PART B

ACTION PLANS

YELLOW BOX–BLAKELY'S RED GUM GRASSY WOODLAND

ENDANGERED ECOLOGICAL COMMUNITY

DRAFT ACTION PLAN

PREAMBLE

Yellow Box-Blakely's Red Gum Grassy Woodland was declared an endangered ecological community on 19 May 1997 (Instrument No. DI1997-89 *Nature Conservation Act 1980*; Appendix A).

Under section 101 of the *Nature Conservation Act 2014*, the Conservator of Flora and Fauna is responsible for preparing a draft action plan for listed ecological communities. The first action plan for this ecological community was prepared in 1999 (ACT Government 1999). This revised edition supersedes all previous editions.

In this action plan, '*Endangered YB-BRG Woodland*' refers specifically to remnants of the federally listed (EPBC Act 1999) Yellow Box-Blakely's Red Gum Grassy Woodland endangered ecological community. Reference to '*YB-BRG Woodland*' encompasses areas of Yellow Box-Blakely's Red Gum Grassy Woodland that may not meet all criteria for listing as an endangered ecological community, but contain critical components of the community, thereby retaining biodiversity values worthy of management action.

Measures proposed in this action plan complement those proposed in the action plans for Natural Temperate Grassland, and for component threatened species that occur in Box-Gum woodland: Small Purple Pea (*Swainsona recta*), Superb Parrot (*Polytelis swainsonii*), and Tarengo Leek Orchid (*Prasophyllum petilum*), available at the ACT Government's Environment website.

CONSERVATION STATUS

Yellow Box-Blakely's Red Gum Grassy Woodland is declared a threatened ecological community according to the following legislation:

National

Environment Protection and Biodiversity Conservation Act 1999 (Critically Endangered).

Australian Capital Territory

Nature Conservation Act 2014 (Endangered).

New South Wales

Biodiversity Conservation Act 2016 (Endangered).

CONSERVATION OBJECTIVES

The overarching goal of this action plan is to conserve Endangered Yellow Box-Blakely's Red Gum Grassy Woodland (hereafter *Endangered YB-BRG Woodland*) in perpetuity as a viable ecological community across its geographic range in the ACT. This includes managing and restoring natural ecological and evolutionary processes within the community. Objectives of the action plan are to:

1. **protect remaining areas of Endangered YB-BRG Woodland from unintended impacts**
2. **maintain the ecological values of Endangered YB-BRG Woodland to promote ecosystem function and prevent biodiversity loss, including maintaining:**
    - **understorey structural and floristic diversity in Endangered YB-BRG Woodland**
    - **optimal habitat for threatened species, including keystone structures**
3. **improve the condition and ecological function of Endangered YB-BRG Woodland by undertaking restoration**
4. **improve understanding of Endangered YB-BRG Woodland ecology, restoration principles and best practice threat management**
5. **strengthen stakeholder and community collaboration in the conservation of Endangered YB-BRG Woodland.**

COMMUNITY DESCRIPTION AND ECOLOGY

DEFINITION AND DESCRIPTION

The distribution of Yellow Box-Blakely's Red Gum dominated woodland in the ACT has declined by approximately 66% since 1750 (TSSC 2006; see Figure 1 for current distribution). The endangered YB-BRG Woodland community in the ACT meets the IUCN classification as an endangered ecological community and is a component of the federally listed, critically endangered *White Box-Yellow Box-Blakely's Red Gum Grassy Woodland*.

Endangered YB-BRG Woodland is characterised by a discontinuous stratum of trees of medium height (10-35 m) with canopies that are separated and with 4-30% foliage cover. The community is dominated by Yellow Box (*Eucalyptus melliodora*) and/or Blakely's Red Gum (*Eucalyptus blakelyi*); Apple Box (*Eucalyptus bridgesiana*) and Candlebark (*Eucalyptus rubida*) are the most common co-dominant trees.

Endangered YB-BRG Woodland is characterised by a species-rich understorey of native tussock grasses, herbs and scattered shrubs. Remnants of the community in good condition have a ground cover dominated (50% or more of the perennial species) by native grasses and forbs. The ground cover of remnants in lower condition may not be dominated by native species, yet retain a canopy of mature trees (20 or more per hectare on average) and/or support natural regeneration. Derived grasslands (also known as secondary grassland) are an expression of the Endangered YB-BRG Woodland that develop when the tree canopy cover is removed (or suffers dieback), but a relatively diverse understorey remains intact. The size of YB-BRG Woodland remnant patches varies, but to be listed as part of the endangered ecological community a patch must be at least 0.1 ha.

Endangered YB-BRG Woodland provides important habitat for a range of flora and fauna, including rare and threatened species (Table 1). Woodland areas that provide critical habitat for threatened species include: Mulligans Flat Nature Reserve (NR), Goorooyarroo NR, lower slopes of Mount Ainslie NR, Callum Brae NR, Kinlyside NR, Castle Hill, Tharwa, Upper Naas Valley, Newline Quarry, and Dunlop NR. Remnants of YB-BRG Woodland, including those in poorer condition, contain habitat attributes that support a diversity of fauna associated with, or dependant on, woodland ecosystems. Small patches are considered important if they retain a groundcover dominated by native species and a canopy dominated by Yellow Box or Blakely's Red Gum, especially where mature trees are present. Maintaining and enhancing habitat features and keystone structures, including tree hollows, leaf litter, coarse woody debris, mistletoe, and bark complexity, contributes to the maintenance of biodiversity and on-going ecosystem function of YB-BRG Woodland in poorer condition.

DISTRIBUTION

In the ACT, Endangered YB-BRG Woodland occurs across several land tenures, including land managed by the ACT Government (e.g. reserves and urban open space), the Commonwealth Government, and private land holders (e.g. rural lease and agistment properties). The community persists on low-lying undulating plains in the north, and the rolling hills and valleys of the Naas Valley. Patches of YB-BRG Woodland persist at altitudes of 625 - 800 m above sea level and encompass two woodland communities described by Armstrong et al. (2013). These are: (1) *Blakely's Red Gum – Yellow Box ± White Box tall grassy woodland of the Upper South Western Slopes and western South Eastern Highlands bioregions*, commonly occurring on flat, fertile soils; and (2) *Yellow Box – Apple Box tall grassy woodland of the South Eastern Highlands bioregion*, occurring on similar soil types as (1), but along steeper well-drained slopes.

Aerial photography has been used to map vegetation communities in the ACT. A number of the characteristics required to determine if areas meet the definition of the Endangered YB-BRG Woodland community (see above) are not discernible using this method (e.g. ground cover composition). Therefore, Figure 1 illustrates the potential distribution of Endangered YB-BRG Woodland in the ACT (21,974 ha). It incorporates woodland between 625 and 800 metres above sea level, with a canopy dominated by Yellow Box and/or Blakely's Red Gum (and associated trees) and/or a groundcover dominated by native species. Field inspection is required to confirm the true distribution of Endangered YB-BRG Woodland within this range.

Figure 1. Potential distribution of the Endangered Yellow Box-Blakely's Red Gum Grassy Woodland Community.

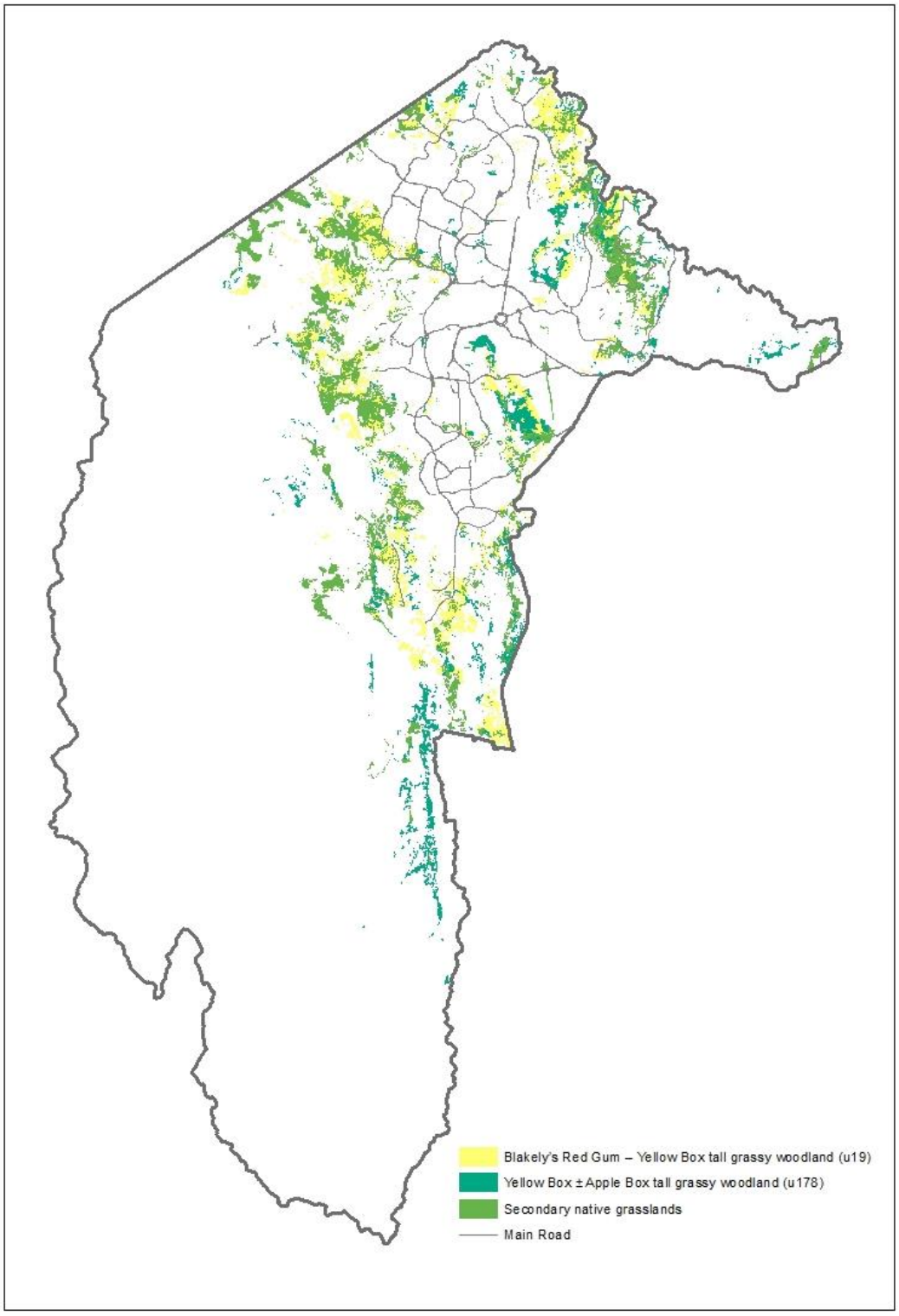

Table 1. Species associated with woodlands in the ACT that are listed as threatened under the *EPBC Act 1999* and/or the *Nature Conservation Act 2014*, and their frequency of occurrence in potential Endangered Yellow Box-Blakely's Red Gum Grassy Woodland (EEC).

Species	Status	Sightings in EEC (%)
Tarengo Leek Orchid (*Prasophyllum petilum*)	Endangered	100
Swift Parrot (*Lathamus discolor*)	Vulnerable	43
Pink-tailed Worm-lizard (*Aprasia parapulchella*)	Vulnerable	38
White-winged Triller (*Lalage sueurii*)	Vulnerable	36
Varied Sittella (*Daphoenositta chrysoptera*)	Vulnerable	35
Canberra Spider Orchid (*Caladenia actensis*)	Endangered	32
Regent Honeyeater (*Anthochaera phrygia*)	Endangered	31
Hoary Sunray (*Leucochrysum albicans* var. *tricolor*)	Endangered	27
Brown Treecreeper (*Climacteris picumnus*)	Vulnerable	26
Painted Honeyeater (*Grantiella picta*)	Vulnerable	25
Superb Parrot (*Polytelis swainsonii*)	Vulnerable	23
Hooded Robin (*Melanodryas cucullata*)	Vulnerable	23
Scarlet Robin (*Petroica boodang*)	Vulnerable	23
Small Purple Pea (*Swainsona recta*)	Endangered	21
Glossy Black-Cockatoo (*Calyptorhynchus lathami*)	Vulnerable	16
Golden Sun Moth (*Synemon plana*)	Endangered	13
Perunga Grasshopper (*Perunga ochracea*)	Vulnerable	12
Austral Toadflax (*Thesium australe*)	Vulnerable	11

PREVIOUS AND CURRENT MANAGEMENT

PROTECT

Nature reserves

A core focus of previous management has been to ensure Endangered YB-BRG Woodland is protected in an adequate, representative, and comprehensive reserve network. The ACT contains some of the largest (> 100 ha) and best connected remnants of good quality box-gum grassy woodland in Australia (ACT Government 2004). The establishment of leasehold title and associated planning policies in the ACT discouraged the adoption of intense pasture improvement techniques that have contributed to YB-BRG Woodland degradation more broadly.

Since the implementation of the *ACT Lowland Woodland Conservation Strategy* (ACT Government 2004), 1,156 hectares of lowland woodland have been formally protected. This includes woodland areas added to the reserve network and/or rezoned to Hills, Ridges or Buffers under the *Territory Plan 2008* (Table 2). Objectives outlined in the *Territory Plan 2008* for Hills, Ridges and Buffers seek to conserve environmental integrity, natural heritage resources, natural habitats, and wildlife corridors. The total area of lowland woodland managed for conservation in the ACT is 5,371 hectares.

Environmental offsets

Under the *Environmental Protection Biodiversity Conservation* (EPBC) *Act 1999*, the ACT Government is committed to assess and offset direct impacts to Endangered YB-BRG Woodland from development. Commonwealth approval is required for any action that may significantly impact Endangered YB-BRG Woodland, or threatened species associated with YB-BRG Woodland. Environmental offset requirements for endangered ecological communities in the ACT are outlined in the *ACT Environmental Offsets Policy 2015*. Offset areas are managed for conservation, often for a net gain in biodiversity outcomes. Avoidance, mitigation, and offset measures detailed in offset packages approved by the Commonwealth Government meet requirements for the protection of *Matters of National Environmental Significance* (*2013*) under the *EPBC Act 1999*.

Prior to 2012, assessment of ecological values impacted by development were largely undertaken on a site-by-site basis. However, since 2012, the ACT Government also undertakes *strategic assessments* to examine the ecological values of future development areas, and considers the cumulative environmental impacts of ongoing development in the areas. Strategic assessment areas where Endangered YB-BRG Woodland has been identified include Gungahlin, Molonglo Valley, West Belconnen, and Eastern Broadacre (ACT Environmental Offsets Register). Strategic assessments result in environmental protection across landscapes and contribute to sustainable development. The *EPBC Offsets Policy 2012* and *ACT Environmental Offsets Policy 2015* has resulted in reduced clearing and increased protection for Endangered YB-BRG Woodland due to offset requirements (Table 2). Many environmental offset sites are added to the ACT reserve network.

Table 2. Patches of Endangered Yellow Box-Blakely's Red Gum Grassy Woodland that have received protection status in the ACT since implementation of the ACT Lowland Woodland Conservation Strategy.

Location		Management
Mount Mugga Mugga		Nature Reserve
Goorooyarroo		Nature Reserve
Kenny		Environmental Offset
Molonglo Valley Strategic Assessment		Environmental Offset
Gungahlin Strategic Assessment	Kinlyside	Environmental Offset
	Throsby	Environmental Offset
	Horsepark North	Environmental Offset
	Jacka	Environmental Offset
	Taylor	Environmental Offset
	Kenny broadacre	Environmental Offset
Isaacs Ridge		Environmental Offset
The Pinnacle		Environmental Offset
Justice Robert Hope Park		Environmental Offset
Bonner		Environmental Offset
Williamsdale		Environmental Offset

MAINTAIN

Maintaining the extent and condition of Endangered YB-BRG Woodland requires active monitoring and management of threatening processes. The ACT Government conducts monitoring of Endangered YB-BRG Woodland communities to track ecological condition and better understand threats and management outcomes. Monitoring occurs at 104 sites located in box-gum woodland across the ACT, of which 75 sites are located in Endangered YB-BRG Woodland. Woodland monitoring focuses on trends in vegetation structure and floristic diversity to determine whether management actions are maintaining or enhancing ecological values.

Management practices that aim to maintain woodland condition have focused on reducing intense grazing pressure, controlling invasive species, and maintaining habitat for threatened species.

Grazing pressure

The ACT Government invests significant resources into monitoring and managing the impacts of grazing (predominantly by Eastern Grey Kangaroo [*Macropus giganteus*] and European Rabbit [*Oryctolagus cuniculus*]) grazing on vegetation and wildlife in YB-BRG Woodland. Ecological field data on kangaroo densities, pasture growth, floristic diversity, and other habitat features are used to build predictive models of appropriate site-level kangaroo densities to maintain ecological values. Complementary research on faunal responses to kangaroo grazing indicates that a mosaic of grass structures is necessary to maintain native fauna diversity across landscapes (Howland et al. 2014, 2016). Kangaroo grazing pressure in YB-BRG Woodland is managed according to this aim; specific actions and policies are outlined in the *ACT Kangaroo Management Plan 2010.*

Rabbit control measures can include harbour removal, warren ripping, fumigation and poison baits. Rabbit control is particularly important in areas targeted for revegetation with direct seeding and tube stock planting.

Invasive species

Invasive species management in the ACT is guided by the *ACT Weeds Strategy 2009-2019* and the *ACT Pest Animal Strategy 2012-2022*. An important focus of management is the establishment of priorities for invasive species control to assist in the allocation of limited resources. In YB-BRG Woodland, priorities for managing invasive plants include controlling, and preventing the further spread of, highly invasive species such as Chilean Needlegrass (*Nassella neesiana*), Serrated Tussock (*Nassella trichotoma*), African Lovegrass (*Eragrostis curvula*), and St John's Wort (*Hypericum perforatum*). The ACT Government and ParkCare also undertake removal of woody weeds, including Cootamundra Wattle (*Acacia baileyana*), Blackberry (*Rubus fruticosus* aggregate), and Sweet Briar (*Rosa rubiginosa*).

There has been an overall reduction of weeds in ACT woodland areas, due to targeted efforts within Canberra Nature Park. For example, in 2015-2016, targeted control resulted in a total of 3,600 ha of invasive plants being treated (predominantly African Lovegrass, Serrated Tussock, and St John's Wort), and early invader work resulted in outbreaks of Fireweed (*Senecio madagascariensis*) and Mexican Feather Grass (*Nassella tenuissima*) being contained at urban locations adjacent to grassy woodland.

Invasive animals prioritised for control in YB-BRG Woodland include European Red Foxes (*Vulpes vulpes*), and Feral Cats (*Felis catus*), which are major predators of wildlife occurring in this community. Some research and control measures are implemented by the ACT Government and community groups (e.g. Canberra Indian Myna Action Group) to better understand and limit the impact of exotic species that compete with native fauna for nesting hollows and roost sites, such as the Common Myna (*Acridotheres tristis*) (Grarock et al. 2012) and European Honey Bee (*Apis mellifera*).

Threatened species habitat

Woodland-dependent threatened species and vulnerable fauna communities are monitored across a range of YB-BRG Woodland patches. For example, long-term monitoring programs for woodland birds, implemented by the Australian National University and Canberra Ornithologists Group, are active on Canberra Nature Parks and private land to determine the conservation status (including trends in abundance and distribution) of vulnerable avifauna. The ACT Government has also supported extensive

ecological research into the habitat requirements of YB-BRG Woodland flora (Johnson et al. 2018) and fauna (e.g. Howland et al. 2014; Ikin et al. 2014; Le Roux et al. 2016), including threatened species (e.g. Rayner et al. 2016), to identify critical habitat resources. Details for monitoring actions undertaken for woodland-dependent threatened species are provided in the respective action plans.

Climate change

The ACT Government has conducted an assessment of biodiversity refugia in the ACT region (MacKenzie et al. 2018) to identify locations where regional native plant species are likely to persist under future climate change. Species distribution models are based on climate scenarios proposed by the NSW and ACT Regional Climate Modelling (NARCliM) project. Results of the study provide guidance to practitioners on where to protect and manage YB-BRG Woodland and component species for their long-term persistence within the ACT.

IMPROVE

Evidence-based ecological restoration has been a strong focus of Endangered YB-BRG Woodland management. Improvements to the extent, condition, and connectivity of YB-BRG Woodland have been delivered through The ACT Woodland Restoration Project and Biodiversity Fund Project, and Environmental Offset restoration operations (ongoing). These projects aim to improve woodland condition and connectivity using a whole-of-landscape approach.

To contribute to the adaptive management of YB-BRG Woodland, the ACT Government has supported research on woodland restoration (e.g. Manning et al. 2011, Johnson et al. 2018), connectivity (e.g. Drielsma et al. 2007), and threat assessment (e.g. Cowood et al. 2018). In the ACT, restoration of YB-BRG Woodland has focussed primarily on revegetation, understorey rehabilitation, and structural enhancement.

Revegetation

Revegetation works in the ACT have been undertaken to address multiple YB-BRG Woodland conservation aims, including: increasing extent of the community, reversing tree loss, maintaining appropriate stand densities, enhancing landscape connectivity, promoting threatened species habitat, retaining genetic integrity, controlling soil erosion, and restoring plant diversity. Extensive revegetation has occurred over the past 5 years in Greater Goorooyaroo (in the ACT and NSW), Lower Cotter Catchment, the Murrumbidgee River Corridor, Pinnacle Nature Reserve, Justice Robert Hope Park and Mulligan's Flat Nature Reserve. Future priority landscapes are in rural areas.

Understorey rehabilitation

Understorey plants play a critical role in maintaining and enhancing the ecological function of woodlands. The ACT Government has supported research trials of methods to restore the native herbaceous ground layer where plant diversity is highest (Zerger et al. 2011). The ACT Government also undertakes management activities such as weed removal, slashing (to reduce biomass of exotic dominants and reduce standing nitrogen), fire management, ecological scrapes (to remove nutrient-rich topsoil before reseeding), and direct seeding of native grasses and forbs. Research from Kama Nature Reserve has shown that native forb enhancement via direct seeding is a viable technique, provided that sufficient quantities of seed are used, excess litter is removed, soil fertility is low, and competition is reduced (Johnson et al. 2018).

Structural enhancement

Vast areas of woodland have been degraded through human activities such as tree removal and firewood collection. Such activities simplify community structure and can compromise ecological function. Logs and tree hollows are two key elements of ecosystem structure that are critical to the maintenance of biodiversity (Barton et al. 2011; Manning et al. 2013; Gibbons and Lindenmayer 2002).

