Yes
Magnolia	<i>Magnolia</i>	Yes	Yes
Paperbark (N)	<i>Melaleuca</i>	Yes	Yes
White Cedar (N)	<i>Melia</i>	Yes	Yes
Mock Orange (not as a tightly pruned hedge)	<i>Murraya</i>	No	Yes
Photinia	<i>Photinia</i>	Yes	Yes
Mock Orange, Native Daphne (some N)	<i>Pittosporum</i>	Yes	Yes
Leadwort	<i>Plumbago</i>	No	Yes
Cherry, Plum	<i>Prunus</i>	No	Yes
Azalea	<i>Rhododendron</i>	No	Yes
Tree Rose	<i>Rhododendron</i>	Yes	Yes
Rose	<i>Rosa</i>	No	Yes
Turpentine (N)	<i>Syncarpia</i>	Yes	Yes
Lilac	<i>Syringa</i>	No	Yes
Lilly Pilly (N)	<i>Syzygium</i>	Yes	Yes
Lasiandra	<i>Tibouchina</i>	No	Yes
Water Gum (N)	<i>Tristaniopsis</i>	Yes	Yes
Snowball tree	<i>Viburnum</i>	No	Yes
Fairy Trumpets	<i>Weigelia</i>	No	Yes

Garden design

Reduce the areas of hard landscaping to provide deep soil and the area required for trees and shrubs.

Have complex vegetation in some areas of each park or garden. Complexity should be horizontal, vertical and by species. Shrubs of different heights approximately, 2 to 10 m, are needed for shelter and feeding. Dense shrubs are needed so possums and gliders do not have to venture onto the ground.

The garden style with a central lawn and dense shrubs along the fence lines and one or two large gums is ideal for Powerful Owls and Possums. Extensive paving with neat hedges of Box (Buxus) or Murraya is far less suitable.

If you have limited outdoor space, co-operate with your neighbours and have one tree in the back corner of the garden and have a thin line of shrubs against both back fences to create a corridor.

Fire risk

Some of the recommendations for garden design and plant selection for possum habitat may make homes less safe in a bushfire, particularly within 100 m of bushland. It may be necessary to consider relevant standards for asset protection zones.

There are at least two main documents to consult to protect houses and maintain habitat; one by the NSW Rural Fire Service [24] and one by the Victorian Country Fire Authority [53].

The main design principles of an asset protection zone and for general fire safety are:

- trees and shrubs should form a horizontal discontinuous canopy;
- shrub foliage should be vertically separate from the tree canopy; and
- the ground layer should provide minimal flammability near the house; pebbles for mulch and a mown lawn.

This is obviously not going to provide good habitat for possums and gliders.

Landscaping for Bushfire [53] provides sensible guidelines for planning and designing a garden as well as plant selection and maintenance. The Habitat Network has published a short guide to habitat provision in asset protection zones [54].

If in doubt about safety, garden design and plant selection seek advice from the local Rural Fire Service (NSW and Queensland), CFA (Victoria), local council or suitably qualified consultants.



The garden in the background is far more possum friendly than that in the foreground



Dense trees with a central lawn is a far better garden design for Powerful Owls than formal clipped hedges



Deep soil and space around units allow trees to thrive

Arborists

Includes tree contractors and consulting arborists, local government.

Powerful Owls face a high risk of extinction (see p 1). It is up to all of us to protect and improve their habitat to ensure their survival.

Include a habitat assessment in the various report types [55], particularly for large trees, as is done for bats in the United Kingdom [56]. In NSW, habitat assessment may be required under the *Biodiversity Conservation Act 2016* [1] and may require a biodiversity licence from the Office of Environment and Heritage.

Make sure you are up to date with new training re habitat management.

Avoid tree lopping, pruning and removal in peak nesting time. For most fauna this is from late winter to late spring.

Do not remove trees suitable for Powerful Owl nesting if at all possible.