Research from the Mulligans Flat-Goorooyarroo Woodland Experiment has been instrumental in guiding the scale and placement of coarse woody debris for the enhancement of YB-BRG Woodland. Over 4,000 tonnes of coarse woody debris have been added to ACT woodland areas, primarily to improve reptile and

invertebrate habitat. Similarly, to address the loss of habitat values associated with mature trees (including carved hollows and artificial bark), the addition of vertical structures enriched with fauna habitat is being trialled in the Molonglo Valley. Monitoring is underway to evaluate their effectiveness.

COLLABORATE

The ACT community plays a significant role in the protection and restoration of YB-BRG Woodland in the ACT. For over 30 years, community members have made significant contributions to woodland threat management (e.g. weed removal and grazing control), restoration actions (e.g. revegetation and erosion treatment), and biodiversity monitoring (e.g. *Vegwatch* and woodland birds). In particular, community groups such as Greening Australia, ParkCare, Friends of Grasslands, Canberra Ornithologists Group, and the Molonglo, Ginninderra and Southern ACT Catchment Groups, considerably extend the capacity for woodland management through public outreach and the coordination of volunteer effort.

The ACT community also make major contributions towards woodland conservation through advocacy, education and communication. For example, the Conservation Council has established *Bush on the Boundary* groups that bring together government and non-government stakeholders with an interest in conserving the integrity of ecosystems located on the urban fringe. Important educational advances have also resulted from the establishment of the Southern Tablelands Ecosystems Park within the National Arboretum, and the Canberra Nature Map website, where the public can share knowledge of native flora and fauna occurring within YB-BRG Woodland.

Positive outcomes for the protection and restoration of YB-BRG Woodland have and will continue to come from collaborative land management partnerships with traditional owners. For example, the *Caring for Ngunnawal Pathways* project, developed by the Molonglo Catchment Group (in partnership with Buru Ngunnawal Aboriginal Corporation, Thunderstone Aboriginal Cultural and Land Management Services, Friends of Grasslands, Save Stirling Park, Yarralumla Residents Association, and the ACT Government) facilitates Ngunnawal leadership in the environmental restoration of a culturally and ecologically important site at Yarralumla called *Bullan Mura*.

Over 40% of ACT lowland woodland communities occur on rural land, making respectful and innovative collaboration with private landholders pivotal to achieving regional conservation goals. Rural landholders have collaborated with the ACT Government to implement a range of projects on their properties, including those that aim to achieve sustainable agriculture and woodland conservation outcomes. For example, in collaboration with 18 rural landholders and a number of community and volunteer groups, the Woodland Restoration and Biodiversity Fund Project enhanced woodland connectivity and condition across all land tenures.

THREATS

Nationally, the primary threats to temperate woodland ecosystems include clearing, grazing, weed invasion, salinity, nutrient enrichment, deteriorating soil condition, altered fire regimes, and the effects of fragmentation and climate change. In the ACT, the key threats to YB-BRG Woodland are urbanisation, inappropriate disturbance regimes, invasive plants, pest animals, eucalypt dieback, and climate change.

URBANISATION

In south-eastern Australia, grassy woodland ecosystems have been extensively and disproportionately cleared for agriculture and urban development, and what remains is highly modified and fragmented. In the ACT, ongoing loss and fragmentation of woodland vegetation is driven primarily by urbanisation. Most of the remaining Endangered YB-BRG Woodland in the ACT occurs in the northern half of the Territory (Figure 1) where low-lying, open country, close to existing human infrastructure, is favoured for ongoing urban development and expansion.

While significant ecological value may be retained by small woodland patches (Fischer and Lindenmayer 2002; Eldridge and Wong 2005) and scattered or isolated remnant trees (Manning et al. 2006; Fischer et al. 2010; Le Roux et al. 2018), fragmentation may reduce structural connectivity and habitat condition that facilitates foraging and dispersal movements by species, and population gene flow (Doerr et al. 2014). In turn, this compromises the population viability of plants and animals (e.g. Amos et al. 2014). In

addition, overall habitat loss may limit species persistence such that efforts to improve landscape connectivity for particular species or taxa could be ineffective (Mortelliti et al. 2010). The predicted impacts of climate change will further exacerbate the impacts of fragmentation on species because small and isolated populations will be less able to adapt to change, or to track critical habitat resources and locally favourable bioclimatic conditions (Doerr et al. 2014).

Urbanisation also has the potential to degrade YB-BRG Woodland, and the effects of disturbance may be greatest proximal to urban areas. Urbanisation can reduce the condition of YB-BRG Woodland and disrupt ecological function through direct human disturbance (e.g. high visitation, track creation), habitat modification (e.g. firewood and rock removal), poaching (i.e. illegal plant and animal collection), nutrient enrichment (e.g. urban run-off), pollution (e.g. noise, light), biotic homogenisation (i.e. the loss of habitat specialists), altered fauna communities (including predator and competitor abundances), altered hydrology, and increased pest invasion (plants and animals) (Alberti 2005). Management of urban-related threats to YB-BRG Woodland condition and biodiversity require sensitive and strategic management, particularly in woodland remnants located on the urban fringe (Ikin et al. 2015).

INAPPROPRIATE DISTURBANCE REGIMES

Grazing

Inappropriate grazing regimes – characterised by the frequency, timing, and intensity of grazing – can cause significant disruption to plant communities, fauna habitat, and ecosystem processes in grassy woodland communities (Eldridge et al. 2016). Regardless of the dominant herbivore (native species or livestock), heavy grazing regimes negatively impact groundlayer structure (e.g. litter removal and tussock loss; McIntyre et al. 2015), native plant richness (Dorrough et al. 2012), fauna and their habitat (Lindenmayer et al. 2018; Lindsay and Cunningham 2009), regeneration and recruitment potential (Sato et al. 2016), and soil condition (Close et al. 2008). Inappropriate grazing regimes can also exacerbate other woodland threats. For example, groundlayer disturbance and soil nutrient enrichment associated with livestock grazing can facilitate weed invasion and reduce overstorey tree health (Close et al. 2008; Pettit et al. 1995).

Where grazing pressure is moderated, woodland condition can improve. Improvements include more abundant, diverse and healthy native plant flora, and improved ecosystem function through, for example, increased rates of litter decomposition (Lindsay and Cunningham 2009). However, the impacts of inappropriate grazing regimes and the outcomes of grazing control, are dependent on climate and other site-level factors (e.g. fertilisation history, exotic plant competition and microsite conditions). These factors must be considered and managed (where possible) to achieve positive conservation outcomes for Endangered YB-BRG Woodland (Dorrough et al. 2011, Driscoll 2017; Prober et al. 2011; Sato et al. *in review*; Yates et al. 2000).

Fire

Fire regimes are characterised by the frequency, intensity and season of burning. Inappropriate fire regimes can cause significant disruption to plant communities, fauna habitat, and ecosystem processes in grassy woodland communities (Driscoll et al. 2010). The most immediate and visible threat to Endangered YB-BRG Woodland from inappropriate fire regimes occurs in the understorey. Excessively frequent fires simplify woodland ecosystems by reducing the density and viability of native plant communities, and destroying groundlayer habitat elements (e.g. fallen timber, leaf litter). If fire is too infrequent, the woodland understorey can become structurally dense (Close et al. 2011; Wilson et al. 2018) and floristically homogenous (Penman et al. 2011). In turn, this alters groundlayer microclimates and limits regeneration niches (Bailey et al. 2012).

Severe fires can kill native vegetation, including overstorey trees. The loss of young trees and seedlings can stunt recruitment and bias the age structure of stands. The loss of mature trees can reduce the carbon-storage and water-production potential of the ecosystem (Keith et al. 2017), increase midstorey regeneration and fire fuel loads (Wilson et al. 2018), and decrease habitat availability and diversity (e.g. destroying tree hollows; Stojanovic et al. 2016). Further, inappropriate fire regimes may impact woodland condition indirectly through altered water- and nutrient-relations. For example, Close et al. (2011)

suggest that water-use efficiency, foliar nutrients, and crown health of woodland eucalypts is influenced by fire-governed understorey conditions. Weather patterns, especially precipitation, will also influence the impacts of fire frequency and severity on woodland vegetation (Hill and French 2004).

INVASIVE PLANTS

Invasive plants that threaten the condition of Endangered YB-BRG Woodland include exotic grasses (e.g. Chilean Needlegrass, Serrated Tussock and African Lovegrass), exotic forbs (e.g. St John's Wort and Paterson's Curse [*Echium plantagineum*]), exotic shrubs (e.g. Blackberry), and native invasive scrub ('woody weeds', e.g. Cootamundra Wattle). Invasion is driven by resource availability and is commonly associated with disturbance. If invasive plants are left untreated, native plant communities can be transformed into exotic pastures that further fragment the ecological community. In turn, this can lead to significant biodiversity loss, particularly in the herbaceous ground layer where plant diversity is greatest (Zerger et al. 2011).

Effective restoration of YB-BRG Woodland that achieves a species-rich native understorey is impeded by limited scientific understanding of the mechanisms that bolster a plant community's resistance to weed encroachment (Prober and Wiehl 2011). Competitive exclusion by exotic species and by native swards can inhibit efforts to restore diverse native plant communities (Lindsay and Cunningham 2011). Hence, management of herbivore grazing and soil nutrient loads, and consideration of the disturbance history of a given site, is critical to providing native plant communities with a competitive advantage over exotic invaders (Prober and Wiehl 2011; Driscoll 2017).

PEST ANIMALS

Pest animals that occur in YB-BRG Woodland include over-abundant and introduced herbivores (e.g. Eastern Grey Kangaroo and European Rabbit), introduced predators (e.g. European Red Fox, Feral Cat), introduced habitat competitors (e.g. Common Myna, Common Starling [*Sturnus vulgaris*]) and native habitat competitors (e.g. Noisy Miner [*Manorina melanocephala*] and Rainbow Lorikeet [*Trichoglossus moluccanus*]). The impacts of pest animals on woodland communities have been widely documented, with the management of habitat structure a re-occurring theme in abatement (e.g. Allcock and Hik 2004; Stokes et al. 2004; Pickett et al. 2005; Maron 2007). Currently, there is limited understanding of the relationship between pest animal densities and their impacts on YB-BRG Woodland to inform targeted management action.

DIEBACK

Dieback of native eucalypts is widespread across south-eastern Australia; woodlands across the Tablelands of NSW and the ACT are severely affected (ACT Government 1999). Trees suffering from dieback typically have smaller, sparse crowns with a high proportion of dead branches and epicormic foliage (Lynch et al. 2017). This episodic, and typically dramatic, decline in crown health can lead to extensive tree mortality in woodland communities (e.g. Ross and Brack 2015).

Dieback is generally attributed to over-abundant insect populations (e.g. psyllids [*Glycaspis* spp.]) and exotic plant pathogens (e.g. *Phytophthora cinnamom*) (Jurskis 2005; O'Gara et al. 2005). However, the cause and primary stressors of dieback are poorly understood and include multiple, interacting factors such as drought, human-related disturbance, altered fire regimes, loss of understorey vegetation, water-logged or nutrient-enriched soils, and depauperate insectivore/predator communities (Jurskis 2005; Wardell-Johnson and Lynch 2005; NSW TSSC 2008, ACT Legislative Assembly 2017). Dieback effects are particularly relevant to Endangered YB-BRG Woodland because Blakely's Red Gum trees are disproportionately affected in the ACT region. Recent modelling indicates that the change in condition of Blakely's Red Gum and YB-BRG Woodland in the ACT between 2004 and 2017 was influenced by a range of habitat (e.g. soil characteristics and water table height), climate (e.g. seasonal precipitation) and cohort (e.g. tree canopy density) variables (Cowood et al. 2018). The impacts of dieback will be exacerbated by more extreme weather events associated with climate change (Ross and Brack 2015).

CLIMATE CHANGE

Climate change has become a significant emerging challenge in the conservation and management of natural ecosystems and biodiversity (Williams et al. 2014). Predicted impacts of climate change in the ACT region include (but are not limited to) increased maximum temperatures, prolonged drought**,** reduced soil moisture, increased intensity of heavy rainfall events, and harsher fire-weather climate (Timbal et al. 2015). As a consequence, climate change is likely to alter the structure and floristic composition of Endangered YB-BRG Woodland and compromise the resilience of grassy woodland communities. Fragmented systems are the most susceptible to condition decline (Brouwers et al. 2013), and degraded systems are likely to be the least equipped to adapt (Prober et al. 2012a). Furthermore, it is likely that climate change effects will interact with, and potentially exacerbate, other threatening processes, such as fire and dieback.

Actions to enhance the long-term ecological integrity of Endangered YB-BRG Woodland must involve protection of climate refugia, as well as the management and restoration of extant YB-BRG Woodland remnants to safeguard and prepare future potential colonisation sites. Ameliorating climate change driven biodiversity loss in YB-BRG Woodland is likely to require innovative solutions that may challenge traditional approaches to conservation management (e.g. assisted colonisation; McIntyre 2011), but are critical to achieving adaptive ecological management in what may soon be novel environments.

CONSERVATION ISSUES AND INTENDED MANAGEMENT ACTIONS

PROTECT

Patches of Endangered YB-BRG Woodland occurring in the ACT require formal protection to increase the extent, and improve the condition of the community. More degraded remnants of YB-BRG Woodland require formal protection if they support threatened species, or if they contribute to buffering, connecting or extending patches of the Endangered YB-BRG Woodland. Environmental assessments and other statutory processes are used to determine which areas are assigned formal protection.

Unintended impacts (those not already considered through an environmental assessment or other statutory process) can reduce the extent, condition and function of the Endangered YB-BRG Woodland community. Therefore, a key objective is to **protect all Endangered YB-BRG Woodland from unintended impacts, as well as those areas of YB-BRG Woodland that either contribute to the integrity of the Endangered YB-BRG Woodland community or contain rare and / or threatened species.**

Mapping the condition of large patches of YB-BRG Woodland and those that make a significant contribution to the integrity of the Endangered YB-BRG Woodland community (due either to their position in the landscape [e.g. elevation, ecological buffers], regional context [e.g. connectivity], ecological values [e.g. function and species diversity] or restoration potential [e.g. contributing to ecosystem recovery aims]), will assist in future reserve design and the prioritisation of woodland-based conservation action.

MAINTAIN

Conservation of Endangered YB-BRG Woodland requires the maintenance of ecological and evolutionary processes, and the persistence of biodiversity within the community.

It has been suggested that the single most effective management action to protect woodland integrity is to moderate grazing pressure; in particular, to avoid overgrazing (e.g. Weinberg et al. 2011). Fire, applied at low intensity and within ecologically tolerable frequencies, will also contribute to meeting our conservation objectives in Endangered YB-BRG Woodland.

The primary management action, to **implement appropriate grazing and fire management regimes,** demands:

- regular engagement with Australian temperate grassy woodland grazing and fire research

- strategic operations planning coordinated across management teams (including kangaroo population management, livestock conservation grazing, fuel reduction and ecological burning) at local (patches and paddocks), landscape (reserves and farms) and regional (Territory wide) scales
- robust monitoring and evaluation of management actions to determine the outcomes of intervention against stated conservation goals, and to adaptively plan for successive management seasons
- collaboration with non-government stakeholders, in particular Traditional Custodians and rural landholders.

Additionally, as the ACT climate changes, the application of grazing and fire in Endangered YB-BRG Woodland must continue to be informed by an evaluation of management interventions and ecological responses to support ongoing conservation decision-making (e.g. Driscoll et al. 2010; Werner 2012; Gibbons et al. 2018).

Another core management objective in this action plan is to maintain understorey structural and floristic diversity in Endangered YB-BRG Woodland. The greatest loss of biodiversity in woodland communities occurs through the degradation of understorey elements (Zerger et al. 2011). The ACT Government will take action to emphasise the importance of ground layer ecological management in conservation planning, and improve the effectiveness of understorey management operations. The **Woodland Conservation Effectiveness Monitoring Plan (CEMP)** will provide guidance on the development of target values for understorey condition as well as recommendations for appropriate management, and assist in determining if these understorey condition targets are being met and maintained.

Actions outlined above will support the maintenance of threatened species habitat. However, to best serve the population recovery objectives of multiple threatened species, consideration must be given to specific resource requirements of threatened species. At some sites, it may be prudent to advance the persistence of one (or multiple) threatened species to the detriment of another; in such cases, management decisions should be made with consideration for the rarity, habitat specialisation, functional traits, mobility and adaptability of impacted species, as well as their local, regional, and national conservation status.

Large, mature trees are keystone structures in woodland communities. They encourage movement of fauna, which facilitates pollination and seed dispersal (Doerr et al. 2014). They also provide a critical source of seed for recruitment (Vesk et al. 2008), provide abundant breeding, roosting and foraging habitat (Ikin et al. 2013; Le Roux et al. 2018), and enhance critical ecosystem functions (e.g. carbon-storage, water-production; Keith et al. 2017). The *Loss of mature native trees (including hollow bearing trees) and a lack of recruitment* is listed as a key threatening process under the *Nature Conservation Act 2014*. Thus, a critical action for maintaining keystone structures in Endangered YB-BRG Woodland is to **retain mature trees** and their habitat features, even where they may be isolated or occur on poorer quality woodland sites, and **promote appropriate levels of overstorey development.**

IMPROVE

Restoration

High density regeneration or plantings can significantly reduce the growth rate and maturity of woodland trees, delaying the creation of large boughs, tree hollows and fallen timber by decades (Vesk et al. 2008; Killey et al. 2010). Thus, **creating optimal stand densities and maintaining diverse age structure** in Endangered YB-BRG Woodland overstorey vegetation is critical to sustaining woodland biodiversity and may require a combination of planting and thinning operations, as well as efforts to enhance germination and recruitment.

Increased resilience of the Endangered YB-BRG Woodland community can also be achieved through strategic **restoration projects** that enhance ecosystem function. The ACT Government will **develop spatially and temporally explicit revegetation goals** to inform the management of offset areas and other restoration projects implemented by the ACT Government (e.g. the Protecting and Connecting Box-Gum Woodland project). The location and timing of revegetation in Endangered YB-BRG Woodland, and the purpose of restoration will be considered in the development of project specific revegetation guidelines

(e.g. increasing habitat, improving connectivity, and / or restoring soil condition). Consideration will also be given to: (i) landscape context and landuse history of the location, including connectivity (ii) functional traits of planted species, (iii) timeline of successional plantings, and (iv) location of predicted climate refugia (MacKenzie et al. 2018). The ACT Government will aim to support revegetation works across mixed land tenures (Manning et al. 2010), particularly those that may enhance Endangered YB-BRG Woodland climate resilience (Prober et al. 2012b; Hancock et al. 2018). The capacity of natural regeneration to meet restoration objectives that would otherwise be addressed with revegetation should be explored concurrently. Natural regeneration is often cheaper than planting, and typically establishes healthy plants, well-adapted to site-specific conditions (Spooner et. al. 2002; Rawlings et al. 2010).

Research

There remain significant knowledge gaps about how best to manage grazing in Endangered YB-BRG Woodland; particularly, how to balance grazing pressure from native herbivores with controlled conservation grazing by livestock. Effective **guidelines for achieving ecologically sensitive and adaptive grazing regimes** that incorporate both native and introduced herbivores, would be advanced by a robust **evaluation of the conservation outcomes of controlled grazing by different herbivore species**. Evaluating the differences between native and ungulate grazing management outcomes will include ecological (e.g. soil compaction, nutrient enrichment), social (e.g. animal welfare, lethal control), and economic (e.g. fencing and infrastructure) considerations. Further, this evaluation would be supported by long-term monitoring to assess the spatial (e.g. herbivore-related distribution of grazing pressure) and temporal (e.g. natural versus controlled timing of grazing) outcome of experimental grazing regimes.

There is limited knowledge regarding the causes and stressors of dieback in YB-BRG Woodland. This lack of ecological and technical knowledge is recognised as a barrier to effective policy development to mitigate the impacts of dieback (O'Gara et al. 2005). The ACT Government has identified a number of issues that warrant future research, these include studying the interactions between dieback and; fire frequency, landuse, vegetation density, soil moisture and condition, insects and fungal pathogens. The ACT Government has embarked on provenance trials of seeds from Blakely's Red Gum trees that appear to be more resilient to dieback in this region, and those that occur in warmer drier regions that represent the possible future climate of the ACT. However, there are many research questions that need to be addressed to inform the protection of remaining Endangered YB-BRG Woodland remnants from the effects of dieback. Therefore, this action plan seeks to **ensure monitoring of dieback is undertaken and support is provided to projects that improve our understanding of the causes of dieback.**

The ACT Government will **undertake monitoring and support research projects that improve our understanding of the impacts of climate change on the Endangered YB-BRG Woodland.** This includes spatial and ecological modelling of: (i) climate refugia of the community and component species; (ii) future potential colonisation sites; (iii) understorey responses to predicted climate impacts; and (iv) changes to woodland soil condition with drying conditions. Research and monitoring findings will inform the development of climate resilient revegetation principles, and guide future restoration field trials. Important progress is already underway through collaborative projects involving, for example, the Australian Government and CSIRO (Prober et al. 2014a, 2014b, 2015).

The ACT Government will **undertake monitoring and research to improve our understanding of how to successfully restore understorey elements of Endangered YB-BRG Woodland.** There is also a need to **better understand how invasive plants impact efforts to maintain and improve Endangered YB-BRG Woodland condition, and the effectiveness of invasive plant control.** This information will improve projects that aim to enhance YB-BRG Woodland condition and will inform the development of revegetation goals (see above).

COLLABORATE

Ongoing collaboration between the ACT Government and non-government groups (including community groups, conservation organisations, rural land holders, Traditional Custodians and research institutions) is critical to achieving effective conservation of YB-BRG Woodland.

The ACT Government will continue to **facilitate community participation in YB-BRG Woodland conservation.** It will also **continue to refine and develop new ways of collaborating with the community** to ensure that YB-BRG Woodland remains a viable ecological community for future generations. This will be undertaken through, for example, providing volunteering opportunities through the Landcare Gateway and ACT Government's ParkCare Hub. ParkCare programs such as *Ranger Assist* provide opportunities for the public to work directly with Park Rangers in land management roles and involves undertaking activities such as survey data collection, fencing, and digital mapping. Providing support to citizen science programs (such as Canberra Nature Map and other programs delivered by non-government agencies) is another excellent way the ACT Government can enhance community knowledge and participation in conservation.

In collaboration with Greening Australia, Molonglo Catchment Group and rural landholders, the Act Government is implementing the Protecting and Connecting Box-Gum Woodland project. This project aims to enhance and connect Endangered YB-BRG Woodland, including improving conservation outcomes for woodland biodiversity on rural properties. Rural landholders will also collaborate with the ACT Government and CSIRO to host research into the genetic variation of traits that may give Blakely's Red Gum resistance to dieback.

The ACT Government is committed to **working with Traditional Custodians to undertake management in YB-BRG woodlands**. The Murumbung Rangers in the ACT Parks and Conservation Service and the Aboriginal ACT Natural Resource Management Facilitator will provide a key role in raising awareness, appreciation and application of traditional land management. Cultural burns, which employ both traditional and contemporary knowledge are often referred to as 'cool burns' and may be adopted to facilitate cultural renewal, safeguard culturally significant sits and reduce fuel load and risk of high intensity burns in woodlands.

As conservation opportunities and challenges evolve, the need to learn through collaborative research and adaptive management remains critical. Further, new knowledge must be disseminated to the ACT community so that shared protection and restoration priorities can be developed and implemented. The ACT Government will **facilitate open and timely communication of YB-BRG Woodland research findings with the ACT community**. This will involve sharing research findings, as well as undertaking targeted communications to community stakeholders with an interest in woodland conservation. Feedback from the community on research advances will be considered and, where possible, incorporated into future conservation planning for Endangered YB-BRG Woodland.

OBJECTIVES, ACTIONS AND INDICATORS

Table 1 Key objectives, actions and indicators to support the conservation of Endangered Yellow Box-Blakely's Red Gum Grassy Woodland.

Objective	Action	Indicator
PROTECT		
1. Protect remaining areas of YB-BRG Woodland from unintended impacts (unintended impacts are those not already considered through an environmental assessment or other statutory process)	1a. Protect all Endangered YB-BRG Woodland from unintended impacts	All Endangered YB-BRG Woodland are protected from unintended impacts
	1b. Protect YB-BRG Woodlands that make a significant contribution to the integrity of the Endangered YB-BRG Woodland community and/or contain rare or threatened species from unintended impacts	YB-BRG Woodland that contributes significantly to the integrity of the Endangered YB-BRG Woodland community are protected from unintended impacts YB-BRG Woodland areas that support rare or threatened species are protected from unintended impacts
	1c. Map the condition of large patches of YB-BRG Woodland and those that make a significant contribution to the integrity of the Endangered YB-BRG Woodland community	Develop and make publicly available maps of large patches of YB-BRG Woodlands and those that make a significant contribution to the integrity of the Endangered YB-BRG Woodland community
MAINTAIN		
2. Maintain the ecological values of Endangered YB-BRG Woodland to promote ecosystem function and prevent biodiversity loss, including maintaining: • understorey structural and floristic diversity • optimal habitat for threatened species, including keystone structures	2a. Implement appropriate grazing and fire management regimes 2b. Develop and implement the Woodland Conservation Effectiveness Monitoring Program	Monitoring indicates understorey condition targets are consistently being met Monitoring indicates that habitat for threatened species is maintained within range of acceptable variability

Objective	Action	Indicator
	2c. Retain mature trees by protecting them fire, urban and infrastructure development and applying lease conditions	Where appropriate, healthy mature trees, and standing dead trees are retained in YB-BRG Woodland
	2d. Promote appropriate levels of overstorey development in Endangered YB-BRG Woodland	Regeneration of overstorey species is occurring
IMPROVE		
3. Improve the condition and ecological function of Endangered YB-BRG Woodland by undertaking restoration	3a. Create optimal stand densities, and maintain diverse age structure in Endangered YB-BRG Woodland overstorey vegetation	Endangered YB-BRG Woodland remnants are open (4-30% foliage cover), with a distribution of tree ages and sizes
	3b. Develop spatially and temporally explicit revegetation goals (for Endangered YB-BRG Woodland) for restoration projects	Restoration projects for Endangered YB-BRG Woodland are implemented and informed by spatially and temporally explicit restoration goals
	3c. Undertake restoration projects in Endangered YB-BRG Woodland	Monitoring indicates restoration goals for Endangered YB-BRG Woodland are achieved
4. Improve understanding of Endangered YB-BRG Woodland ecology, restoration principles and best practice threat management	4a. Evaluate the conservation outcomes of controlled grazing by different herbivore species in Endangered YB-BRG Woodland	Monitoring indicates conservation values are improving in Endangered YB BRG Woodland
	4b. Continue to adapt guidelines for controlled grazing regimes in Endangered YB BRG Woodland	
	4c. Monitor dieback in Endangered YB-BRG Woodland and support research projects that improve our understanding of the causes of dieback	Knowledge of dieback in Endangered YB-BRG Woodland is enhanced and informs woodland restoration projects
	4d. Undertake monitoring and support research projects that improve our understanding of the impacts of climate change on the Endangered YB-BRG Woodland community	Monitoring and research on the impacts of climate change inform woodland restoration projects

Objective	Action	Indicator
	4e. Undertake monitoring and support research projects that improve our understanding of how to successfully restore Endangered YB-BRG understorey	Monitoring and research on understorey restoration techniques inform woodland restoration projects
	4f. Undertake monitoring and support research projects to improve our understanding of: • the impact of invasive plants on the condition of Endangered YB-BRG • the effectiveness of invasive plant control in maintaining / improving biodiversity values.	Monitoring and research on invasive plants and their control informs the ongoing management woodlands and restoration projects
COLLABORATE		
5. Strengthen stakeholder and community collaboration in the conservation of Endangered YB-BRG Woodland	5a. Work with Traditional Custodians to undertake management in YB-BRG woodlands	Traditional Custodians have participated in activities to manage the conservation and cultural values of YB-BRG woodland Traditional Custodians are satisfied with their level of participation in conservation of YB-BRG Woodland
	5b. Facilitate community participation in YB-BRG Woodland conservation and raise community awareness 5c. Continue to refine and develop new means of collaborating with the community in the conservation of Endangered YB BRG Woodland	The ACT Government has implemented and/or provided support to citizen science and other community programs for the conservation of YB-BRG Woodland The ACT Government has delivered projects in collaboration with rural landholders for YB-BRG Woodland conservation. Community stakeholders are satisfied with their level of participation in conservation of YB-BRG Woodland

Objective	Action	Indicator
	5d. Facilitate open and timely communication of Endangered YB-BRG Woodland research findings with the ACT community	Findings of woodland research are effectively communicated to the community

IMPLEMENTATION

Implementation of this action plan will result in new knowledge about the ecology of Endangered YB-BRG Woodland. This knowledge will recurrently inform conservation advice and the delivery of management actions in Endangered YB-BRG Woodland during the life of the plan. Critical to the effective conservation management of Endangered YB-BRG Woodland will be the timely review of monitoring data that captures ecological responses to proposed management interventions. Toward this aim, the ACT Government commits to the development of the *Woodland Integrated Ecosystem Implementation Plan*, and the *Conservation Effectiveness Monitoring Program for Lowland Woodlands*. These documents will facilitate adaptive management of Endangered YB-BRG Woodland to maximise conservation gains intended from measures proposed in this action plan. Further, implementation of this action plan will require:

- land planning and land management areas of the ACT Government to take into account the conservation of threatened species and communities
- allocation of adequate resources to undertake the actions specified in the strategy and action plans
- liaison with other jurisdictions (particularly NSW) and other landholders (Commonwealth Government) with responsibility for the conservation of the threatened community and component species
- collaboration with universities, CSIRO and other research institutions to facilitate and undertake required research
- collaboration with non-government organisations to undertake on-ground actions
- collaboration with the community, where relevant, to assist with monitoring and other on-ground actions, and to help raise community awareness of conservation issues.

Under s.108 of the *Nature Conservation Act 2014* the Conservator of Flora and Fauna must report to the Minister about each action plan at least once every five years and make the report publicly accessible within 30 days. The Scientific Committee must review an action plan every 10 years, or at any other time at the Conservator's request.

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APPENDIX A

NATURE CONSERVATION ACT (1980) CRITERIA SATISFIED

3.2 The community is subject to current and continuing threats or other processes likely to lead to premature extinction as demonstrated by:

3.2.1 Severe decline in distribution.

3.2.2 Marked alteration of composition or structure.

3.2.3 Community is approaching non-sustainability.

3.2.4 Loss or decline of species that play a major role in community function.

3.2.5 Small distribution causing the community to be at risk of premature extinction.

3.2.6 Community processes being altered to the extent that interaction between the community components will be impeded.

CANBERRA SPIDER ORCHID

Caladenia Actensis

DRAFT ACTION PLAN

PREAMBLE

The Canberra Spider Orchid (*Caladenia actensis*, D. A. Jones & M. A. Clem, 1999 syn. *Arachnorchis actensis*) was declared an endangered species in the ACT on 11 April 2005 (Instrument No. DI2005- 39 under the *Nature Conservation Act 1980*). The species is currently being considered for listing as Critically Endangered under the *Nature Conservation Act 2014.* Under section 101 of the *Nature Conservation Act 2014*, the Conservator of Flora and Fauna is responsible for preparing a draft action plan for listed species. The first action plan for this species was prepared in 2010 (Frawley 2010).

This action plan supersedes the earlier edition.

Measures proposed in this action plan complement those proposed in the action plans for the endangered *Yellow Box-Blakely's Red Gum Grassy Woodland* and component threatened species such as the Tarengo Leek Orchid (*Prasophyllum petilum*), Small Purple Pea (*Swainsona recta*) and Superb Parrot (*Polytelis swainsonii*).

CONSERVATION STATUS

The Canberra Spider Orchid is declared a threatened species in line with the following legislation:

National

Environment Protection and Biodiversity Conservation Act 1999 (Critically Endangered)

Australian Capital Territory

Nature Conservation Act 2014 (Critically Endangered)

Nature Conservation Act 2014 (Special Protection Status Species).

CONSERVATION OBJECTIVES

The objective of this action plan is to preserve the Canberra Spider Orchid in perpetuity in the wild across its natural geographic range in the ACT and contribute to the regional and national conservation of the species.

Specific objectives of the action plan are to:

- protect sites where the species is known to occur in the ACT from unintended impacts
- manage the species and its habitat to maintain the potential for evolutionary development in the wild
- improve the long-term viability of populations through management of woodlands to increase habitat area and connect populations
- expand the range of the species in the ACT by identifying suitable habitat and establishing new populations by translocation
- improve understanding of the species' ecology, habitat and threats
- strengthen stakeholder and community collaboration in the conservation of the species.

SPECIES DESCRIPTION AND ECOLOGY

DESCRIPTION

The Canberra Spider Orchid is a small terrestrial orchid (40-90mm) that may grow as a single plant or in small groups. It has a densely hairy lanceolate-shaped leaf (between 4-9cm long and 0.6-0.8 cm wide) that is dull green with a purple-blotched base. The flowers of the species are solitary (rarely two) and grow to 12–20 mm in diameter. The base of the flower is greenish and is heavily marked with red- crimson lines and suffusions (Jones and Clements 1999). The Canberra Spider Orchid is a seasonal perennial; it remains as a dormant underground tuber over summer and emerges from the ground following good rains in late autumn or early winter. Flower buds appear in late winter or early spring and plants flower from late September to mid-October. Plants are sexually deceptive, imitating female insects by emitting floral volatiles to achieve pollination by a thynnine wasp, nov. gen. (actensis) sp. 1 (Hayashi 2016). To germinate, seeds of the Canberra Spider Orchid are reliant on a symbiotic association with a mycorrhizal fungus of the Serendipita genus (syn. Sebacina vermifera) (C. Linde 2018, personal communication, 31 July). The species depends on the same fungus to supply them with adequate carbon and nutrients (especially phosphorus) throughout their lives (Milburn and Rouse 2004).

DISTRIBUTION

The Canberra Spider Orchid is endemic to the ACT. Until recently, it was only known to occur within a small area (approximately five hectares) on the lower western slopes of Mt Ainslie and Mt Majura in Canberra Nature Park (Milburn and Rouse 2004). Additional populations of the species have been located at these sites, as well as within the Majura Valley (Department of Defence land) and Kowen Escarpment Nature Reserve.

Populations of the Canberra Spider Orchid recorded on Mt Ainslie (in the suburb of Campbell) and adjacent to Old Weetangera Road (to the north of Black Mountain), are no longer present.

A map of the current distribution of the species is available on the ACT Government's mapping portal, ACTmapi.

HABITAT AND ECOLOGY

The Canberra Spider Orchid grows at an altitude of 645 - 745 m, most commonly on the Burra and Campbell soil landscapes. These soil landscapes consist of shallow, well drained Lithosols and Red and Yellow Earths on upper slopes, and moderately deep, moderately drained Red and Yellow Podzolic Soils on lower slopes. The species less commonly occurs on the Queanbeyan and Williamsdale soil landscapes, which comprise moderately well-drained, shallow Lithosols and moderately deep Red and Yellow Podzolic Soils (Jenkins 2000).

The species occurs within a number of vegetation communities across its range; specifically *Blakely's Red Gum – Yellow Box ± White Box tall grassy woodlands of the Upper South Western Slopes and western South Eastern Highlands Bioregions*, *Yellow Box ± Apple Box tall grassy woodland of the South Eastern Highlands* and *Red Stringybark – Scribbly Gum – Red-Anthered Wallaby Grass tall grass-shrub dry sclerophyll open forest on loamy ridges of the central South Eastern Highlands Bioregion* (Armstrong and Turner et al. 2013). Small populations on Mt Ainslie and Mt Majura Nature Reserve occur in *Drooping She-oak low woodland to open forest on shallow infertile hillslopes in the Australian Capital Territory and surrounds* (Baines et al. 2013). The majority of populations across the species distribution occur within the endangered *Yellow Box-Blakely's Red Gum Grassy Woodland*. Canberra Spider Orchid plants occur amid a groundcover of grasses, forbs and low shrubs, often among rocks. The largest populations on Mt

Majura are partly shaded from the tree canopy, in otherwise open areas among rocks (Milburn and Rouse 2004).

PREVIOUS AND CURRENT MANAGEMENT

MT AINSLIE AND MT MAJURA

Most populations of the Canberra Spider Orchid located on Mt Ainslie and Mt Majura are protected within nature reserves. Dr Peter Milburn of the Australian National University first began monitoring these populations in the 1990s. The ACT Government has conducted all monitoring of the populations since 2015.

While the size of the populations at Mt Ainslie and Mt Majura fluctuate annually, there has been an overall increase in the total number of individuals at these sites. In 2002, there were approximately 100 individuals; by 2003, 250 individuals were recorded (Frawley 2010). Over 480 plants were recorded from the two populations in 2014 (ACT Government unpublished data). This increase is partially due to an increase in survey effort.

Milburn (2008) highlighted that grazing and disturbance by rabbits, kangaroos and other vertebrates threaten the survival of the populations. In 2010, permanent fences were erected to protect two populations from grazing and other disturbance. Temporary cages have since been used successfully to protect small, dense patches of the species from grazing. The ACT Parks and Conservation Service also conduct extensive rabbit control across Mt Ainslie and Mt Majura.

MAJURA VALLEY

Populations of the Canberra Spider Orchid at Majura Valley grow on Department of Defence land, where access and land use restrictions are enforced. These controls, along with weed and grazing management, have ensured the ongoing persistence of the species within the woodland habitat in the valley.

Monitoring of the population is managed by the Department of Defence.

KOWEN ESCARPMENT

The recently discovered population of the Canberra Spider Orchid on the Kowen Escarpment is located within a nature reserve. No specific management actions have been undertaken to maintain or enhance the population.

THREATS

The Canberra Spider Orchid has a small distribution in the ACT. Urban development and agricultural practices have resulted in the loss, degradation and fragmentation of appropriate woodland habitat for the Canberra Spider Orchid. As a result, populations of the species in the ACT are small and severely fragmented, and thus likely to be genetically depauperate. Poor genetic diversity and life history strategies of the species (including short flowering period, dependence on a single sub-family of wasps for pollination and association with soil fungi) is likely to leave it vulnerable to the impacts of climate change, disturbance and disease. The most common disturbances to the habitat of the Canberra Spider Orchid include animal trampling, grazing pressure, the development and maintenance of infrastructure, and bushfire.

CHANGING CLIMATE

A range of indirect impacts resulting from a changing climate may threaten the persistence of the species at some sites. These include increased drought conditions, and changes in plant species composition (including invasive species) and fire frequency and intensity.

A lack of connectivity and genetic diversity within populations is likely to reduce the resilience of the species to the impacts of climate change.

CONSERVATION ISSUES AND INTENDED MANAGEMENT ACTIONS

PROTECTION

A critical element in the conservation of the Canberra Spider Orchid is the conservation of lowland grassy woodlands including the endangered *Yellow Box-Blakely's Red Gum Grassy Woodland*. The majority of the extant populations in the ACT are protected on reserved land or are located on Commonwealth land (Defence).

ENVIRONMENTAL OFFSET REQUIREMENTS

Environmental offset requirements for species and ecological communities in the ACT are outlined in the ACT Environmental Offsets Policy and associated documents such as the ACT Environmental Offsets Assessment Methodology and the Significant Species Database. In the Assessment Methodology and Database, some of the threatened species have special offset requirements to ensure appropriate protection. The Canberra Spider Orchid has been determined to not be able to withstand further loss in the ACT so offsets for this species are not appropriate.

SURVEY, MONITORING AND RESEARCH

Monitoring of Canberra Spider Orchid populations has improved understanding of the ecology and population trends of the species. The ACT Government monitors the condition of all populations on Territory land and collects data on the size of populations as required.

Surveys for undiscovered populations of Canberra Spider Orchid have previously occurred; continuing to undertake surveys to improve our understanding of the distribution of the species in the ACT is a priority. Other future monitoring and research projects should aim to improve knowledge of:

- the life history and ecology of the species, including plant and seed longevity
- how the frequency, seasonality and intensity of fire impacts the species and its habitat
- the genetic variation within and between populations of the species and the genetic viability of the current seed bank
- how habitat fragmentation and reduced population size impacts genetic variability of the species
- the reliance on, and limitations of, appropriate pollinators and symbiotic fungi
- potential refugia sites for the Canberra Spider Orchid under a changing climate
- suitable seed collection methods and methods for establishing new populations via translocation
- the links between the persistence and fluctuations in abundance of the species, and abiotic and biotic variables (including disturbance, predation, vegetation dominance and structure, and soil moisture, chemistry and temperatures).

MANAGEMENT

The Canberra Spider Orchid persists as small, fragmented populations across the ACT that are at high risk of local extinction. Thus, the management priorities for the species are to maintain and enhance site condition and undertaking translocation projects. Specifically, priority management actions include:

- develop an annual monitoring program for all known sites, including habitat condition assessment
- manage biomass to maintain an open, heterogeneous habitat structure and diverse floristic composition within populations
- control invasive plants that pose a threat to a population or site
- maintain an *ex-situ* population (seed bank and orchard)

- reduce the impacts of vehicle movement, trampling, soil disturbance and over grazing
- limit the public availability of information regarding the location of populations
- increase the size of existing populations and establish new populations through translocation.

All translocation projects undertaken must be consistent with the principles outlined in the Conservator Guidelines for the Translocation of Native Flora and Fauna in the ACT (ACT Government 2017) and the Guidelines for the Translocation of Threatened Plants in Australia (3rd Ed.) (Commander *et al* 2018).

IMPLEMENTATION

Implementation of this action plan and the ACT Woodland Conservation Strategy will require:

- information identified in threatened species actions plans and other relevant documents to inform land planning and management on ACT Government Land
- allocation of adequate resources to undertake the actions specified in the strategy and action plans
- liaison with other jurisdictions (particularly NSW) with responsibility for the conservation of a threatened species or community
- collaboration with universities, CSIRO, ANBG and other research institutions to undertake research
- collaboration with non-government organisations such as Greening Australia to undertake on-ground actions
- collaboration with the community, where relevant, to assist with monitoring and other on-ground actions, and to help raise community awareness of conservation issues.

OBJECTIVES, ACTIONS AND INDICATORS

Table 1 Objectives, Actions and Indicators

Objective	Action	Indicator
Protect		
1. Protect all populations from unintended impacts (unintended impacts are those not already considered through an environmental assessment or other statutory process).	1a. Apply formal measures to ensure all populations are protected from unintended impacts (including recreation, infrastructure works and other potentially damaging activities).	All populations are protected from unintended impacts by appropriate formal measures.
	1b. Encourage other jurisdictions to protect sites where the species occurs on their lands from unintended impacts.	
	1c. Ensure protection measures require site management to conserve the species.	Protection measures include requirement for conservation management.

Objective	Action	Indicator
	1d. Identify other sites where the species occurs by maintaining alertness to the possible presence of the species while conducting vegetation surveys in suitable habitat.	Vegetation surveys in suitable habitat also aim to detect the species.
Maintain		
2. Manage the species and its habitat to maintain the potential for evolutionary development in the wild.	2a. Monitor populations and the effects of management actions.	Trends in abundance are known. Management actions are recorded.
	2b. Manage to conserve the species and its habitat.	Populations are stable or increasing. Habitat is managed appropriately (indicated by maintenance of appropriate sward/shrub structure and herbage mass). Potential threats (e.g. weeds) are avoided or managed.
	2c. Maintain a database of sightings of the species, and if available, record habitat information.	Records of sightings are maintained and used to determine the distribution of the species in the ACT.
Improve		
3. Enhance the long-term viability of populations through management of adjacent grassland/woodland to increase habitat area and connect populations.	3a. Manage grassland/woodland adjacent to the species' habitat to increase habitat area or habitat connectivity.	Grassland/woodland adjacent to or linking habitat is managed to improve suitability for the species (indicated by an appropriate sward structure and plant species composition).
	3b. Undertake or facilitate research and trials into techniques for increasing the population size.	Research trials have been undertaken to increase the size of the population. The population is stable or increasing.
4. Expand the range of the species in the ACT by providing suitable habitat and establishing new populations by translocation	4a. Undertake or facilitate research and trials into establishing new populations.	Research and trials have been undertaken to establish new populations. New population(s) established.

Objective	Action	Indicator
5. Improved understanding of the species' ecology, habitat and threats.	5a. Undertake or facilitate research on habitat requirements, techniques to manage habitat, and aspects of ecology directly relevant to conservation of the species.	Research undertaken and reported and where appropriate applied to the conservation management of the species.
Collaborate		
6. Promote a greater awareness of, and strengthen stakeholder and community engagement in, the conservation of the species.	6a. Undertake or facilitate stakeholder and community engagement and awareness activities.	Engagement and awareness activities undertaken and reported.

ACKNOWLEDGMENTS

The illustration of the species was prepared for the ACT Government by John Pratt.

COMMUNICATIONS

Linde, C. 2018 (personal communication).

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SCARLET ROBIN

Petroica boodang

ACTION PLAN

BACKGROUND

The Scarlet Robin (*Petroica multicolor*) was declared a vulnerable species on 20 May 2015 (Instrument No. DI2015-88) under the former *Nature Conservation Act 1980* (NC Act 1980). The declaration followed a recommendation by the Flora and Fauna Committee, guided by criteria formerly set out in Instrument No. DI2008-170 (Table 1). On 3 June 2015 the Committee recommended the scientific name for the Scarlet Robin be changed to *P. boodang* following a molecular study (Kearns *et al* 2015) and a revision of the taxonomy of Australian passerine bird species (Dickinson and Christidis 2014).