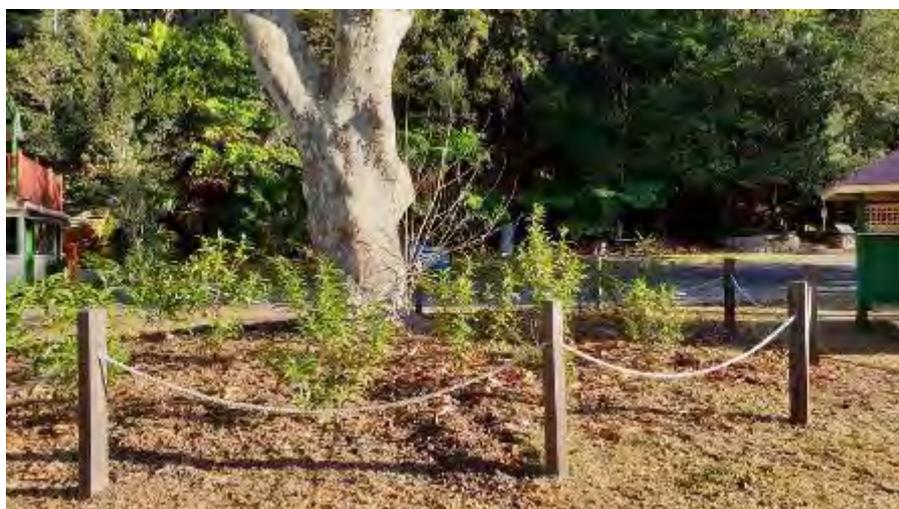
Recommend redesign of proposed developments to avoid tree loss.

Recommend a reduction in risk by fencing off/ reducing the use of the target area.

Consider pruning for habitat creation as an alternative to complete tree removal in target areas [22].



Trees with this diameter would have had potential hollows for a Powerful Owl nest



Fence the area around potentially hazardous trees so people are excluded and therefore not injured if a branch falls

Services and Transport

Includes electricity, water, sewer, National Parks and Wildlife Service, roads, local government, Roads and Maritime Services, RailCorp, Transport for NSW and equivalents in Queensland and Victoria.

Powerful Owls face a high risk of extinction (see p 1). It is up to all of us to protect and improve their habitat to ensure their survival.

BEFORE work begins check for nesting sites

Make sure you have up-to-date information on nesting sites by contacting the local land manager and by checking the Atlas of Living Australia [27] and (in NSW) BioNet [28].

Inform all relevant staff and contractors of nesting sites.

Establish a mechanism for rescheduling works if required.

DURING work protect nesting and roost sites

Provide a buffer of 100 m around nest sites and 50 m around roost sites.

During the breeding season (early May to late October) avoid loud machinery, equipment, night time lighting, pruning, clearing and trittering.

Fencing on roads

Creek and riparian crossings on roads with a speed limit of 80 km/h or over should have fencing of sufficient height to lift the flight path of a Powerful Owl above the average height of a semi-trailer. The fencing should be the width of the rainforest and wet sclerophyll forest not just the stream width.

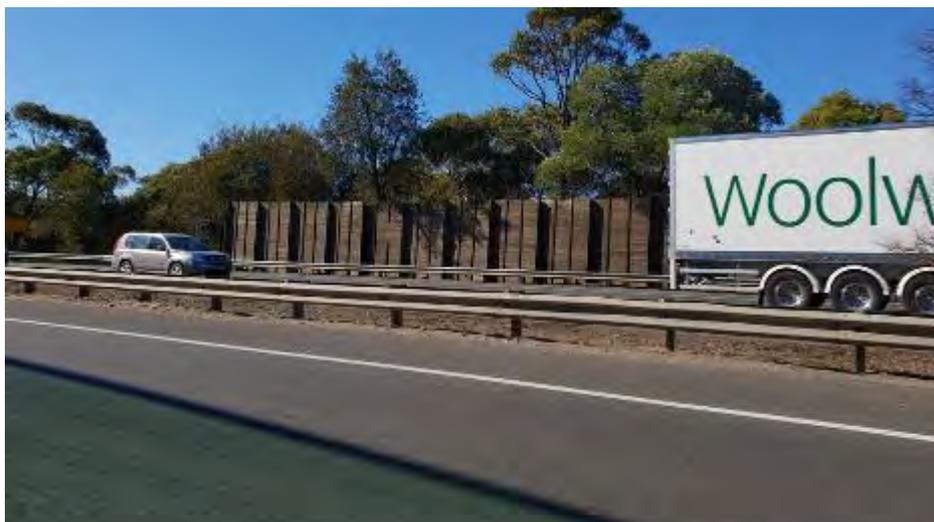
Initially this may require projects to focus on key areas around known nesting/roosting habitat as well as incorporating roadkill records to identify hot spots.