The NC Act 1980 was repealed and replaced with the current *Nature Conservation Act 2014* (NC Act 2014) on 11 June 2015. Part 2.4 of the NC Act 2014 established the Scientific Committee to replace the Flora and Fauna Committee. On 29 July 2015 (Instrument No. NI2015-438) listings of threatened species as declared under the NC Act 1980, including the formerly declared vulnerable species, the Scarlet Robin, were listed under the NC Act 2014. The scientific name of the Scarlet Robin was updated to *P. boodang* on 30 May 2016.

CRITERIA SATISFIED

2.2 Species is observed, estimated, inferred or suspected to be at risk of premature extinction in the ACT region in the medium term future, as demonstrated by:

2.2.1 Current serious decline in population or distribution from evidence based on direct observation, including comparison of historic and current records.

Subsection 100(a)(i) of the NC Act 2014 outlines requirements for action plans.

Measures proposed in this action plan complement those proposed in the action plan for Yellow Box/Red Gum Grassy Woodland (ACT Government 2004) and for listed threatened woodland bird species such as the Hooded Robin (*Melanodryas cucullata*), Brown Treecreeper (*Climateris picumnus*), White-winged Triller (*Lalage sueurii*), Varied Sittella (*Daphoenositta chrysoptera*), Painted Honeyeater (*Grantiella picta*), Regent Honeyeater (*Anthochaera phrygia*), Superb Parrot (*Polytelis swainsonii*) and Swift Parrot (*Lathamus discolor*).

DESCRIPTION

The Scarlet Robin, *P. boodang*, is 12–14 centimetres in length and averages 13 grams in weight. Adult male birds have bold red, black and white plumage and females are brownish with a red/orange wash on the breast (Pizzey and Knight 2012) (Figures 1a and 1b).
Young birds resemble the adult female.

Figure 1a. Scarlet Robin, *P. boodang* (male). G. Dabb.

Figure 1b. Scarlet Robin, *P. boodang* (female). G. Dabb.

P. boodang is one of three red breasted robins in Australia, the others being the Flame Robin (*P. phoenicea*) and the Red Capped Robin (*P. goodenovii*). *P. boodang* is distinguishable from the other red breasted robins by the obvious white forehead and red wash on the breast in females. Unlike *P. phoenicea*, the red breast plumage colour of *P. boodang* does not continue up the throat to the bill. Distinctions from *P. goodenovii* are *P. boodang*'s lack of a scarlet red cap in the males and *P. goodenovii*'s lack of a dull reddish wash on the forehead in females (Pizzey and Knight 2012).

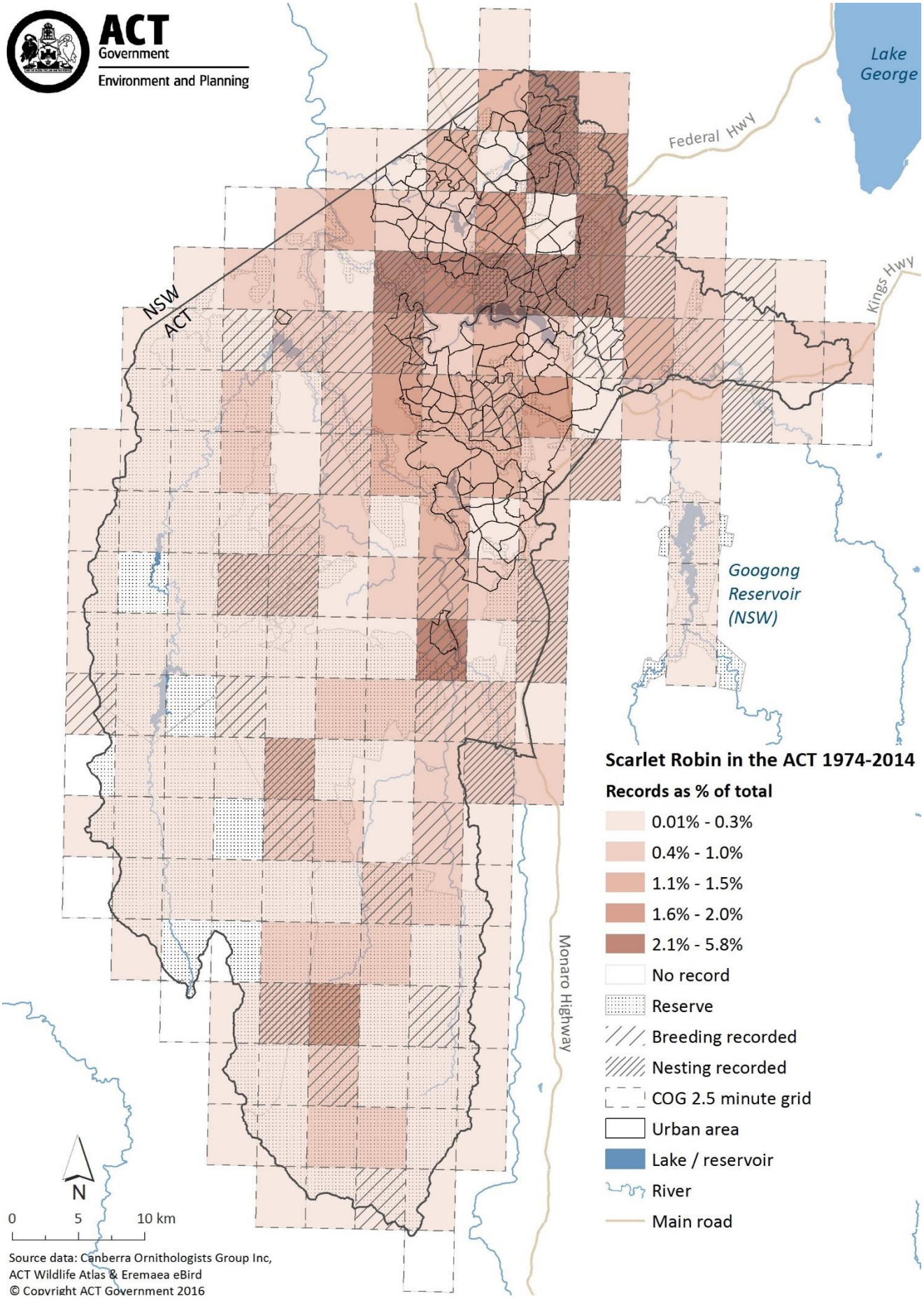

Figure 2. Distribution Map of *P. boodang* in the ACT.

DISTRIBUTION

P. boodang is found in south-eastern Australia (extreme south-east Queensland to Tasmania, western Victoria and south-east South Australia) and south-west Western Australia. In NSW it occupies open forests and woodlands from the coast to the inland slopes (Higgins and Peter 2002), with dispersing birds sometimes appearing in autumn or winter on the eastern fringe of the inland plains (NSW Scientific Committee 2010).

P. boodang is distributed widely across the ACT in eucalypt woodlands and dry, open forest, particularly where shrubs, logs, coarse woody debris and native grasses are present, but is generally absent from open areas where no trees remain (Taylor and COG 1992). Figure 2 shows a distribution map of *P. boodang* in the ACT, summarised for 1 July 1982 to 30 June 2014 and based on records of observations submitted to Canberra Ornithologists Group (COG) and eBird Australia (COG 2015a).

In the warmer months, *P. boodang* can be found mainly at higher altitude in the foothills of the ranges in open forest and shrubby habitats. Occupancy rates decline significantly at higher elevations over the cooler months; birds are more often seen in lowland woodland, peri-urban woodland, grazed paddocks with scattered trees, gardens and parklands at lower altitude during autumn and winter (Taws *et al* 2012). The current COG Annotated Checklist describes *P. boodang* as an 'Uncommon breeding resident/ altitudinal migrant' in the ACT (COG 2015b).

The *P. boodang* records (Figure 2) were supplied by Canberra Ornithologists Group (COG Database), including from eBird Australia (eBird Australia 2016) and excluding the Garden Bird Survey data (COG 2014). *P. boodang* distribution has been summarised for 187x2.5 minute grids covering the ACT and the Googong Reservoir in NSW, currently managed by the ACT. The mapping classes recognise natural breaks inherent in the data to best group similar values using Jenk's Natural Breaks algorithm (Jenks 1967).

POPULATION TRENDS

Analysis of data from COG's Woodland Bird Survey (Bounds *et al* 2010) found strong evidence of decline in *P. boodang* abundance in the ACT. More recent research has confirmed *P. boodang* as one of five woodland-dependent species showing a long term decline in abundance over 14 years (Rayner 2015 PhD thesis *unpubl.*). The study analysed 56 species, with the Grey Shrike-thrush, Mistletoebird, Striated Thornbill and Tree Martin also being found to be in decline.

P. boodang has also been classified as one of three 'urban avoider' bird species (including the Striated Thornbill and Rufous Whistler)—native birds that show a long-term declining population in the ACT. Urban avoider species are more likely to be observed at sites at an increasing distance from the urban fringe (0–3 kilometres), are likely to be migratory or dispersive species, and are likely to be smaller-bodied, woodland- dependent species that rely on mid to upper canopy structures for nesting (Rayner *et al* 2015).

CONSERVATION STATUS

P. boodang has a listed conservation status under legislation as follows:

Australian Capital Territory:
Vulnerable, Section 91 *Nature Conservation Act 2014*; Special Protection Status species, Section 109 *Nature Conservation Act 2014*.

New South Wales:
Vulnerable, listed in Part 1 of Schedule 2 *Threatened Species Conservation Act 1995*.

South Australia:
Rare, listed as '*P. m. boodang* (eastern subspecies)' in Schedule 9 *National Parks and Wildlife Act 1972*.

HABITAT AND ECOLOGY

Appendix 1(a) describes the habitat and ecology of *P. boodang* in detail.

THREATS

Following a detailed literature review of the habitat and ecology of *P. boodang* in eastern Australia, four key threats to maintaining a viable, stable and breeding population in the ACT have been identified. The four key threats, in decreasing order of significance, are:

- **Habitat loss and degradation**
- **Predation**
- **Climate change**
- **Competition**

Appendix 1(b) documents the four key threats in detail, citing sources from the scientific literature.

ACTIONS

OBJECTIVES AND INTENDED MANAGEMENT ACTIONS

Five management objectives have been identified, each to be achieved by management actions, to address the risk of premature extinction of *P. boodang*.

OBJECTIVES

1. Identify, protect and restore breeding and foraging habitat critical to survival of the species in the ACT.
2. Manage critical habitat to conserve the species in response to the identified threats.
3. Promote and support the survey, monitoring and research of the species in the ACT to better understand its ecology and conservation needs.
4. Co-operate with state and local government agencies in formulating and implementing conservation measures.
5. Increase community awareness of the need to protect the species in its habitat in the ACT and engage in community-based conservation action.

Table 1 identifies the proposed management actions and indicators against each of the objectives.

Table 1. Key objectives, actions and indicators

Objective	Action	Indicator
1. Identify, protect and restore *P. boodang*'s breeding and foraging habitat.	1a. For environmental offsetting purposes treat *P. boodang* as a 'significant species' predicted by vegetation types assessed according to the method for assessing ecological community credits.	*P. boodang* is included within the Environmental Offsets Calculator for assessing ecological community credits by July 2018.
	1b. Map the location and extent of prime occupied breeding and foraging habitat of *P. boodang* in the ACT (including through working with volunteers) to guide management activity.	Maps of breeding sites and the current extent of foraging habitat occupied by *P. boodang* are prepared by July 2018.
	1c. Retain currently occupied *P. boodang* breeding and foraging habitat in open forest and woodland on public and rural leasehold land and increase the size of these habitat patches by planting indigenous trees and shrubs to provide additional foraging habitat for *P. boodang*.	The area of currently occupied breeding and foraging habitat for *P. boodang* is increased.
	1d. Restore *P. boodang*'s degraded open forest or woodland habitat by replacing missing structural layers to provide protection from predation (e.g. Pied Currawong) and deter Noisy Miners (e.g. mid-layer wattles, shrub layer and ground layer species) using locally indigenous species.	The areas of treated open forest or woodland habitat are more structurally diverse.
	1e. Where feasible, establish 'fenced corridor' or 'stepping stone' plantings (plots a minimum 20x20 metres wide and a maximum of 100 metres apart) to reconnect isolated habitat and deter Noisy Miners.	The number of established plantings increases.

Objective	Action	Indicator
2. Manage habitat to conserve *P. boodang*.	**Coarse woody debris** 2a. Maintain a program to place 'coarse woody debris' on the ground in known or potential breeding or foraging habitat suitable for *P. boodang*.	Area of breeding or foraging habitat enhanced by placement of 'coarse woody debris' or by similar ground layer enhancement treatments increases.
	Grazing 2b. Encourage landowners to fence areas of known forest or woodland habitat suitable for *P. boodang* to control grazing and to facilitate shrub and tree regeneration.	The area of fenced forest or woodland habitat suitable for *P. boodang* increases.
	Fire 2c. For areas of known suitable *P. boodang* habitat in open forest or woodland, take account of research findings on the optimum prescribed burning regime favouring Category C species (i.e. *P. boodang*).	Ecological guidelines for maintaining habitat conditions for Category C species (i.e. *P. boodang*) are incorporated into planned prescribed burning regimes.
	Predation 2d. Maintain or extend existing predator-proof fencing and cat containment zones where they coincide with known *P. boodang* breeding sites or potential breeding habitat (e.g. Mulligans Flat/Goorooyarroo, Molonglo Valley).	The area protected through predator proof fencing and cat containment zones that coincides with *P. boodang* habitat increases.
	2e. Monitor effectiveness of predator reduction measures for *P. boodang.*	Effectiveness of predation reduction measures on known or potential *P. boodang* breeding sites is reported.
	2f. Maintain control of exotic, berry-bearing trees or shrubs e.g. Sweet Briar Rose, Hawthorn, Blackberry) in open forest and woodland and replace removed woody weeds with locally indigenous species, particularly bi-pinnate wattles (*Acacia* spp.), native shrubs (e.g. *Bursaria* sp., *Kunzea* sp.) or she-oaks (*Allocasuarina* spp.) to reduce food resources for the abundant, predatory Pied Currawong (*Strepera graculina*).	Area of exotic trees or shrubs cleared and replaced with locally indigenous species increases.
3. Promote and support a survey, monitoring and research program.	3a. Continue monitoring *P. boodang* occurrence at permanent forest and woodland monitoring sites including measuring relevant habitat parameters (i.e. canopy cover, shrub cover, ground cover, logs, fallen branches and litter).	The COG Woodland Survey (Bounds *et al* 2010), including the relevant habitat parameters, or its equivalent, continues to be conducted each year on a quarterly basis.
	3b. Additional monitoring by volunteers of *P. boodang* occurrence to capture responses to climate change (e.g. arrival/departure times at lower altitude sites, timing/altitude of breeding).	Data on *P. boodang*'s arrival/ departure times and timing/ altitude of breeding is recorded and analysed.
	3c. Support research initiatives, for example at PhD/ Masters level, to fill gaps in knowledge of *P. boodang*: » critical habitat areas (i.e. breeding sites, including lowland habitats) » the foraging ecology of *P. boodang* and the habitat variables determining optimum foraging habitat » vulnerability to predators » seasonal migration/movements and habitat corridors.	At least one research project is initiated within the first five years of the action plan's commencement.
	3d. Take new research findings into account by modifying mapped breeding and foraging habitat and reviewing management actions.	ACTmapi is updated and management actions are revised.

Objective	Action	Indicator
4. Co-operate with state and local government agencies.	4a. Collaborate in joint monitoring and research initiatives for the bio-region that take into account management issues for threatened species dependent on open forest and woodland habitat (e.g. *P. boodang*).	At least one joint monitoring and research initiative is undertaken.
5. Increase community awareness of and engagement in managing *P. boodang* as a vulnerable species.	5a. Collaborate with community groups (e.g. Landcare, Parkcare and catchment groups) and citizen science groups (e.g. COG, eBird Australia, Canberra Nature Map) promoting both incidental and systematic data collection of *P. boodang* sightings, in particular: » breeding behaviour (i.e. nest site location, characteristics, breeding success and predation) » altitudinal migration (i.e. arrival/departure, breeding dates, use of wildlife corridors/habitat patches, proximity to urban areas).	Records of submitted and targeted information collected on *P. boodang* behaviour, distribution and altitudinal migration show the rates of recording have increased, e.g. as reported in the COG Annual Bird Report for the ACT, COG (2015a).
	5b. Collaborate with volunteer community groups and rural landholders at suitable fora (e.g. Parkcare; Rural Landholders Association; Fringe fora; Conservation Research) to demonstrate conservation actions (e.g. woody weed control, planting, coarse woody debris placement, temporary grazing) that will improve habitat conditions for small, passerine birds, including *P. boodang.*	A number of conservation workshops are held at least on a biennial basis.

BOX 1 - ADAPTIVE RESOURCE MANAGEMENT

The Adaptive Resource Management (ARM) approach was conceived as a technical–ecological model to deal with uncertainty (Walters and Holling 1990, Allan 2007). Consequently ARM involves learning from implementation; learning opportunities need to be identified, hypotheses stated and different management treatments tested. Of necessity, ARM also focuses on the problem of using such new knowledge in policy and planning (e.g. Stankey *et al* 2003).

The ACT Nature Conservation Strategy 2013–23 (ACT Government 2013) signals a shift away from reliance on static planning documents towards more flexible tools designed for adaptive management and feedback into implementation cycles.

Interactive mapping tools may be able to be used to support ARM in the context of this action plan. Mapping of habitat and setting baselines is an essential first step in adaptive management. Statistical or mathematical models could be developed using spatially referenced and/or time- series data based on *P. boodang* occurrence to predict or trade-off future management scenarios (e.g. use of prescribed fire). In most cases, in order to be readily understood, such modelled output would need to be mapped.

Monitoring is crucial if learning by conservation managers is to occur and to assist in review of this action plan. Under s.108 of the NC Act 2014 the Conservator of Flora and Fauna must monitor the effectiveness of an action plan and make the findings publicly accessible.

IMPLEMENTATION AND REVIEW OF THIS ACTION PLAN

Implementation of this action plan will result in new knowledge about the habitat and ecology of *P. boodang.* This knowledge should inform implementation of relevant actions in this action plan. To emphasise the importance of new knowledge in implementing this action plan, specific benchmarks have been included for three actions to highlight the need to implement these actions as a high priority. These actions are numbered 1a, 1b and 3c (see Table 1).

New knowledge will also inform review of the action plan. Under s.108 of the NC Act 2014 the Conservator of Flora and Fauna must report to the Minister about each action plan at least once every five years and make the report publicly accessible within 30 days. The Scientific Committee must review an action plan every 10 years, or at any other time at the Conservator's request.

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GLOSSARY

Altitudinal migrant
A species that breeds at higher altitude in summer and migrates to lower altitude areas in winter.

Breeding record
A breeding record for *P. boodang*, including any of the following activities: carrying food ('cf'), copulation ('co'), display ('di') or dependent young ('dy').

Critical habitat
Habitat that is critical to the survival of a species or ecological community (Dictionary, s.3 of the *Nature Conservation Act 2014*.)

Congeneric
A species which is a member of the same genus as another species.

Dependent
A bird fed by its parents.

Dispersing
A species spreading to other areas, often after breeding has ceased.

Migrant
A bird that moves between locations in a regular annual cycle, usually breeding in one and wintering in another.

Nesting recorded
A breeding record for *P. boodang* including any of the following nesting activities: sitting on ('on'), building a nest ('nb), a nest with eggs ('ne') or a nest with young ('ny').

Passerine
A member of the order Passeriformes, a perching song- bird with three forward-pointing toes and one rear- pointing toe.

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APPENDIX 1(A)

HABITAT AND ECOLOGY

P. boodang lives in dry eucalypt forest and woodlands, usually with trees and shrubs present and an open or grassy understorey. The species lives in both mature and regrowth vegetation. It occasionally occurs in wet forest or near wetlands. Shrub cover, native grasses, a healthy eucalypt canopy, abundant logs and fallen timber are important components of its habitat (Taws *et al* 2012).

P. boodang are quiet and unobtrusive foragers found on or near the ground and on branches and the trunks of shrubs and trees (Frith 1984, Higgins and Peter 2002). They forage from low perches, fence-posts, tree trunks, logs or the ground, pouncing on small insects and other invertebrates. They sometimes forage in the shrub or canopy layer.

Birds usually occur singly or in pairs, occasionally in small family parties. Pairs stay together all year round. In autumn and winter *P. boodang* joins mixed flocks of other small insectivorous birds that forage through dry forests and woodlands.

P. boodang breeds on ridges, hills and foothills of the western slopes, the Great Dividing Range and eastern coastal regions of NSW; and occasionally breeds up to 1000 metres in altitude. A similar pattern of breeding occurs in the ACT.

P. boodang forms breeding pairs that defend a breeding territory. They mainly breed between July and January although in recent years earliest breeding dates in the ACT have tended to be later in August or early September (COG 2014, 2015a).

P. boodang may raise two or three broods a season. The nest, an open cup made of plant fibres and cobwebs, is often built in the fork of a tree that is usually more than two metres above the ground. Nests are often found in a dead branch on a live tree or in a dead tree or shrub. Eggs are pale greenish-, bluish- or brownish-white,

with brown spots; clutch size ranges from one to four. The generation time of *P. boodang* has been estimated at five years based on the congeneric Flame Robin, *P.phoenicea* (Garnett and Crowley 2000).

CRITICAL HABITAT

For the purposes of this action plan, the critical habitat of *P. boodang* is defined as its breeding habitat in open forest and woodland areas.

APPENDIX 1(B)

THREATS

Habitat loss and degradation

The main threat to *P. boodang* is the loss of its open forest or woodland breeding and foraging habitat (NSW Scientific Committee 2010) and habitat degradation (Radford and Bennett 2007). In comparing surveyed woodland sites stratified by habitat and land use category, *P. boodang* was found to be:

- less common in habitat patches less than:
  - » 30 hectares in area with no tree cover within
  - » 200 metres and less than 2% cover within 1 kilometre
  - » less common at sites surrounded by cattle grazing
  - » absent from sites surrounded by cereal cropping (Barrett *et al* 2003).

Nest sites, food sources and foraging substrates (i.e. standing dead timber, log and coarse woody debris) are susceptible to depletion by firewood collection and 'tidying up' of rough pasture (e.g. mowing, slashing) and overgrazing (Recher *et al* 2002, Olsen *et al* 2005).

However, *P. boodang* occurrence (presence/absence) can be positively associated with habitat patch size and components of habitat complexity such as increasing tree canopy cover, shrub cover, ground cover, logs, fallen branches and litter (Watson *et al* 2003).

P. boodang habitat may become unsuitable if dense regeneration (e.g. wattles) occurs after bushfires in forest or woodland. Research into bird and animal responses to fire in dry forests and woodlands has identified *P.boodang* as a 'Response C' species. Response C species show a long-term decline post-fire with or without a short-term increase in numbers. Although the response may be favourable to these species in the short term, regeneration of the shrub layer renders the habitat unsuitable after a few years. Eventual species recovery is expected as the shrub layer thins out over time. However, there is insufficient knowledge about when this would happen (MacHunter *et al* 2009).

Predation

Open nesting, small, passerine birds (e.g. robins, flycatchers, whistlers and honeyeaters) experience poor nesting success in fragmented and degraded eucalypt woodlands (Woinarski 1985, Robinson 1990, Ford *et al* 2001, Higgins and Peter 2002). The Pied Currawong *Strepera graculina* is a nest predator whose population has increased significantly in eastern Australia to become a common breeding bird in urban and peri-urban areas (NSW Scientific Committee 2010). A Pied Currawong population increase is also evident in urban Canberra (COG 2009, COG 2015c). Debus (2006 a,b) investigated whether the Pied Currawong has become a threat to *P. boodang* and Yellow Robin's (*Eopsaltria australis*) breeding productivity by testing whether culling of currawongs during the robins' breeding season led to increased breeding success in remnant woodland at Imbota, near Armidale, northern NSW. Debus found that culling led to a twofold increase in nest success, higher fledgling rates and increased nest survival rates for both robin species. The study confirmed that predation by the Pied Currawong was a major cause of nest failure together with a wide range of other nest predators (e.g. mammals and reptiles) in the cull area (Debus 2006a,b).

Barratt (1997) studied predation by house cats on wildlife in Canberra. Information on the composition of vertebrate prey caught by cats was collected by recording prey deposited at cat owners' residences over 12 months. A total of 1961 prey items comprising 67 species were collected or reported. Birds comprised 27% of the total (14% native, 10% introduced, 3% unidentified). Of the 47 bird species identified as prey, 41 were native bird species.

On Norfolk Island the Scarlet Robin (*P. multicolor*, formerly *P. b. multicolor*) is thought to be affected by cat (*Felis catus*) and black rat (*Rattus rattus*) predation and cat and rat control measures were recommended (Director of National Parks 2010; Garnett and Franklin 2014). Predation by feral cats (*F. catus*) and robbing of nests and predation of fledgling by rats (*Rattus* sp.) are recognised as threats to *P. boodang* in NSW (NSW Office of Environment and Heritage 2016a).

Climate change

An assessment of *P. boodang*'s likely response to climate change has been undertaken as part of the Climate Change Adaptation Plan for Australian Birds (Garnett and Franklin 2014). The comparison of climate suitability for the *P. boodang* species as a whole showed the suitability as mapped for 1985 contracting southwards by about 50% in total area by 2085, but remaining relatively extensive and including the entire ACT within the modelled species distribution. The two Australian mainland subspecies *P. b. boodang* (eastern Australia) and *P. b. campbelli* (south-western Australia) were assessed as being of 'medium' sensitivity to climate change (Garnett and Franklin 2014).

Competition

The Australian Government (March 2013) and the NSW Government (September 2013) have listed the 'Aggressive exclusion of birds from forest or woodland habitat by abundant Noisy Miners' as a Key Threatening Process under legislation (Department of Environment 2014). In making the declaration, the NSW Scientific Committee recognised *P. boodang* as one of a range of listed threatened species which may be adversely affected by aggressive exclusion by abundant Noisy Miners (NSW Scientific Committee 2013). The Noisy Miner, *Manorina melanocephala*, has benefited from the large-scale vegetation changes, such as fragmentation, that accompanied European settlement of Australia (Higgins *et al* 2001; Grey *et al* 2010, Maron *et al* 2011) and, as a result, has increased in abundance (Szabo *et al* 2010). In the ACT, since 1991 the reporting rate for the Noisy Miner in COG's Annual Bird Report increased from 4.3% to 21% in 2010–11 (COG 2015d). Data analysis from across south-eastern Australia has shown Noisy Miner densities of 0.8/hectare or larger are strongly negatively correlated with small to medium sized native birds (Mac Nally *et al* 2012). The experimental removal of Noisy Miners from habitat patches results in the re-colonisation of small to medium sized birds (Grey *et al* 1997, 1998; Debus 2008) even in the absence of restoration of habitat structure.

FURTHER INFORMATION

Further information on this action plan or other threatened species and ecological communities can be obtained from:

Environment and Planning Directorate, ACT Government

Phone: 13 22 81

Website: http://www.environment.act.g

SMALL PURPLE PEA

Swainsona Recta

DRAFT ACTION PLAN

PREAMBLE

The Small Purple Pea (*Swainsona recta,* A.T. Lee 1948) was declared an endangered species on 15 April 1996 (Instrument No. DI1996-29 under the *Nature Conservation Act 1980*). Under section 101 of the *Nature Conservation Act 2014*, the Conservator of Flora and Fauna is responsible for preparing a draft action plan for listed species. The first action plan for this species was prepared in 1998 (ACT Government 1998). This revised edition supersedes the earlier edition.

Measures proposed in this action plan complement those proposed in the action plans for Yellow Box-Blakely's Red Gum Grassy Woodland, Natural Temperate Grassland and component threatened species such as the Tarengo Leek Orchid, Brown Treecreeper and Canberra Spider Orchid.

CONSERVATION STATUS

The Small Purple Pea is declared a threatened species in line with the following legislation:

National
Environment Protection and Biodiversity Conservation Act 1999 (Endangered).

Australian Capital Territory
Nature Conservation Act 2014 (Endangered)

Nature Conservation Act 2014 (Special Protection Status Species)

New South Wales
Biodiversity Conservation Act 2016 (Endangered)

Victoria
Flora and Fauna Guarantee Act 1988 (Threatened)

CONSERVATION OBJECTIVES

The objective of this action plan is to preserve the Small Purple Pea in perpetuity in the wild across its natural geographic range in the ACT and contribute to the regional and national conservation of the species.

Specific objectives of the action plan are to:

- protect sites where the species is known to occur in the ACT from unintended impacts
- manage the species and its habitat to maintain the potential for evolutionary development in the wild
- improve the long-term viability of populations through management of adjacent woodland to increase habitat area
- expand the range of the species in the ACT by identifying suitable habitat and establishing new populations by translocation
- improve the understanding of the species' ecology, habitat and threats
- strengthen stakeholder and community collaboration in the conservation of the species.

SPECIES DESCRIPTION AND ECOLOGY

DESCRIPTION

The Small Purple Pea is a slender, erect perennial plant that produces several rigid stems 20-30 cm high. It has a thick taproot that can extend at least 60 cm below the soil surface (NSW OEH 2012). The leaves of the species are odd pinnate, they are composed of 7-11 narrow leaflets, 5-7cm long. The terminal leaflet is distinctly longer than adjacent laterals. The species produces 10-21 racemes (that range from 10-27cm long), which bear purple or blue-purple flowers that are 5-6mm long. Individual flowers are borne on short recurved stalks, 0.1-0.3 cm long; they have two distinct white spots or short stripes on the base of the standard (central) petal (NSW OEH 2012). The pods are rounded–oblong (7-11 mm long and 4-6 mm wide) and are hairless except along the suture and base. Pods contain several small, hard-coated kidney shaped seeds that are approximately 2 mm long (Briggs and Leigh 1990, Leigh and Briggs 1992).

DISTRIBUTION

In the past, the Small Purple Pea was relatively widespread; it has been recorded in north-eastern Victoria and the South and Central Western Slopes and Tablelands of NSW. Over the past 80 years the known range of the species has declined considerably; its distribution is now fragmented into two clusters of populations, one in central eastern NSW (between Wellington and Mudgee) and the other in the Canberra – Williamsdale district. Young (2001) found a moderate genetic difference between the populations in the central eastern NSW region and those in the ACT. A single plant was found near Glenrowan, Victoria in 1995 but has since died (NSW OEH 2012).

In 1996, the largest known population comprised approximately 3,400 plants; these plants continue to persist along 22 km of railway easement from Tralee to Williamsdale along the ACT/NSW border (Briggs 1994, Briggs and Müeller 1997). In 2010 a large population of more than 1,000 plants was discovered nearby, on private land in the Williamsdale area. Another population of 4,200 plants was discovered on Mount Arthur near Wellington in 2011. This discovery increased the local population to 4,576 individuals. Other sites in NSW where the species survives includes Burrendong (160 plants), Mudgee (270 plants), Burra (100 plants), Mandurama (10 plants) and Guises Creek (50 plants) (Briggs and Leigh 1990, NSW OEH 2012). The total known population in NSW is approximately 9,270 plants.

At Mt Taylor in the ACT, over 400 individual plants have been recorded since monitoring began at the site; the highest annual count of emergent plants is 268. While recruitment of new individuals to the population each year is low, the total population at Mt Taylor is considered to be stable.

A small population of the species persists in the suburb of Kambah. Twenty one plants have been recorded since monitoring began at the site; the highest annual count of emergent plants is 10. This isolated population has been fenced to protect it from unintended disturbance. No recruitment has been observed in this population. In October 2003 another population (several plants) was located in Yellow Box-Blakely's Red Gum grassy woodland in south-east Belconnen, near Gungahlin Drive (Caswell Drive).

In 2012 and 2013, 112 plants raised at the Australian National Botanic Gardens (ANBG) were translocated to 3 plots near the Gigerline Nature Reserve in the southern ACT (as part of the Icon Water Murrumbidgee to Googong Pipeline (M2G) offset project) (Eco Logical Australia 2017). The original seed for this project was sourced from three populations (Mt Taylor, Burra and Williamsdale). Approximately 32% of the translocated plants survived.

In the ACT region, the Small Purple Pea was previously recorded, but no longer persists, in the following locations: Queanbeyan, Black Mountain, O'Connor, Harman and Mawson. A single plant was recorded adjacent to Long Gully Road (Isaacs Ridge) but it has not been observed since 1995. Similarly, a single plant recorded in Farrer Ridge has not been observed in the last 10 years.

A map of the current distribution of this species is available on the ACT Government's mapping portal, ACTmapi.

HABITAT AND ECOLOGY

In the ACT region, the Small Purple Pea occurs on grey sandy or stony loams, on all aspects of undulating terrain (Briggs and Leigh 1990). It occurs in open woodland dominated by one or more of the following canopy species: Blakely's Red Gum (*Eucalyptus blakelyi*), Apple Box (*E. bridgesiana*), Yellow Box (*E. melliodora*), Mealy Bundy (*E. nortonii*), Long-leaved Box (*E. goniocalyx*) or Black Cypress Pine (*Callitris endlicheri*). The grassy understorey is dominated by Kangaroo Grass (*Themeda triandra*), Snow Grass (*Poa sieberiana* var. *sieberiana*), Red-Anther Wallaby grass (*Rytidosperma pallidum*) or Spear grasses (*Austrostipa* spp.) The groundcover also includes a wide range of native forbs; the most common species include Bulbine Lily (*Bulbine bulbosa*), Common Everlasting (*Chrysocephalum apiculatum*), Billy Buttons (*Leptorhynchos squamatus*), Common Raspwort (*Gonocarpus tetragynus*) and Pale Sundew (*Drosera peltata*). Occasionally the understorey may have a low shrub component that includes Curved Rice-flower (*Pimelea curviflora*), Bitter Cryptandra (*Cryptandra amara*), Daphne Heath (*Brachyloma daphnoides*) and Leafy Bitter-pea (*Daviesia mimosoides*) (NSW OEH 2012, NSW OEH 2017). Most ACT sites have a mid-storey shrub layer containing Australian Blackthorn (*Bursaria spinosa* subsp. *lasiophylla*), Sifton bush (*Cassinia quinquefaria*), Narrow leaved hopbush (*Dodonaea viscosa* subsp. *angustissima*), Native indigo (*Indigofera australis*) or Burgan (*Kunzea ericoides*).

The Small Purple Pea is a perennial forb that persists as woody rootstock throughout late summer and autumn. It re-sprouts between April and August and flowers during spring. Peak flowering occurs during a 2 – 3 week period in October. By the end of December, when seed is ripe, individuals enter dormancy once again (NSW OEH 2012). Insects are the primary means of pollination, and seed set is assumed to be influenced by annual climatic variation (NSW OEH 2012). Recent analysis of monitoring data from Mt Taylor suggests there is a relationship between the likelihood an individual will flower and the number of frost nights in the preceding year. A plant is most likely to flower when there are between 7 and 15 nights equal to or less than -4°C (Wilson et al. 2016). The life span of the Small Purple Pea is unknown. Individual plants have been monitored for over 30 years; it is estimated they may live up to 50 years (NSW OEH 2012).

Research and monitoring programs demonstrate that fire may enhance the recruitment of populations by facilitating and / or stimulating critical stages of its reproduction. Fire is believed to facilitate re-sprouting as it removes biomass that may otherwise overcrowd new shoots (Briggs and Müller 1999, NSW OEH 2012). This association appears weaker in less disturbed sites where groundcover density is limited by a mature overstorey and thus the species is subject to less competition. Fire may also stimulate seed germination (Briggs and Müller 1999, NSW OEH 2012), however no effect on the production of seed pods has been identified (Briggs and Müller 1999). Analysis by Wilson et al. (2016) indicated a linear decline in the proportion of flowering individuals with increasing time since fire.

Although re-sprouting has been observed from damaged rootstock, persistent grazing of annual shoots is likely to inhibit an individual's capacity to continue to re-sprout (NSW OEH 2012).

PREVIOUS AND CURRENT MANAGEMENT

MT TAYLOR

In 1996 the ACT Government commenced monitoring the population of Small Purple Pea at Mt Taylor. To better understand recruitment in the population, the ACT Government commenced tagging individual plants in 2001. Each year, previously unrecorded plants are tagged with a unique identification number (on a metal tag inserted into the ground).

In 2000 an ecological burn was carried out at the site. The number of flowering plants increased over the following two springs. However, as data was not collected systematically before the burn was conducted, the exact relationship between the fire and flowering success cannot be determined. A high intensity fire burnt the site during the 2003 Canberra Bushfires. Despite the severity of the burn, and ongoing drought conditions, the population of Small Purple Pea responded by producing new spring growth and flowering that year. The number of flowering plants recorded in 2003 was the highest on record at that time. After

2003, surveys of the Mt Taylor population were not undertaken until 2009. Annual surveys have been undertaken since this time.

Since 1991 the Mount Taylor Park Care group has undertaken a number of management activities within the reserve but outside the habitat area, including: the removal of woody weeds, planting native trees, shrubs and grasses, and erosion control. There is current evidence of grazing on individuals of the species at Mt Taylor (ACT Government 2015), however it is not possible to attribute this activity to specific vertebrate or invertebrate grazers without further research.

In 2015 the ACT Government partnered with the ANBG to further develop the seed bank for the Small Purple Pea (and various other rare flora species) from multiple *in-situ* populations. In 2016, a seed orchard of the Small Purple Pea was established at the ANBG to facilitate future translocations of the species by the ACT Government.

KAMBAH

The population in the suburb of Kambah was fenced during the 1980's to protect the population and habitat from grazing or inadvertent damage. In 1988 and 1989 twelve plants (raised from seed collected from the Tralee-Williamsdale railway easement in NSW) were translocated to the Kambah population to increase genetic variation and recruitment. Only three of these plantings were still alive in 2009. There has been no improvement in recruitment at the site.

To reduce the density of Kangaroo Grass (*Themeda triandra*) in the absence of grazing, ecological burns were conducted at the site in 2000, 2011 and 2013. Weed control has been undertaken at the Kambah site to remove Sweet Briar (*Rosa rubiginosa*), naturalised Prickly Spiderflower (*Grevillea juniperina*) and dense eucalypt regeneration. There is also current evidence of grazing on individuals of the species at Kambah (ACT Government 2015). The fence excludes both macropods and rabbits; however possums, birds and invertebrates can still access the area. Slug and snail bait has occasionally been laid at the site to control potential slug damage to Small Purple Pea plants.

CASWELL DRIVE

Until recent years, the population of Small Purple Pea near Caswell Drive was located on a rural lease. In addition to grazing pressures by kangaroos and rabbits, the site was subject to grazing by cattle and sheep. The site has now been incorporated into the ACT Nature Reserve System and is managed by the Parks and Conservation Service. The population has been inspected and monitored regularly since 2012; individual plants have been tagged since 2015. Translocation of plants from the ANBG to this site may be undertaken to improve genetic variation and recruitment.

THREATS

Urban development and agricultural practices have resulted in the loss, degradation and fragmentation of appropriate woodland habitat for the Small Purple Pea. As a result, populations of the species in the ACT are small and severely fragmented, and thus vulnerable to extinction as a result of stochastic events. Small populations are also subject to inbreeding and reduced genetic diversity; this reduces germination success and fitness within populations, and leaves them vulnerable to the impacts of disease, climate change and disturbance. Invasive plants, inappropriate fire regimes, and browsing by native and feral herbivores places additional pressure on the survival of this species (NSW OEH 2012).

Young (2001) identified genetic erosion and inbreeding as a major threat facing small populations of this species. This is due, in part, to the Small Purple Pea being an autotetraploid species that is potentially self-compatible. This results in a reduction in fitness and reproductive capability, and can impact germination success, growth rates (including maximum plant weight), disease resistance, and increased accumulation of deleterious mutations (Buza et al. 2000, Young 2001).

Changing climate

A range of indirect impacts resulting from a changing climate may threaten the persistence of the species at some sites, these include increased drought conditions, changes in plant species composition (including invasive species), and fire frequency and intensity.

A lack of connectivity and genetic diversity within populations is likely to reduce the resilience of the species to the impacts of climate change.

CONSERVATION ISSUES AND INTENDED MANAGEMENT ACTIONS

PROTECTION

A critical element in the conservation of the Small Purple Pea is the conservation of lowland grassy woodlands, including the endangered *Yellow Box-Blakely's Red Gum Grassy Woodland* under the *Nature Conservation Act (2014).* All extant populations in the ACT are protected within the ACT reserve system or are located on ACT land that is managed for conservation purposes.

ENVIRONMENTAL OFFSET REQUIREMENTS

Environmental offset requirements for species and ecological communities in the ACT are outlined in the ACT Environmental Offsets Policy and associated documents such as the ACT Environmental Offsets Assessment Methodology and the Significant Species Database. In the Assessment Methodology and Database, some of the threatened species have special offset requirements to ensure appropriate protection.

The Small Purple Pea has been determined to have a high risk of extinction in the event of further loss of habitat in the ACT. As such, offsets for this species are not appropriate.

SURVEY, MONITORING AND RESEARCH

Regular monitoring of Small Purple Pea populations by the ACT Government has improved knowledge regarding the ecology and population trends of the species. Projects have been undertaken to model the influences of climatic variables on flowering within the Mt Taylor population (Wilson et al. 2016).

The ACT Government partners with the ANBG to collect and bank the seed from various threatened plant species in the ACT, including the Small Purple Pea. There is approximately 3,400 Small Purple Pea seeds banked from populations in the ACT region. Due to the small size of ACT populations and the challenges in collecting viable seed, ongoing efforts to collect seed from ACT populations is a priority.

Survey for undiscovered populations of Small Purple Pea have previously occurred; continuing to undertake surveys to improve our understanding of the distribution of the species in the ACT is a priority. Other future monitoring and research projects should aim to improve knowledge of:

- the life history and ecology of the species, including its reproductive processes, plant and seed longevity and germination requirements
- how minimum winter temperatures affect the life history of the species
- how the frequency, seasonality and intensity of fire impacts the species and its habitat
- the genetic variation within and between Small Purple Pea populations and the genetic viability of the current seed bank
- how habitat fragmentation and reduced population size impacts genetic variability of the species
- the reliance on, and limitations of, appropriate pollinators

- the effect of future climate change scenarios on the frequency and severity of frost nights and the likely impact on flowering success
- the feasibility of translocating this species
- potential refugia sites for the Small Purple Pea under a changing climate
- suitable seed collection methods and methods for establishing new populations via translocation
- the links between the persistence and fluctuations in abundance of the species, and abiotic and biotic variables (including disturbance, predation, vegetation dominance and structure, and soil moisture, chemistry and temperatures).

MANAGEMENT

The Small Purple Pea persists as small, fragmented populations across the ACT that are at high risk of local extinction. Thus, the management priorities for the species is to maintain and enhance site condition and undertake translocation projects. Specifically, priority management actions include:

- continue annual monitoring of all known sites, including habitat condition assessments
- manage biomass through the use of fire, to maintain a heterogeneous habitat structure and diverse floristic composition
- control invasive plants that pose a threat to a population or site
- maintain an *ex-situ* population (seed bank and orchard)
- reduce the impacts of recreational activity, vehicle movement, trampling, soil disturbance and over grazing
- limiting information regarding the location of populations that is available to the public
- increase the size of existing populations and establish new populations through translocation.

All translocation projects undertaken must be consistent with the principles outlined in the Conservator Guidelines for the Translocation of Native Flora and Fauna in the ACT (ACT Government 2017) and the Guidelines for the Translocation of Threatened Plants in Australia (3rd Ed.) (Commander et al 2018).

IMPLEMENTATION

Implementation of this action plan requires:

- information identified in threatened species actions plans and other relevant documents to inform land planning and management on ACT Government Land
- allocation of adequate resources to undertake the actions specified in the strategy and action plans
- liaison with other jurisdictions (particularly NSW) with responsibility for the conservation of a threatened species or community
- collaboration with universities, CSIRO, ANBG and other research institutions to undertake research
- collaboration with non-government organisations such as Greening Australia to undertake on-ground actions
- collaboration with the community, where relevant, to assist with monitoring and other on-ground actions, and to help raise community awareness of conservation issues.

OBJECTIVES, ACTIONS AND INDICATORS

Table 1 Objectives, Actions and Indicators

Objective	Action	Indicator
Protect		
1. Protect all populations from unintended impacts (unintended impacts are those not already considered through an environmental assessment or other statutory process).	1a. Apply formal measures to ensure all populations are protected from unintended impacts (including recreation, infrastructure works and other potentially damaging activities).	All populations are protected from unintended impacts by appropriate formal measures.
	1b. Encourage other jurisdictions to protect sites where the species occurs on their lands from unintended impacts	
	1c. Ensure protection measures require site management to conserve the species.	Protection measures include requirement for conservation management.
	1d. Identify other sites where the species occurs by maintaining alertness to the possible presence of the species while conducting vegetation surveys in suitable habitat.	Vegetation surveys in suitable habitat also aim to detect the species.
Maintain		
2. Manage the species and its habitat to maintain the potential for evolutionary development in the wild.	2a. Monitor populations and the effects of management actions	Trends in abundance are known. Management actions are recorded.
	2b. Manage to conserve the species and its habitat.	Populations are stable or increasing. Habitat is managed appropriately (indicated by maintenance of an appropriate sward structure and herbage mass). Potential threats (e.g. weeds) are avoided or managed.
	2c. Maintain a database of sightings of the species, and if available, record habitat information.	Records of sightings are maintained and used to determine the distribution of the species in the ACT.