Aerial pathways and underpasses

Provide passes under roads and aerial pathways across roads (for example ropes, cables and glide poles) to help keep prey off roads and so reduce the risk of car strike for both prey and Powerful Owls [57] [58].



Aerial rope crossings are designed to keep possums and hence Powerful Owls off the road and reduce the risk of them being hit by cars



Sound and wildlife barriers along busy roads should be higher than the average truck and continued across flight ways in valleys to ensure Powerful Owls fly over the trucks and not into them – this fence fails as it too low and not continued through bushland; crossings should also be provided for possums

Children

Includes schools, preschools, guides, scouts, discovery and environmental centres, local government.

Powerful Owls face a high risk of extinction (see p 1). It is up to all of us to protect and improve their habitat to ensure their survival.

Encourage schools to provide permanent conservation for patches of remnant forest that support suitable habitat.

Help children protect existing trees, design gardens, plant and maintain trees and shrubs in and around schools and halls.

Engage children in regeneration projects in the community.

Demonstrate the links between plants, possums, flying-foxes and Powerful Owls.

Use the Powerful Owl Education Kit available from Birdlife Australia by request and download the accessory resources from the Powerful Owl Project website [17].

Become involved in activities that promote the conservation of native fauna and their habitat, such as the Threatened Species Children's Art Competition [59].



This new habitat garden in a primary school incorporates all the right elements: understorey, native shrubs including Tea-trees and trees for the future which will form a linkage to the existing trees in the background



Children love owls and often see them in a different way to adults. Image by a talented young artist from the Threatened Species Art Competition

Ecologists and Students

Includes ecologists; biodiversity offset scheme certifiers; high school, TAFE and university students.

Powerful Owls face a high risk of extinction (see p 1). It is up to all of us to protect and improve their habitat to ensure their survival.

Powerful Owls are a useful management species at many levels – flagship, indicator, umbrella, apex predator, focal and landscape.

They are good indicator species for the health of forests and urban areas. While direct measurement [60] of trees and dense shrubs by aerial imagery may be easier, these images give a static view of vegetation complexity.

Powerful Owls give an indication of the intricacy of life from the canopy to the soil and more importantly the ecosystem functions. These functions are the complex workings of an ecosystem, such as nutrient cycling (food production, through to decomposition), water cycling, soil formation, disturbance, predation, dispersal and pollination [30].

Powerful Owls are an umbrella species, a species that gives protection to other species simply by its conservation [18]. This is now considered a simplistic concept [18] but conservation of Powerful Owls will certainly protect moist, sheltered, upper gullies, forests in bushland and trees in gardens as well as large foraging areas. Habitat for species such as Crimson Rosellas (large hollows), Rufous

Whistlers (moist shaded understorey along gullies) and creeks for Water Dragons will therefore be protected.

Powerful Owls are also an apex predator and their presence or absence can alter the functioning of an ecosystem; they are therefore a keystone species [18] as they have a disproportionately large effect on species below them in the food chain.

Focal species [60] are sensitive to a threatening process; in the case of Powerful Owls it is the ‘historical loss and fragmentation of suitable forest and woodland habitat from land clearing for residential and agricultural development’ [6]. If their population decreases, perhaps to local extinction, it will indicate that numbers of other species may also be decreasing.

Powerful Owls could also be considered a landscape species; ‘species that use large ecologically diverse areas and often have significant impacts on the structure and function of natural ecosystems’ [18].

Landscape-managed species are best assisted by addressing threats such as habitat loss or degradation within a landscape. This is because these species are often widely distributed, highly mobile or dispersed, or affected by landscape-scale threats [4].

Get the correct training to be able to understand and assess the impacts of small and large scale alterations to the landscape. Powerful Owls need experts with specific knowledge to provide advice on vegetation management.



Eastern Water Dragon habitat is protected by the preservation of Powerful Owl habitat

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