Objective	Action	Indicator
3. Reduce the impacts of genetic erosion on existing small populations	3a. Undertake genetic rescue on targeted small populations using plants sourced from genetically diverse populations.	Genetic rescue attempted at all small populations (<200 individuals).
Improve		
4. Enhance the long-term viability of populations through management of adjacent grassland/woodland to increase habitat area and connect populations.	4a. Manage grassland/woodland adjacent to the species' habitat to increase habitat area or habitat connectivity.	Grassland/woodland adjacent to or linking habitat is managed to improve suitability for the species (indicated by an appropriate sward structure and plant species composition).
	4b. Undertake or facilitate research and trials into techniques for increasing the population size.	Research trials have been undertaken to increase the size of the population. The population is stable or increasing.
5. Expand the range of the species in the ACT by providing suitable habitat and establishing new populations by translocation (upon advice from feasibility studies).	Undertake or facilitate research and trials into establishing new populations.	Research and trials have been undertaken to establish new populations. New population(s) established.
6. Improved understanding of the species' ecology, habitat and threats.	Undertake or facilitate research on habitat requirements, techniques to manage habitat, and aspects of ecology directly relevant to conservation of the species.	Research undertaken and reported and where appropriate applied to the conservation management of the species and Hall Cemetery Management Plan.
Collaborate		
7. Promote a greater awareness of, and strengthen stakeholder and community engagement in, the conservation of the species.	Undertake or facilitate stakeholder and community engagement and awareness activities.	Engagement and awareness activities undertaken and reported.

ACKNOWLEDGMENTS

The illustration of the species was prepared for the ACT Government by John Pratt.

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SUPERB PARROT

Polytelis swainsonii

ACTION PLAN

PREAMBLE

The Superb Parrot (*Polytelis swainsonii*) was declared a vulnerable species in the ACT on 19 May 1997 (Instrument No. DI1997-89 *Nature Conservation Act 1980*, Appendix A), and relisted in 2015 (Instrument No. NI2015-438 *Nature Conservation Act 2014*). Under section 101 of the *Nature Conservation Act 2014*, the Conservator of Flora and Fauna is responsible for preparing a draft action plan for listed species. The first action plan for this species was prepared in 1999 (*Action Plan No. 17*; ACT Government 1999). This revised edition supersedes the earlier edition.

Measures proposed in this action plan complement those proposed in the action plan for Yellow Box-Blakely's Red Gum Grassy Woodland, the ACT Native Woodland Conservation Strategy, and for listed threatened woodland bird species such as the Hooded Robin (*Melanodryas cucullata*), Brown Treecreeper (*Climateris picumnus*), Painted Honeyeater (*Grantiella picta*), Regent Honeyeater (*Anthochaera phrygia*), Swift Parrot (*Lathamus discolour*), and Scarlet Robin (*Petroica boodang*); available at available at the ACT Government's Environment website.

CONSERVATION STATUS

The Superb Parrot is recognised as a threatened species in the following sources:

National

Vulnerable – *Environment Protection and Biodiversity Conservation Act 1999*

Australian Capital Territory

Vulnerable – Section 91, *Nature Conservation Act 2014* (June 2016)

Special Protection Status species – Section 109, *Nature Conservation Act 2014*

New South Wales

Vulnerable – Schedule 1, *Biodiversity Conservation Act 2016* (December 2017)

Victoria

Vulnerable – Section 91, *Nature Conservation Act 2014* (June 2016)

SPECIES DESCRIPTION AND ECOLOGY

DESCRIPTION

The Superb Parrot is a medium-sized, slender green parrot, weighing 133 to 157 g. Adult birds have a distinctively long, graduated tail, and pointed, backswept wings in flight. Adult males have brilliant bright green plumage with a bright yellow forehead and cheeks, and a red band across the lower throat. Adult females are green, with a pale green-blue face, red thighs, and rose-pink patches on the inner walls of the tail feathers. Both sexes have an orange iris and a coral-red bill. Immature birds resemble the adult female with a slightly darker iris.

DISTRIBUTION

Superb Parrots are endemic to inland south-eastern Australia. It occurs throughout the inland slopes and plains of New South Wales (NSW), including the Australian Capital Territory (ACT), and extends into northern Victoria (Barrett et al. 2003). The species is considered a vagrant in Queensland (Baker-Gabb 2011).

The Superb Parrot breeding range is located west of the Great Dividing Range, mostly within the South Western Slopes (NSW) and Riverina (NSW and VIC) bioregions (Baker-Gabb 2011). On the South Western Slopes, its core breeding area is roughly bounded by Cowra and Yass in the east, and Grenfell, Cootamundra and Coolac in the west (OEH 2018). However, there are known

outlying breeding areas further east in locations such as Gundaroo and Dalton. In the non-breeding autumn and winter months, birds are observed further north and west in the central and north western slopes and plains as far north as the upper Namoi and Gwydir Rivers, with a general absence of birds in their core breeding range. However, in the last five years, individual birds and small flocks have been recorded in most known core breeding locations during the non-breeding season.

Breeding in NSW also occurs along the Murray, Edward and Murrumbidgee River corridors (OEH 2018) and this has been traditionally referred to as the "Riverina" population. This population is not known to move seasonally like the South Western Slopes population, although birds tend to spend the non-breeding season on the floodplain woodlands away from their River Red Gum forest breeding habitat. In Victoria, the species is largely confined to the Barmah Forest in the Riverina, with occasional sightings east along the Murray River.

Superb Parrots are mainly present in the ACT region during their breeding season (September to January) and sparsely distributed throughout open Eucalypt woodland between Canberra, Yass, Sutton and Gundaroo (Davey 1997). Most Superb Parrot sightings from the ACT region have been in the northern districts of Belconnen and Gungahlin. Group sizes of 20 to 30 Superb Parrots can be observed in a single year at known breeding landscapes (C. Davey/L. Rayner pers. comm.). Figure 1 shows the distribution of Superb Parrot sightings in the ACT region from November 2004 to August 2015, based on observations reported to Canberra Nature Map. Since 2015, there have been an increasing number of Superb Parrot sightings over autumn and winter in the Territory (COG unpublished data), particularly in the southern suburbs of Kambah and Wanniassa (M. Mulvaney pers. comm.). In 2018, a flock of at least 20 birds was observed near the Erindale College sportsfields (D. Oliver pers. obs), and multiple groups of 4-10 birds were present in the central Molonglo Valley until late May (L. Rayner pers. obs.).

High variability in observed Superb Parrot abundance, due primarily to movement, impedes reliable estimates of population size and growth (Manning et al. 2007). Best available recent estimates of Superb Parrot population change, based on survey data, suggest ongoing decline of the wild population across a substantial portion of their range (Ellis and Taylor 2014; Birdlife Australia 2015; A. Manning unpublished data; TSSC 2016; see Appendix B), but with an increasing number of Superb Parrot sightings in the ACT region (COG unpublished data). These regional trend patterns are consistent with bioclimatic modelling that projects a contraction and south-eastward shift of the species' range in response to climate change (Manning et al. in review; see below). However, it was estimated that there were less than 5,000 wild Superb Parrot breeding pairs left in the 1990s (Higgins 1999), a population size of 6,500 mature individuals in 2000 (Garnett and Crowley 2000) and "well over 10,000" in 2010 (Garnett et al. 2011). Most recently, BirdLife International (2016) estimated a population size of up to 20,000 mature individuals. Agreement on population estimates is lacking among experts (TSSC 2016).

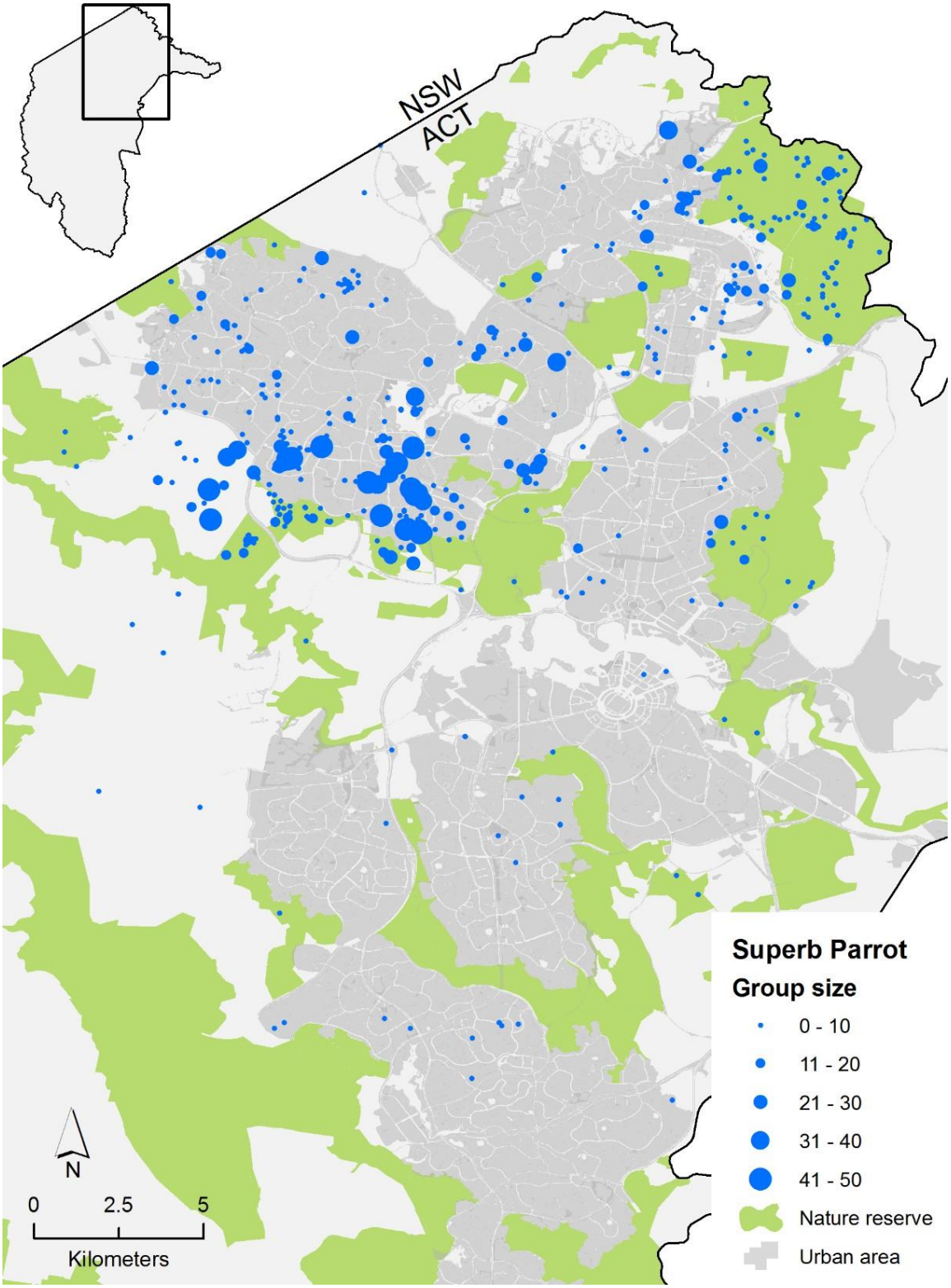
HABITAT AND ECOLOGY

Superb Parrots are an open woodland species relying on riverine forests in the Riverina, and Box-Gum woodlands in the tablelands and slopes (Webster 1988). Tree species associated with the Superb Parrot across its range include: River Red Gum (*Eucalyptus camaldulensis*), Blakely's Red Gum (*Eucalyptus blakelyi*), Scribbly Gum (*Eucalyptus rossii*), Yellow Box (*Eucalyptus melliodora*), Apple Box (*Eucalyptus bridgesiana*), Grey Box (*Eucalyptus microcarpa*), White Box (*Eucalyptus albens*), Red Box (*Eucalyptus polyanthemos*), Mugga Ironbark (*Eucalyptus sideroxylon*), Inland Red Box (*Eucalyptus intertexta*), Black Box (*Eucalyptus largiflorens*), and *Callitris* species (Baker-Gabb 2011; Rayner et al. 2015a).

Superb Parrots are highly mobile, but its movement ecology is poorly understood. The *Superb Parrot National Recovery Plan* (Baker-Gabb 2011) states that "*the Superb Parrot has been considered nomadic (Sharrock 1981), resident (Schrader 1980), dispersive (Webster 1988; Webster & Ahern 1992), migratory (Schrader 1980), or partly migratory (Higgins 1999)*". The direction, drivers and regularity of range-scale movements are unclear, though more recent

research has revealed a strong link between seasonal movements and plant productivity (Manning et al. 2007) and, potentially, changes in food supply (Baker- Gabb 2011) and drought impacts (Higgins 1999).

Figure 1. Distribution of Superb Parrots in the ACT based on sightings over an 11-year period from November 2004 to August 2015. Group sizes show the number of Superb Parrot individuals seen for each sighting. *Source:* Canberra Nature Map. Most records displayed were contributed by the Canberra Ornithologists Group.



Superb Parrots will forage in Box-Gum woodland habitats or in artificial habitats in urban areas or on private land (e.g. crops; Webster 1988; Manning et al. 2004). When breeding, Superb Parrots typically forage within 9 km of nesting habitat (see below; Webster 1988; Manning et al. 2004; Rayner et al. 2015a). The condition and connectivity of Box-Gum woodland communities that provide foraging resources proximal to Superb Parrot breeding colonies may influence the species' breeding success (Leslie 2005). In the ACT, Superb Parrot individuals will forage in urban-adjacent woodland patches (including critically endangered Yellow Box- Blakely's Red Gum Grassy Woodland) and urban forest and greenspace, particularly in flowering Eucalypts and other trees directly adjacent to playing fields (M. Mulvaney unpublished data).

Superb Parrots feed on the ground and in trees, on a variety of plant species. Their diet includes seeds of Wallaby-grass (*Rytidosperma spp.*), Barley-grass (*Critesion spp*.), Wheat (*Triticum aestivum*) and Oats (*Avena sativa*), numerous Wattles (e.g. Silver Wattle (*Acacia dealbata*), Deane's Wattle (*Acacia deanei*), and Gold Dust Wattle (*Acacia acinacea*)), and Elms (*Ulmus spp.*). Superb Parrots feed on flowers, nectar and fruits of Eucalypts (e.g. Mugga Ironbark), Mistletoe (*Amyema miquelii*, *Amyema quandang*), Dwarf Cherry (*Exocarpos strictus*), and Plums (*Prunus spp*.). Lerps taken from Eucalypt foliage are another important component of the Superb Parrot diet (Baker-Gabb 2011). In the ACT, Superb Parrot foraging locations are positively associated with vegetation cover in the 3 to 20 m height range, and the presence of Eucalypts (Blakely's Red Gum, Argyle Apple (*Eucalyptus cinerea*) and River Peppermint (*Eucalyptus elata*)), Wattles (Cootamundra Wattle (*Acacia baileyana*)), and Elms (English Elm (*Ulmus procera*) and Chinese Elm (*Ulmus parvifolia*)) (ACT Government unpublished data). Observations of Superb Parrot foraging are frequently reported in Yellow Box and Mugga Ironbark.

Superb Parrots breed singly or in loose colonies, from September to December, typically near a watercourse (Webster 1988; Manning et al. 2004). In the ACT, core breeding locations are situated in open woodland in Mulligans Flat and Goorooyarroo Nature Reserves (Davey 2010, 2012, 2013b; Rayner et al. 2015a, 2016) and in the central and lower Molonglo Valley (Davey 2013a). An obligate hollow nester, Superb Parrots rely on large, old and senescing *Eucalyptus* trees for breeding (Manning et al.2004). On the inland slopes, Superb Parrots show a strong reliance on Blakely's Red Gum for nesting (Manning et al. 2006) and this tree species, along with Scribbly Gum, contribute the majority of known Superb Parrot nest trees in the ACT (Rayner et al. 2015a, 2016). Nest trees in the ACT are typically live individuals with an average trunk diameter of 110 cm (at breast height; Rayner et al. 2016), but Superb Parrots will also nest in large standing dead trees (Manning et al. 2004; Umwelt 2015).

Superb Parrots favour nest hollows located in a trunk or primary limb, 5 to 35 m above ground (Webster & Ahern 1992; Manning et al. 2004; Umwelt 2015; Rayner et al. 2015a, 2016). Internal dimensions of Superb Parrot nest hollows vary across tree species. For example, in the ACT, nest hollows in Blakely's Red Gum are typically deeper than in Scribbly Gum. Superb Parrot nest hollows are often re- used in successive breeding seasons, and not always by the same pair (L. Rayner pers. obs.). In the ACT, re-use rates are higher for nest trees (80%) than for nest hollows (40%). That is, Superb Parrots will preferentially use a different hollow in the same nest tree, when the original hollow is otherwise unavailable (Rayner et al. 2016).

Superb Parrots lay 4–6 eggs that are incubated by the female for approximately 22 days before hatching (Higgins 1999; L. Rayner unpublished data). Nestlings are fed by both parents for approximately 40 days before fledging (Forshaw & Cooper 1981; L. Rayner unpublished data). It is estimated that Superb Parrots can live for 25 years or more (Baker-Gabb 2011). A generation time of 7.5 years is derived from an age at first breeding of 1 year and a maximum longevity in the wild of 14 years (TSSC 2016).

PREVIOUS AND CURRENT MANAGEMENT

The previous action plan for the Superb Parrot states that: "*the focus of attention for habitat protection is in the northern part of the ACT near Hall, and at Mulligans Flat*". (ACT Government

1999). Indeed, areas of public land that provide significant breeding habitat for the species (i.e. multiple adult pairs breeding over multiple years) in the northern ACT have been removed from urban zoning and formally protected as part of Goorooyarroo Nature Reserve. In this landscape, ACT Government enforced a 100-m buffer between the urban boundary and any known nest tree, and restricted development works and vehicle access in the vicinity of nest sites during the breeding season.

The second, and equally important, breeding area for Superb Parrots in the ACT is in the Yellow Box-Blakely's Red Gum Grassy Woodland located in the central and lower Molonglo Valley (Davey 2013a). On 19 August 2008, the then Minister for Planning, Andrew Barr, removed the central Molonglo Valley area from ever being considered as a future urban area (ACT Legislative Assembly – Hansard). A Memorandum of Understanding between the ACT Government and landholders guides management of the central Molonglo Valley to protect and maintain the biodiversity values of the area, including Superb Parrot nest trees, in perpetuity while enabling other compatible land uses to occur.

Superb Parrots occur in woodland and forest habitats with sparse tree cover and a grassy understorey. Historically, grassy woodland communities have been extensively cleared and severely modified throughout south-eastern Australia (Hobbs and Yates 2000). Habitat loss has been high in Yellow Box-Blakely's Red Gum Grassy Woodland, which is listed as an endangered ecological community (nationally under the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*, and in the ACT under the *Nature Conservation Act 2014*) and supports Superb Parrot breeding habitat. Due to this association, previous and current practices to improve and maintain the extent and quality of grassy ecosystems in the ACT assist management objectives for conserving the Superb Parrot population. Such practices include:

- Retaining and protecting mature, hollow-bearing trees;
- Prohibiting illegal firewood and wildlife collection;
- Thinning or replanting endemic Eucalypts to promote appropriate woodland stand densities;
- Planting of endemic Eucalypts to promote landscape connectivity; and
- Managing grazing impacts through fencing and stock rotation.

The protection and management of Superb Parrot breeding habitat is also strengthened by the listing of '*The Loss of mature trees and a lack of recruitment*' as a Key Threatening Process under the Nature Conservation Act 2014 (accepted 27 September 2018). This listing is supported by Conservation Advice (ACT Government 2018) that explicitly recognises time lags in tree hollow development and the role of dieback in accelerating mortality of trees suitable for hollow-nesting fauna.

THREATS

Due to the migratory habit of Superb Parrots, threats beyond the Territory are likely to be impacting on birds that breed, and were bred, in the ACT. The ACT Government is therefore committed to supporting research and recovery actions implemented elsewhere in the species' range, where practicable.

Within the ACT, three key threats to maintaining a viable, stable and breeding population of Superb Parrots have been identified. These threats are: (1) habitat loss; (2) climate change and (3) nest competition.

HABITAT LOSS

Superb Parrots have lost significant areas of breeding and foraging habitat due to widespread destruction and degradation of Box-dominated woodlands throughout its range in south-eastern Australia (Hobbs and Yates 2000). Consequently, Superb Parrots have undergone a substantial historical range contraction, particularly evident in Victoria (Baker-Gabb 2011). The species

currently occupies only a fraction of its former range (BirdLife International 2016), primarily in the NSW South Western Slopes bioregion (Manning et al. 2007), where over 92% of temperate woodland has been cleared (TSSC2006).

Remaining suitable Superb Parrot habitat in NSW is largely confined to roadside vegetation and small, fragmented patches of woodland on travelling stock routes and private land (Baker-Gabb 2011), which continue to be degraded by illegal clearing and habitat simplification (e.g. firewood collection, Driscoll et al. 2000). In contrast, the ACT contains some of the largest and most intact patches of lowland temperate woodland; a high proportion of which is formally protected (ACT Government 2004). However, simulation models undertaken by Manning et al. (2013) indicate that large hollow-bearing trees will continue to be lost from temperate woodland landscapes in lieu of strategic action to reduce tree mortality and increase tree recruitment. For example, in the South Western Slopes, the number of potential Superb Parrot nest trees is predicted to decline by 38% from current densities by 2050 (Manning et al. 2013).

Tree mortality within the Superb Parrot range can be exacerbated by human-induced habitat degradation caused by illegal firewood harvesting, artificially high water levels due to irrigation, inappropriate fire regimes, and overgrazing by stock, rabbits and native herbivores (Baker-Gabb 2011; Webster & Ahern 1992). Further, Eucalypt dieback, which is characteristic among Superb Parrot nest trees (Manning et al. 2004) and significantly worse in Blakely's Red Gum (Lynch et al. 2017), may accelerate nest tree mortality in the ACT region.

The loss of hollow-bearing trees poses a particular challenge to Superb Parrot conservation in the ACT because: (1) it is estimated that suitable Superb Parrot nest hollows take more than 120 years to form (Manning et al. 2004); (2) Superb Parrots show a strong preference for breeding in nest trees previously occupied by Superb Parrots (Rayner et al. 2015a, 2016), such that the loss of known nest trees may have a disproportionate negative impact on the local population; (3) Superb Parrots experience intense competition for nesting hollows, particularly from resident parrot species (Rayner et al. 2016) but also exotic species (see below); and (4) to date, attempts to supplement nest site availability with artificial structures (e.g. nest boxes) has shown little benefit to Superb Parrots (e.g. Lindenmayer et al. 2017).

CLIMATE CHANGE

A recent study by Manning et al. (in review) suggests that Superb Parrots are highly sensitive to climate change. Their analysis, using BIOCLIM models (e.g. Xu and Hutchinson 2013), projected the total bioclimatic range of the Superb Parrot will decrease by approximately 47% by 2050, and by 75% by 2070 as a result of climate change. Similar predictions have been made for Superb Parrots by the Central West Local Land Services, which are supported by detailed climate change model projections for the Central West region (Rawson 2016); a critical region for species migration, particularly from north to south and from low to high elevation.

Along with these further range contractions, it is predicted that the core range of the Superb Parrot will shift south-eastward concentrating the population over the ACT and areas to the immediate north. Such predictions are supported by regional population trends estimated for the species (Appendix B), which show significant declines in the north-west of the range (Ellis and Taylor 2014), stable or weak declining trends toward the current core range (Birdlife International 2015; A. Manning unpublished data) and an increased number of sightings in the ACT region (COG unpublished data).

The high mobility of Superb Parrots is likely to assist the species in finding viable habitat in future climates. However, supporting necessary movement through dispersal pathways and habitat continuity, and protecting and creating habitat that supports all stages of the species' life cycle, will be critical.

Importantly, the condition of woodland habitats is likely to influence future colonisation dynamics for the Superb Parrot. For example, a recent study by Tulloch et al. (2016) found that Superb Parrots have a higher probability of colonising new habitats where grazing intensity is reduced.

Climate modelling indicates that conditions suitable for Blakely's Red Gum will persist across its entire range in the ACT for the mid to long term (Mackenzie et al. 2018). Indirect influences of climate change, such as more intense insect-related defoliation, may increase levels of dieback in

Blakely's Red Gum (Lynch et al. 2017). A decline in this critical nesting resource could threaten Superb Parrot population recovery by reducing landscape-scale hollow availability and increasing competitive pressure for suitable breeding sites in novel nest tree species.

NEST COMPETITION

Inter-specific competition is a documented threat to the Superb Parrot population (Baker-Gabb 2011). Superb Parrots are an obligate hollow-nesting species and, as such, concern about the impacts of nest site competition is highest where there is a lack, or perceived shortage, of potential nest sites (Webster 1988). While ongoing loss of hollow-bearing trees is widely accepted to be an unsustainable threat to the Superb Parrot population, there is debate over whether (and, if so, where) suitable nest hollow availability is a factor limiting population growth (Davey and Purchase 2004; Manning et al. 2013; BirdLife International 2016).

Superb Parrots in the ACT show a preference for tree hollows with an average entrance diameter of 12-13 cm (Umwelt 2015; Rayner et al. 2016), and an average chamber depth exceeding 70 cm (Rayner et al. 2016). The prevalence, abundance and distribution of such hollows, among tree species and across known breeding landscapes, has not been measured or estimated. Such information is critical to understanding and forecasting resource limitation for Superb Parrots. Further, the dynamics of hollow access and exclusion in diverse woodland faunal communities are difficult to measure and have not been studied in detail. Where aggressive, competitive interactions do not result in the obtainment or usurpation of a Superb Parrot nesting site, indirect effects of competitor visitation and harassment on individual fitness and provision rates remain plausible (L. Rayner pers. comm.).

Given such knowledge gaps, understanding the effects of nest competition on Superb Parrots is currently limited to data on the presence and abundance of known and potential competitors. Potential nest site competitors include the Crimson Rosella (Platycercus elegans), Common Starling (Sturnus vulgaris), Sulphur-crested Cockatoo (Cacatua galerita), Eastern Rosella (Platycercus eximius), Common Myna (Acridotheres tristis), Galah (Eolophus roseicapilla), Little Corella (Cacatua sanguinea) and Long-billed Corella (Cacatua tenuirostris) (Webster 1988; Baker-Gabb 2011; Rayner et al. 2015a). In the ACT, concern has been raised about the impact of the exotic Common Myna (Pell and Tidemann 1997; Davey 2013b), but clear evidence of disruption to Superb Parrot nesting success from this species is lacking. Rayner et al. (2015, 2016) identify the native Crimson Rosella and the exotic Common Starling as the dominant competitors for Superb Parrot nesting sites in the ACT. There are also anecdotal reports of feral honey bees (Apis mellifera) occupying potential Superb Parrot nest sites, although their significance and level of impact is not known (Baker-Gabb 2011).

In the ACT, nest site competition in Superb Parrot breeding landscapes is high (Davey et al. 2013b; Rayner et al. 2015a, 2016) and likely to increase given projected increases in the regional population due to climate change (Manning et al. in review). The potential impacts of current and future urban developments in Canberra on urban and woodland bird communities, and specifically the abundance of hollow-dependent birds, is likely to influence competition for nesting sites in the ACT (Rayner et al. 2015b).

ADDITIONAL THREATS

Other threats to Superb Parrots that are poorly understood or prevalent outside of the species' range, and therefore not a focus of this action plan, include:

Urban impacts – Superb Parrots commonly breed in peri-urban woodland, and research into the disruption to Superb Parrot breeding activity from existing suburbs and new developments is in its infancy. Preliminary results from the ACT indicate that Superb Parrots require a distance of at least 200 m to buffer the impacts of urban development on nest selection (ACT Government unpublished data). Negative urban impacts can include: construction disturbance, altered competitor and predator exposure, noise and light pollution, increased human activity, and/or loss of habitat connectivity. Urban impacts may be direct or indirect and may increase with proximity to the urban boundary (e.g. Rayner et al. 2015b).

Vehicle strike – Superb Parrots are highly susceptible to death by vehicle strike, particularly in rural areas

where large flocks can be killed while feeding at the roadside on spilt grain (Rees 2016).

Predation – Predation of Superb Parrot nests is low in the ACT (Rayner et al. 2015a, 2016). However, predation of adult Superb Parrots by feral cats, dogs and foxes, particularly while individuals forage on the ground, has not been studied.

Poisoning – Poisons used for pest control, and pesticides used for crop management, have been identified as potential threats to Superb Parrot breeding success (Baker-Gabb 2011).

Illegal trade - It is believed that many thousands of wild Superb Parrots have illegally entered the aviculture trade (Baker-Gabb 2011), but the level of ongoing threat from such activities is unclear.

Psittacine beak and feather disease (PBFD) - Superb Parrots are susceptible to PBFD, but incidence and transfer of this fatal disease among Superb Parrot individuals is poorly understood.

MAJOR CONSERVATION OBJECTIVES

The overall objective of this plan is to maintain a wild, self-sustaining population of Superb Parrots across its natural geographic range in the ACT. This includes the conservation of natural evolutionary processes. Specific objectives of the action plan are to:

- Conserve the ACT population of Superb Parrots by protecting landscapes that support confirmed breeding colonies.
- Enhance long-term viability of Superb Parrot populations through management of open woodland to increase breeding and foraging habitat area.
- Enhance long-term viability of Superb Parrot populations through management of urban landscapes to aid connectivity and promote foraging habitat.
- Improve understanding of Superb Parrot ecology, including habitat selection, resource requirements and emerging threats.
- Promote greater awareness of, and strengthen stakeholder and community engagement in, the conservation of Superb Parrots.

CONSERVATION ISSUES AND INTENDED MANAGEMENT ACTIONS

PROTECTION

Superb Parrots are a highly mobile species that moves through much of northern ACT during the breeding season. During this time it nests in open woodland habitats and forages in small woodland patches and urban greenspace. This pattern of habitat use also has become increasingly common in southern Canberra. As such, Superb Parrots occur on land under a range of tenures.

A major focus of Superb Parrot protection measures in this action plan are on critical breeding habitat as indicated by the presence of: (i) a known nest tree, or (ii) a confirmed breeding colony. Here, we define a breeding colony as the aggregation of at least four adult Superb Parrot pairs that attempt to nest, in the same year, within an 80-ha area, where the maximum distance between these nesting attempts is 1 km. This definition is supported by Superb Parrot breeding research undertaken in the ACT (Rayner et al. 2015a, 2016) and may not be a suitable definition for areas beyond the ACT or under future climates. Where a new superb parrot breeding colony is located in the ACT, further survey work will be required to determine the extent of nesting effort in the supporting landscape (as per Superb Parrot survey guidelines, see Table 1 - Action 1d). Once all nesting events are located, the area requiring formal protection will be the minimum convex polygon area (IUCN 2015) containing those nesting events, with an additional 200 m conservation buffer applied to the polygon perimeter. This is an evidence-based buffer distance, with results of ACT Superb Parrot research indicating that the distribution of breeding Superb Parrots in woodland is impacted within 200 m of disturbance. As such, this action plan seeks to protect critical breeding habitat from direct and indirect threats.

Bioclimatic projections indicate that additional areas of the ACT may become suitable for breeding Superb Parrots in the future, particularly in the south of the Territory. Similarly, with an increasing

number of birds over-wintering in the ACT in recent years, the protection of emerging wintering grounds may be required. For the purpose of this action plan, wintering grounds are defined as locations in the ACT where repeat sightings of Superb Parrots, within or between years, occur from 1 June to 31 August.

ACT Government will explore options for the protection of new and future Superb Parrot habitat on Territory land, as such information becomes available (see below). ACT Government also will seek to apply formal protections to known Superb Parrot movement pathways on Territory land, which can include the nomination of trees identified as important movement 'stepping stones' to the ACT Tree Register, established under the Tree Protection Act 2005 (https://www.legislation.act.gov.au/a/2005-51/default.asp). The ACT Government also will cooperate with surrounding shires in NSW to protect and enhance regional habitat and movement corridors for the species.

ENVIRONMENTAL OFFSET REQUIREMENTS

Environmental offset requirements for species and ecological communities in the ACT are outlined in the ACT Environmental Offsets Policy 2015. The ACT Government has committed to assess and offset impacts to Superb Parrots from the Throsby and Molonglo Valley residential developments. These commitments form part of the Gungahlin Strategic Assessment and Molonglo Strategic Assessment offset packages approved by the Commonwealth Government under the EPBC Act 1999.

Avoidance, mitigation and offset measures detailed in the Gungahlin Strategic Assessment Biodiversity Plan 2013 and Molonglo Valley Plan for the Protection of Matters of National Environmental Significance 2011 meet requirements for the protection of matters of national environmental significance under the EPBC Act. As a condition of these plans, the ACT Government is required to manage Superb Parrots to ensure long-term persistence of breeding individuals in northern ACT. These plans, and supporting documents, are publicly available on the ACT Environmental Offsets Register.

The Molonglo Valley plan does not specify conservation actions and outcomes for Superb Parrots but acknowledges benefit to Superb Parrots through the protection and conservation of Box-Gum woodland within the Molonglo Valley strategic assessment area. However, a targeted survey was undertaken as part of the Molonglo Adaptive Management Strategy 2013 to establish the baseline distribution, abundance and breeding status of Superb Parrots within the Molonglo Valley strategic assessment area.

Conservation outcomes planned for Superb Parrots in the Gungahlin Strategic Assessment Biodiversity Plan 2013, to be achieved through direct and indirect offsets, include:

- Long-term persistence of a breeding Superb Parrot population in northern ACT;
- Improved management of potential Superb Parrot habitat to support population recovery;
- Improved understanding of Superb Parrot habitat requirements for foraging and dispersing within peri-urban and urban environments;
- Improved understanding of Superb Parrot breeding ecology in the northern ACT in terms of site fidelity and nest success; and
- Improved Superb Parrot habitat connectivity through strategic planting in the northern ACT.

The *Superb Parrot Habitat Improvement Plan 2015* and *Extension to the Mulligans Flat and Goorooyarroo Nature Reserves Offset Management Plan 2015* were developed to guide the implementation of ecological management activities and support progress toward the above conservation outcomes within the offset areas.

Environmental offset research commitments have advanced ecological knowledge of Superb Parrots in northern ACT and, in turn, support the development of conservation priorities defined in this action plan. Annual reports (Rayner et al. 2015a, 2016) that summarise the findings of Superb Parrot offset research are publicly available on available at the ACT Government's Environment website. There remain significant knowledge gaps about the ecology of Superb Parrots and further ecological research and monitoring of Superb Parrots is required to fulfil the ACT Government's strategic assessment commitments (see below).

MONITORING AND RESEARCH

Superb Parrot distribution and abundance varies in response to seasonal conditions at the landscape scale (Manning et al. 2007). Therefore, long-term monitoring is essential to determine the population status of Superb Parrots in the ACT region and evaluate the success (or otherwise) of conservation measures implemented. The collection of baseline population data at key breeding locations is needed to: (i) determine Superb Parrot population size and growth; (ii) track population variability to derive robust population trend estimates that inform the species' conservation status; and (iii) measure the potential direct and indirect impacts of human-related disturbance and climate change.

Superb Parrot survey data has been collected in the ACT by Davey (2010, 2012, 2013a, 2013b), by the Canberra Ornithologists Group through the *ACT Woodland Bird Monitoring Program* and *Garden Bird Survey*, by the public through the online reporting tool *Canberra Nature Map*, and by the ACT Government (Umwelt 2015, SMEC 2017, Rayner et al. 2015a, 2016). Preliminary survey work by Davey (2010) aimed to identify ecological constraints to proposed urban development and resulted in improved understanding of the distribution and habitat preferences of Superb Parrots in the ACT, including the identification of active breeding colonies and core breeding areas (Davey 2010, 2013a).

A monitoring and research project was initiated by the ACT Government in 2015 within the Mulligans Flat and Goorrooyarro Nature Reserves and within a rural lease in the lower Molonglo, as part of environmental offset area management under commonwealth approval conditions. The project is a collaboration between the Australian National University and the ACT Government, and involves surveys for breeding individuals, nest hollow surveillance and GPS tracking. The project aims to measure reproductive output and identify variables influencing nest success and movement of Superb Parrots in the ACT. In 2017, this project was expanded to include the central and lower Molonglo Valley breeding colony identified by Davey (2013a). This work involved developing and implementing a comprehensive monitoring strategy for Superb Parrots in the ACT, resulting in mapping of known Superb Parrot nest trees, and an improved understanding of breeding success, nest site selection and local foraging movements (Rayner et al. 2015a, 2016). In 2017, the ACT Government used tracking data from individual Superb Parrots tagged within Goorooyarroo Nature Reserve (Rayner et al. 2015a) to investigate foraging site selection within the ACT.

Superb Parrot monitoring and research in the ACT will continue to focus primarily on reproductive participation and output in woodland habitats on reserve and rural land. Further monitoring and research is required to better understand Superb Parrot movement ecology and future habitat selection in response to climate change and habitat-related disturbance. Specific research priorities for the ACT are outlined in Table 1 (below). Key research objectives include:

Monitor reproductive participation and output – in critical breeding habitat.

Characterise breeding and foraging resources – that support reproductive success of the ACT population.

Assess competition and predation at known nesting sites – to be achieved through remote camera data collection and nest survival analysis.

Investigate efficacy of artificial breeding habitat – exploring whether designed artificial hollow structures (nest box, log hollow, artificial limb or created hollow chamber) can increase Superb Parrot recruitment.

Monitor emerging occupancy – confirm new Superb Parrot habitat through field surveys in the breeding season, with focus on southern grassy woodland areas (e.g. Tuggeranong district).

Update guidelines for surveying Superb Parrots – at different stages of the species' life cycle, to deliver robust estimates of abundance, distribution and annual productivity.

Identify future potential habitat – using a combination of monitoring surveys, ecological

research, and predictive modelling to guide long-term protection of critical Superb Parrot habitat, with focus on the distribution and abundance of large (> 75 cm diameter at 130 cm above ground) hollow-bearing trees.

Investigate movement ecology – advance cross-jurisdictional partnerships to develop tracking techniques, identify wintering habitats and advance knowledge of range-wide movements.

MANAGEMENT

Due to the high mobility of Superb Parrots and the uncertainty associated with future habitat use, management actions will be focused on maintaining and enhancing habitat quality at known breeding and foraging locations (based on best available evidence) and preventing or minimising any adverse impacts on Superb Parrots from activities occurring in adjacent landscapes.

Known breeding areas in the ACT are described in Davey (2010, 2012, 2013a, 2013b), Umwelt (2015), Rayner et al. (2015, 2016) and SMEC (2017), providing valuable ecological data for managing broad structural attributes of breeding habitat. Hotspots of foraging activity by breeding Superb Parrots have been identified by Rayner et al. (2015) and the ACT Government (unpublished data). This research showed that 68%, 28% and 4% of foraging stops occurred on urban, reserve and rural land respectively. Superb Parrot foraging on reserved land was contained almost exclusively to the Mulligan's Flat-Goorooyarroo Extended Woodland Sanctuary, while foraging stops in urban environments were more widely distributed. The ACT Government will explore opportunities to develop conservation arrangements with managers of ACT urban forest and greenspace to protect foraging locations critical to Superb Parrots. Foraging locations within the ACT urban environment that require sensitive ecological management include, but are not limited to:

- Mullion Park and surrounds, Harrison
- Gungahlin Cemetery, Mitchell
- Bellenden Street, Crace
- Kaleen Playing Fields and North Oval, Kaleen
- Fern Hill Park. Australian Institute of Sport and surrounds, Bruce
- Billabong Park and Just Robert Hope Park, Watson
- John Knight memorial Park, Belconnen
- Spofforth Street Golf Course, Holt
- Parkland around Ginninderra Creek near MacGregor Oval, MacGregor
- Parkland between Ginninderra Drive and Goodwin Hill, MacGregor
- Charnwood Playing Fields and Boslem/Harte Park, Charnwood

Maintaining the ecological integrity of ACT habitat that supports Superb Parrot breeding colonies is a priority and contributes to population recovery efforts undertaken throughout the species' range. Key management actions for ensuring the persistence of Superb Parrots in the ACT include:

Map and retain known nest trees - living and dead - that have been used by Superb Parrots in the last five years. Potential nest trees in future habitats should be protected against removal when relevant bioclimatic projections become available.

Mitigate projected woodland tree loss – to be achieved through a combination of revegetation works and management of grazing pressure to support natural regeneration (where appropriate).

Promote favourable vegetation structure - at breeding and foraging locations; includes the maintenance of suitable tree stand densities, ground layer diversity and strategic augmentation plantings (e.g. acacias near breeding sites).

Promote urban foraging resources – includes liaison with Transport Canberra and City Services Directorate to update Municipal infrastructure Design Standards for urban landscape projects,

with particular attention to suburbs within 9 km of known breeding colonies.

Identify and retain vegetation that facilitates movement – particularly local movements between breeding and foraging locations. Seasonal migration pathways should be protected if/when tracking technology allows for such insight.

In addition to these on-ground actions, the ecological management of woodland remnants and protection of scattered paddock trees on private land will be supported.

IMPLEMENTATION

Implementation of conservation actions outlined in the ACT Native Woodland Conservation Strategy and action plan for Yellow Box-Blakely's Red Gum Grassy Woodland will be fundamental to making progress towards the objectives of this action plan. Further, implementation of this action plan will require:

- Land planning and land management areas of the ACT Government to consider the conservation of Superb Parrots and grassy woodland ecosystems;
- Allocation of adequate resources to undertake the actions specified in the ACT Native Woodland Conservation Strategy and Superb Parrot Action Plan;
- Liaison with other jurisdictions (particularly NSW), landholders (Commonwealth Government) and stakeholders (e.g. National Superb Parrot Recovery Team) with responsibility for the conservation of Superb Parrots and grassy woodland ecosystems;
- Collaboration with universities, CSIRO and other research institutions to facilitate and undertake necessary Superb Parrot research;
- Collaboration with non-government organisations (e.g. Canberra Ornithologists Group), citizen scientists and the wider community to assist with monitoring and on-ground actions, and to help raise awareness of Superb Parrot conservation and recovery issues.

Implementation of this action plan will result in new knowledge about the habitat and ecology of Superb Parrots. This knowledge should inform the implementation and review of actions in this plan. Under s.108 of the *Nature Conservation Act 2014* the Conservator of Flora and Fauna must report to the Minister about each action plan at least once every five years and make the report publicly accessible within 30 days. The Scientific Committee must review an action plan every 10 years, or at any other time at the Conservator's request.

OBJECTIVES, ACTIONS AND INDICATORS

Table 1 Objectives, Actions and Indicators

Objective	Action	Indicator
PROTECT		
1. Conserve the ACT Superb Parrot population by protecting areas that support breeding birds and emerging wintering grounds.	1a. Apply formal measures to protect critical breeding habitat of Superb Parrots on Territory land. Encourage formal protection of critical breeding habitat on Commonwealth land.	All critical breeding habitat of the Superb Parrot is protected by appropriate formal measures.
	1b. Identify and apply formal protection measures to trees on Territory land that support Superb Parrot movement.	All trees identified as 'stepping stones' are nominated for protection via the ACT Tree Register.

Objective	Action	Indicator
	1c. Track the conservation status of Superb Parrots by monitoring abundance in areas that support confirmed breeding colonies and, where appropriate, at emerging ACT wintering grounds.	Superb Parrot abundance is stable or increasing (accounting for temporal population variability and/or future range shift).
	1d. Review and update monitoring and survey guidelines for Superb Parrots.	New guidelines for surveying Superb Parrots are produced.
MAINTAIN & IMPROVE		
2. Enhance long-term viability of Superb Parrot populations through management of open woodland to increase breeding and foraging habitat area.	2a. Manage woodland habitat to ensure persistence of Superb Parrot breeding and foraging resources.	All Superb Parrot nest and forage trees in open woodland, with evidence of use in the last 5 years, are mapped and retained.
	2b. Undertake tree planting to mitigate long-term habitat tree loss in the vicinity of known Superb Parrot breeding locations.	Hollow producing Eucalypt species, such Blakely's Red Gum, Scribbly Gum, River Red Gum and Red Box, are strategically planted within 100 ha of known Superb Parrot breeding locations.
	2c. Maintain suitable understorey structure and condition, particularly ground layer diversity, at known Superb Parrot foraging sites in open woodland.	Understorey condition is maintained or improved at known Superb Parrot foraging sites in open woodland.
3. Enhance long-term viability of Superb Parrot populations through management of urban landscapes to aid connectivity and promote foraging habitat.	3a. Provide advice to planners on plant species favoured by Superb Parrots for foraging in urban open space.	Superb Parrot feed plant species are planted and promoted at known urban foraging locations.
	3b. Provide advice to planners on the location and species composition of Superb Parrot urban movement corridors.	Suitability of known Superb Parrot urban movement corridors is maintained or improved.
4. Improve understanding of Superb Parrot ecology, including habitat selection, resource requirements and emerging threats.	4a. Support Superb Parrot research initiatives that: (i) identify and map critical habitat areas (*i.e.* breeding and foraging locations) and (ii) characterise critical habitat resources (e.g. tree hollows)	Data on Superb Parrot nest tree locations, and nest hollow dimensions, are collected and mapped.

Objective	Action	Indicator
	4b. Support Superb Parrot research initiatives that: (i) evaluate competitive pressure of co- occurring hollow-using species; and (ii) measures prevalence and impacts of nest predation.	Detailed long-term monitoring of Superb Parrot nest success is undertaken at one or more known breeding locations.
	4c. Support research that advances knowledge of Superb Parrot foraging ecology, including the identification of variables (e.g. plant species) that determine optimum foraging habitat.	Data on Superb Parrot multi- strata foraging habitat selection and foraging behaviour are collected and analysed.
	4d. Support research that advances knowledge of Superb Parrot migration flightpaths, including the potential use of habitat corridors across jurisdictions.	The efficacy of local- and range-scale satellite telemetry tracking methods is investigated and tested.
	4e. Support research that investigates the potential of hollow creation, manipulation and supplementation for improving nest success and breeding productivity of Superb Parrots.	Hollow manipulation and supplementation trials are explored at one or more known breeding locations.
	4f. Support research that defines future potential Superb Parrot breeding and movement habitat in response to climate change.	Future potential Superb Parrot habitat is identified and considered in conservation decision making.
COLLABORATE		
5. Promote greater awareness of, and strengthen stakeholder and community engagement in, the conservation of Superb Parrots.	5a. Undertake or facilitate stakeholder and community engagement and awareness activities.	Increased awareness and participation by the community to assist Superb Parrot recovery actions in the ACT.
	5b. Actively seek and facilitate citizen scientist involvement in research activities, where possible.	Citizen science activities are actively supported.
	5c. Support cross-jurisdictional Superb Parrot conservation research and monitoring initiatives.	Cross-jurisdictional engagement activities are undertaken.
	5d. Collaborate with Throsby residents to demonstrate and promote beneficial conservation actions that support Superb Parrot populations in adjacent woodland habitat.	A conservation workshop is held with the residents of Throsby.

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APPENDIX A

NATURE CONSERVATION ACT (1980) CRITERIA SATISFIED

2.1 The species is known to occur in the ACT region and is already recognised as vulnerable in an authoritative international or national listing.

2.2 The species is observed, estimated, inferred or suspected to be at risk of premature extinction in the ACT region in the medium-term future, as demonstrated by:

2.2.1 Current serious decline in population or distribution from evidence based on:

2.2.1.1 Direct observation, including comparison of historical and current records;

2.2.1.3 Serious decline in quality or quantity of habitat; and

2.2.1.5 Serious threats from herbivores, predators, parasites, pathogens or competitors.

2.2.4 Seriously fragmented distribution for a species currently occurring over a moderately small range or having a moderately small area of occupancy within its range.

2.2.6 Small population.

APPENDIX B

POPULATION TREND ESTIMATES

The following trend estimates have been derived for the Superb Parrot:

- The *State of Australia's Birds 2015* report (Birdlife Australia 2015) indicated a weak (non-significant) decline in Superb Parrot reporting rate between 1999 and 2013 for the South-east Mainland Region;
- Ellis and Taylor (2014) indicated a significant decline (50%) in Superb Parrot reporting rate between 2005 and 2013 in central western NSW; and
- An analysis by Manning et al. (unpublished data) indicated a significant decline (53%) in Superb Parrot reporting rate between 2001 and 2014 in the core breeding range.

TARENGO LEEK ORCHID

Prasophyllum petilum

DRAFT ACTION PLAN

PREAMBLE

The Tarengo Leek Orchid (*Prasophyllum petilum*, D.L.Jones & R.J.Bates 1991) was declared an endangered species on 15 April 1996 (Instrument No. DI1996-29, *Nature Conservation Act 1980*). Under section 101 of the Nature Conservation Act 2014, the Conservator of Flora and Fauna is responsible for preparing a draft Action Plan for listed species. The first Action Plan for this species was prepared in 1997 (ACT Government 1997). This revised edition supersedes the earlier edition.

Measures proposed in this Action Plan complement those proposed in the Action Plans for Yellow Box Blakely's Red Gum Grassy Woodland, Natural Temperate Grassland and component threatened species such as the Small Purple Pea. This draft action plan includes any relevant parts of the Draft ACT Native Woodland Conservation Strategy.

CONSERVATION STATUS

The Tarengo Leek Orchid (*Prasophyllum petilum*) is recognised as a threatened species in the following sources:

National

Endangered - *Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth).*

Australian Capital Territory

Endangered - *Nature Conservation Act 2014.*

Special Protection Status Species - *Nature Conservation Act 2014.*

New South Wales

Endangered – *Biodiversity Conservation Act 2016*.

CONSERVATION OBJECTIVES

The overall objective of this plan is to preserve the Tarengo Leek Orchid in perpetuity in the wild across its natural geographic range in the ACT. This includes the need to maintain natural evolutionary processes.

Specific objectives of the action plan are to:

- Protect sites where the species is known to occur in the ACT from unintended impacts; including the implementation of suitable buffers around habitat to safeguard against any negative impacts from potential future re-zoning or development.
- Manage the species and its habitat to maintain the potential for evolutionary development in the wild.
- Improve the long-term viability of populations through management of adjacent woodland to increase habitat area and connect sub-populations.
- Expand the range of the Tarengo Leek Orchid in the ACT by providing suitable habitat and establishing new populations by translocation (upon advice from feasibility studies).

- Improve the understanding of the species' ecology, habitat and threats.
- Strengthen stakeholder and community collaboration in the conservation of the species.

SPECIES DESCRIPTION AND ECOLOGY

DESCRIPTION

The Tarengo Leek Orchid is a slender terrestrial orchid that grows to 30 cm, with its single cylindrical leaf reaching 25 cm (DECCW 2010). The flower spike emerges from October through to November and produces 5 to 18 flowers. After flowering, small obovoid seed capsules form. The leaves and flowers are both dull green with pink tinges on the flowers, making this a very inconspicuous plant when growing among tall grasses or in small numbers.

DISTRIBUTION

Known populations of the Tarengo Leek Orchid occur in grassy woodlands and grasslands of the southern tablelands and western slopes of NSW and the ACT. The largest known population is at the Tarengo Travelling Stock Reserve near Boorowa (NSW), where there is estimated to be up 100,000 plants some years. Other populations have been found as far north as Ilford Cemetery (Bathurst, NSW), to the south at Steve's Travelling Stock Reserve (Delegate, NSW) and to the east at Captains Flat Cemetery (NSW) (DECCW 2010). These populations have relatively few individuals, but provide an insight into the extent of the population. Given the level of fragmentation and degradation across this region, it may be assumed that the Tarengo Leek Orchid was once more common and widespread than it is today.

Within the ACT, the Tarengo Leek Orchid is only known to occur at the Hall Cemetery, where the species was first properly identified in 1991. The number of flowering plants at the Hall Cemetery has fluctuated from year to year, within the range of 0 to 96. However, between 20 and 60 flowering plants are usually counted each year. Statistical analysis of the population indicates that it increased until the early 2000s, from which point it has remained relatively stable (Wilson et al. 2016).

The most up to date distribution data for this species is publicly available on the ACT Government's mapping portal, ACTmapi.

HABITAT AND ECOLOGY

The Tarengo leek Orchid tends to grow among native – and to a lesser extent exotic – grasses on fertile soils of low relief. Species of the genus Prasophyllum are known to prefer moister soils in depressions and swamps (Jones 1988), a trend that appears to apply to the Tarengo Leek Orchid. The population at the Hall Cemetery occurs in a partially cleared area within a Yellow Box Blakely's Red Gum grassy woodland. The site is typical of the Tarengo Leek Orchid habitat and is dominated by Kangaroo grass (Themeda triandra) and Wallaby grasses (Rytidosperma spp.) with a high diversity of forbs. There are localised dominant patches of the exotic grasses Yorkshire Fog (Holcus lanatus) and Sweet Vernal-grass (Anthoxanthum ordoratum), which fluctuate annually.

Given the small population size and relatively recent identification, the biology and ecology of the Tarengo Leek Orchid is poorly understood. For much of the warmer months, the plant persists as a tuber, before shooting in late autumn. The inflorescence develops folded in half inside the leaf before flowering in late spring. An individual flowering in consecutive years is uncommon, and may contribute to the fluctuations in the population (Wilson et al. 2016). When flowering has been observed more than once in an individual, the minimum interval between flowering is generally less than 5 years. However, periods of up to 16 years between flowering have been recorded at the Hall Cemetery. Comparable fluctuations between the Hall Cemetery and Tarengo Travelling Stock Reserve populations indicate that landscape scale factors – such as climate – may influence flowering. Minimum winter temperatures, particularly the

number of nights at or below -4oC, are associated with lower numbers of recorded flowering plants at the Hall Cemetery (Wilson et al. 2016). This finding indicates that cold air and frost may damage the leaf and thus prevent flowering.

The flowers of Prasophyllum species are pollinated by insects, particularly bees and wasps, that are attracted by the nectar and scents produced by the flower (Jones 1988). A generalist thynnine wasp has been observed as an important pollinator for the Tarengo Leek Orchid (DECCW 2010). Like most orchids, Prasophyllum species are generally outcrossers and although reproduction is mostly by seed, daughter tubers are also produced (Jones 1988). The conditions associated with viable seed production are not known and attempts to disperse seed at sites known to have once been occupied by the Tarengo Leek Orchid have been unsuccessful. Prasophyllum species require a fungal symbiont, however the species associated with the Tarengo Leek Orchid remains unknown (DECCW 2010).

PREVIOUS AND CURRENT MANAGEMENT

The only known population of the Tarengo Leek Orchid in the ACT occurs at the Hall Cemetery. The site was set aside in 1883, but was left untouched until 1907 when a small portion of the land was cleared, fenced off and the first burials took place (DECCW 2010). The site was managed by trustees until the mid-1970s. During this time the grass was burnt on an almost annual basis, but grazing by livestock was rare, if not completely absent. After a change in management in 1976, the site was mown at least three times a year. In 1988, the cemetery became a public cemetery managed by the Canberra Public Cemeteries Trust with regular mowing occurring until 1994.

Since the population at the Hall Cemetery was identified in 1991, there have been several instances where individuals have been dug up, or damaged by establishment of graves. In 1994 a mowing plan was established to avoid mowing plants while they are above ground. However, there have been further instances of plants being mown or damaged during or before flowering until around 2013. The Hall Cemetery Management Plan (Wildlife Research and Monitoring and Canberra Cemeteries 2005) provided recommendations on how to undertake common activities, while minimising damage to the Tarengo Leek Orchid population. This Plan was later updated in 2013 (Conservation Research and Canberra Cemeteries 2013).

The Hall Cemetery remains an active site with several burials every year. There is a current proposal for additional burial portions within the existing cemetery block to accommodate burials for the next 20 – 25 years. The scope of the proposal includes the protection of the existing orchid population and habitat as well as ongoing restoration of the grassy Yellow Box Blakely's Red Gum woodland. Neighbouring blocks (310 and 312) have been identified for future expansion of the cemetery. These blocks have a history of grazing and the Tarengo Leek Orchid is not known to occur there. The 'Pf' Public Land overlay of the cemetery block, which allows burials to occur, was expanded on 24/11/05 in the Territory Plan to include Blocks 310 and 312 (ACT Government 2005).

Since 2008, Friends of Grasslands (FoG) – a volunteer organisation – in cooperation with Canberra Cemeteries and Conservation Research, has conducted removal of woody weeds, thistles and exotic grasses as well as the re-planting of under-storey species in the woodland area surrounding the cemetery. Up until 2013, this included the removal of eucalypt regeneration from within and around the Tarengo leek Orchid population as a means of preserving the open grassy habitat occupied by the species. As an adaptive management measure to ensure the ongoing persistence and health of the remnant woodland in the cemetery, this practice has been scaled back and individual saplings have been identified for protection from mowing with the implementation of the updated Hall Cemetery Management Plan in 2013 (Conservation Research and Canberra Cemeteries 2013). The recent findings by Wilson et al. (2016) of a negative relationship between flowering of the Tarengo Leek Orchid at the Hall Cemetery and the number of nights equal to or colder than -4^{o}C also highlights the need to ensure the persistence of elevated vegetation as both a grassy sward and intact woodland in and around the Hall

Cemetery. Maintaining vegetation structural complexity will help in avoiding frequent and severe frosts across the orchid habitat.

THREATS

The major threat to the Tarengo Leek Orchid in the ACT is its restricted range and population size. There is the potential for the ACT population to go extinct in a single event. Further, the isolation from other populations limits localised genetic diversity, leaving it vulnerable to environmental change and disease. Within the current management paradigm, fine-scale habitat loss is likely as new graves are established. However there is consideration for avoiding the establishment of new graves in known Tarengo Leek Orchid habitat.

For many years a flock of Sulphur-Crested Cockatoos (Cacatua galerita) have repeatedly visited the Cemetery to feed during spring, primarily on the bulb of the weed species Onion Grass (Romulea rosea). They often cause damage to Tarengo Leek Orchid flowering stems and those of other native forb species (eg. Bulbine Lily) by biting through the stems. Areas of orchid habitat are also disturbed by the birds digging in their search for Onion Grass bulbs. The extent of disturbance varies annually. Such damage has the potential to reduce the production of viable seed, and could affect the recruitment of new individuals as well as reduce habitat condition.

Competition from both native and exotic species is also considered to be a risk. Patches of the Hall Cemetery are dominated by exotic grasses that are feared to be overcrowding individual plants. Given that exotic grasses have been present throughout the monitoring period, they do not appear to present an imminent threat, but require close monitoring. There are also concerns that Kangaroo Grass may be encroaching and present a threat at the Tarengo TSR site (NSW OEH 2012). However, Kangaroo Grass is the dominant native grass species at the Hall Cemetery and is unlikely to be a threat.

CHANGING CLIMATE

Climate is considered to influence flowering in the Tarengo Leek Orchid, with recent analysis indicating flowering is associated with minimum winter temperatures (Wilson *et al.* 2016). Consequently climate change may present a threat to the population of the Tarengo Leek Orchid if it were to result in an increased number of frost nights. To what extent climate change may influence the species remains unknown.

CONSERVATION ISSUES AND INTENDED MANAGEMENT ACTIONS

PROTECTION

A critical element in the conservation of the Tarengo Leek Orchid is the conservation of Yellow Box

Blakely's Red Gum Grassy Woodland and Natural Temperate Grassland. Both of these communities have been listed as endangered in the ACT, and have their own Action Plans and Strategies. The Hall Cemetery population occurs in partially modified Yellow Box Blakely's Red Gum Grassy Woodland that has remained in relatively stable state for over a century. This land is primarily managed by the Canberra Public Cemeteries Trust, who has worked with ACT Government to maintain this population of the Tarengo Leek Orchid.

ENVIRONMENTAL OFFSET REQUIREMENTS

Environmental offset requirements for species and ecological communities in the ACT are outlined in the ACT Environmental Offsets Policy and associated documents such as the ACT Environmental Offsets

Assessment Methodology and the Significant Species Database. In the Assessment Methodology and Database, some of the threatened species have special offset requirements to ensure appropriate protection. It has been determined that the Tarengo Leek Orchid is not able to withstand further loss in the ACT so offsets for this species are not appropriate.

If threatened species numbers are observed to change dramatically (either increase or decrease), a review of the threshold for that particular species in the Assessment Methodology and Database would be undertaken.

SURVEY, MONITORING AND RESEARCH

Since the population at the Hall Cemetery was first identified, it has been monitored on an almost annual basis, resulting in a quality long term population dataset. Projects have also been conducted to determine the pattern and timing of the annual life stages of the species and to model the stability of the population and the influences of climatic variables on flowering within the Hall population.

Conservation Research have partnered with the Australian National Botanic Gardens (ANBG) on numerous occasions to collect and bank the seed from various threatened plant species in the ACT. The Tarengo Leek Orchid has been part of a number of these projects. There is currently 0.3976 grams (equating to ~ 198, 203 seeds) of Tarengo Leek Orchid seed banked from the Tarengo TSR and Hall Cemetery populations. Owing to the small size of the Hall population and the difficulties faced in collecting seed from Prasophyllum species, there is an ongoing need to add to the seed collection from the Hall Cemetery population.

Searches for potential undiscovered populations have been undertaken in the past, however these searches should continue in to the future. Continued development in spatial modelling and remote sensing will assist in guiding better informed searches for new populations.

Future data collection will be complemented by recording additional observations about localised site conditions. Specifically, this should include measurement of surrounding vegetation structure and dominance, soil moisture and temperatures, as well as evidence of disturbance such as cockatoo diggings or mowing. Such additional information will assist in linking population fluctuations with potential causes.

The conservation of the Tarengo Leek Orchid will also benefit from further research in to its biology, specifically its reproductive processes and fungal symbiotic relationships. These biological traits are likely to be limiting factors in expanding the population size and range of the Tarengo Leek Orchid. Research in these areas will also help to inform population viability analyses.

Priority research areas include:

- Improving knowledge of life history and ecology, such as plant longevity, seed longevity and identification of the environmental germination niche of the Tarengo leek Orchid.
- Investigations of soil chemistry, moisture and mycorrhizal fungi associations.
- Quantification of habitat vegetation dominance and structure.
- Investigation of genetic variation within and between surviving Tarengo Leek Orchid populations, including research into the genetic viability of the current seed bank.
- Investigation of pollinator limitations, effects of habitat fragmentation and reduced population size on genetic variability.
- Improving knowledge of how microsite variations, minimum winter temperatures and soil moisture affect the Tarengo Leek Orchid.
- Investigations into the effect of potential future climate regimes on the frequency and severity of frost nights and subsequent effects on flowering success.
- Identification of potential refugia sites for the Tarengo Leek Orchid under a changing climate.
- Continuing refinement of suitable seed collection methods and identification of methods for establishing additional populations via translocation of greenhouse germinated plants in conjunction with ANBG, Greening Australia and other parties.

MANAGEMENT

The confined distribution and small population of the Tarengo Leek Orchid in the ACT places the species at high risk of local extinction. Thus, the management focus for the Tarengo Leek Orchid should be to maintain adequate site condition and reduce the risk of disturbance to the current population (Jones 1992). Canberra Public Cemeteries Trust are the primary managers of the species in the ACT, owing to their management of the Hall Cemetery. Conservation Research are also actively involved in overseeing the management of the species. Management of the Hall Cemetery is guided by the Hall Cemetery Management Plan (Conservation Research and Canberra Cemeteries 2013). The plan outlines the best course of action associated with the following issues:

- Mowing
- Weeds
- Eucalyptus regeneration
- Vehicle access
- Grave digging
- Fertiliser use
- Cockatoo disturbance
- Fire
- Grazing

Priority management actions include:

- Manage biomass to maintain a heterogeneous habitat structure and diverse floristic composition while allowing for cemetery operations.
- Control weeds if they pose a threat to the population or the site.
- Manage eucalypt regeneration to ensure ongoing persistence of the existing open woodland community.
- Avoid incompatible activities such as grave digging or vehicle movement in habitat areas.
- Maintain a low public profile of the site.
- Limit visitor impacts by curbing access to orchid populations during flowering and seed set, and restricting the species approved for graveside plantings.
- Continue annual monitoring program.
- Maintain an *ex-situ* 'insurance' population (plants and/or seed bank) while there is a high risk of extant populations becoming extinct.

IMPLEMENTATION

Implementation of this action plan and the ACT Woodland Conservation Strategy will require:

- Land planning and land management areas of the ACT Government to take into account the conservation of threatened species.
- Allocation of adequate resources to undertake the actions specified in the strategy and action plans.
- Liaison with other jurisdictions (particularly NSW) and other land managers (Canberra Public Cemeteries Trust) with responsibility for the conservation of a threatened species or community.
- Collaboration with universities, CSIRO, Australian National Botanic Gardens and other research institutions to facilitate and undertake required research.
- Collaboration with non-government organisations such as Friends of Grasslands and Greening Australia to undertake on-ground actions.

- Engagement with the community, where relevant, to assist with monitoring and other on-ground actions, and to help raise community awareness of conservation issues.

OBJECTIVES, ACTIONS AND INDICATORS

Table 1 Objectives, Actions and Indicators

Objective	Action	Indicator
Protect		
1. Protect all populations from unintended impacts (unintended impacts are those not already considered through an environmental assessment or other statutory process).	1a. Apply formal measures to ensure all populations are protected from impacts of recreation, infrastructure works and other potentially damaging activities. 1b. Encourage other jurisdictions to protect sites where the species occurs on their lands from unintended impacts.	All populations are protected from unintended impacts by appropriate formal measures.
	1c. Ensure sites are protected from unintended impacts.	All sites are protected by appropriate measures from unintended impacts.
	1d. Implement ample buffers around habitat to ensure no unintended impacts result from adjacent re- zoning or development actions.	All sites protected from unintended impacts from re-zoning or development by sufficient buffer areas.
	1e. Ensure protection measures require site management to conserve the species.	Protection measures include requirement for conservation management.
	1f. Identify other sites where the species occurs by maintaining alertness to the possible presence of the species while conducting vegetation surveys in suitable habitat.	Vegetation surveys in suitable habitat also aim to detect the species.
Maintain		
2. Manage the species and its habitat to maintain the potential for evolutionary development in the wild.	2a. Monitor populations and the effects of management actions.	Trends in abundance are known. Management actions are recorded and considered in analysis of monitoring data.

Objective	Action	Indicator
	2b. Manage to conserve the species and its habitat, including implementing advice under the Hall Cemetery Management Plan (Conservation Research and Canberra Cemeteries 2013).	Populations are stable or increasing. Habitat is managed appropriately (indicated by maintenance of an appropriate sward structure and herbage mass). Potential threats (e.g. weeds) are avoided or managed.
	2c. Maintain a database of sightings of the species, and if available, record habitat information.	Records of sightings are maintained and used to determine the distribution of the species in the ACT.
Improve		
3. Enhance the long-term viability of populations through management of adjacent grassland/woodland to increase habitat area and connect sub-populations.	3a. Manage grassland/woodland adjacent to the species' habitat to increase habitat area or habitat connectivity.	Grassland/woodland adjacent to or linking habitat is managed to improve suitability for the species (indicated by an appropriate sward structure and plant species composition).
	3b. Undertake or facilitate research and trials into techniques for increasing the population size.	Research trials have been undertaken to increase the size of the population. The population is stable or increasing.
4. Expand the range of the species in the ACT by providing suitable habitat and establishing new populations by translocation (upon advice from feasibility studies).	Undertake or facilitate research and trials into establishing new populations.	Research and trials have been undertaken to establish new populations. New population(s) established.
5. Improved understanding of the species' ecology, habitat and threats.	Undertake or facilitate research on habitat requirements, techniques to manage habitat, and aspects of ecology directly relevant to conservation of the species.	Research undertaken and reported, and where appropriate, applied to the conservation management of the species and Hall Cemetery Management Plan.
Collaborate		
6. Promote a greater awareness of, and strengthen stakeholder and community engagement in, the conservation of the species.	Undertake or facilitate stakeholder and community engagement and awareness activities.	Engagement and awareness activities undertaken and reported.

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