ACT Government

ACT NATIVE WOODLAND CONSERVATION STRATEGY AND ACTION PLANS

ACT Government

Environment, Planning and Sustainable Development

Produced by the Environment, Planning and Sustainable Development

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Acknowledgment to Country

We wish to acknowledge the traditional custodians of the land we are meeting on, the Ngunnawal people. We wish to acknowledge and respect their continuing culture and the contribution they make to the life of this city and this region.

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The people of the ACT working together to create healthy and diverse woodlands for future generations.

Native upland and lowland woodlands cover over 79 000 hectares in the ACT and have significant biodiversity, recreation and cultural values.

The protection of our woodlands is critical for the survival of a range of flora and fauna associated with these ecosystems, including threatened species. Meaningful collaboration between many knowledgeable stakeholders is critical to maintain and enhance these systems.

The ACT Government acknowledges the Ngunnawal people as the Traditional Custodians of the land and waters in the ACT and recognises the importance of their spiritual connections and cultural obligations to Country. For thousands of years Traditional Custodians (and neighbouring language groups) relied on, and actively manipulated woodlands in the region. This has shaped the structure and function of these ecosystems.

Woodlands were widespread prior to European settlement; the current distribution reflects the preferential clearing of the most fertile areas. While much of the historic distribution of subalpine woodland remains today, many lowland woodlands persist as small, often degraded remnants, amongst forest or grassland.

The ACT Native Woodland Conservation Strategy identifies conservation objectives to protect, maintain and improve our woodlands, while prioritising effective collaboration. Since the 2004 Lowland Woodland Conservation Strategy additional woodland has been protected, and significant management, restoration and research and monitoring has been undertaken. This Strategy aims to build on these successes and inform the ongoing protection and adaptive management of our lowland and subalpine woodlands. By working together, we can conserve these areas and their values now and for the future.

INTRODUCTION

I. SCOPE OF THE STRATEGY

The ACT Native Woodland Conservation Strategy (hereafter the Strategy) supersedes and builds on the achievements of the 2004 ACT Lowland Woodland Conservation Strategy (hereafter the 2004 Woodland Strategy). It has a broader scope, including both lowland and subalpine native woodland communities across all tenures and land uses.

Woodland is a general term to describe ecosystems that contain widely spaced trees with crowns that do not overlap. The Strategy considers woodland in all conditions, including areas where the canopy and woody midstorey have been largely cleared (i.e. areas of secondary / derived grassland) and the Endangered Yellow Box – Blakely's Red Gum Grassy Woodland community (hereafter Endangered YB-BRG Woodland).

II. OBJECTIVES OF THE STRATEGY

The purpose of this Strategy is to guide the management and conservation of lowland and subalpine woodlands in the Australian Capital Territory (ACT) for the next 10 years. The Strategy is closely aligned with goals outlined in the ACT Nature Conservation Strategy (ACT Government, 2013a). It identifies how the ACT Government intends to manage threats, safeguard threatened species, enhance woodland structural complexity, undertake monitoring and research, and enhance resilience, ecosystem function and connectivity of woodlands. Collaboration between the ACT Government, non-government entities, the Commonwealth Government and other regional and national partners is considered critical to ensure the successful management and protection of our woodlands into the future.

This Strategy is a reference document for ACT and Australian Government agencies, community groups, landholders, and other stakeholders with responsibilities and interest in the conservation, planning and management of lowland and subalpine woodlands.

This Strategy has four key goals, which are defined below and are outlined in **Box 1**. The development and execution of the Woodland Conservation Implementation Plan (CIP) (outlined in v), and the implementation of actions outlined in the action plans (Part B) will be critical to meeting the goals of this Strategy.

Protect. Commonwealth and ACT statutory requirements and ACT Government policies protect threatened species (and threatened communities) and other fauna and flora associated with woodlands within and outside formal reserves.

Maintain. Ongoing intervention is required to mitigate the impacts of a range of threats to woodland communities and associated flora and fauna. Management practices must adhere to best practice and be informed by an adaptive management system.

Improve. Management activities must, wherever appropriate, aim to enhance ecosystem function of woodlands by improving the condition and connectivity of woodlands. Enhancing ecosystem function improves a community's resilience to existing and emerging threats, including climate change.

Collaborate. Successful protection and management of woodlands requires collaboration between the ACT Government, non-government entities and the broader community. This includes promoting and managing the sustainable use of woodlands within and outside of reserves.

Box 1: The objectives outlined in the Strategy aim to meet the ACT Government's four key goals for woodland conservation

	PROTECT	MAINTAIN	IMPROVE	COLLABORATE
RELEVANT OBJECTIVES	**1.1** Retain and protect native woodlands **3.1** Monitor woodland condition **3.2** Address knowledge gaps in woodland conservation	**1.2** Reduce threats to native woodland biodiversity **3.1** Monitor woodland condition **3.2** Address knowledge gaps in woodland conservation	**1.2** Reduce threats to native woodland biodiversity 1.3 Enhance resilience, ecosystem function and habitat connectivity **3.2** Address knowledge gaps in woodland conservation **3.1** Monitor woodland condition	**2.1** Promote community participation in woodland conservation **2.2** Support sustainable recreational use of woodlands **3.1** Monitor woodland condition **3.2** Address knowledge gaps in woodland conservation

III. STRUCTURE OF THE STRATEGY

This document is divided into two main sections, Part A and Part B.

Part A outlines the primary objectives for woodland conservation in the ACT. These objectives are grouped under three overarching themes:

- Protect and manage woodland and component species
- Collaborate with the community
- Monitoring and research

Section 5.2 of Part A ranks the imperative of conservation objectives identified under these themes for lowland and subalpine woodlands, and secondary grasslands. Part A also includes background information on woodlands in the ACT and the broader region, and an overview of a range of research and other projects that have informed this Strategy.

Part B summarises the relevant literature and details objectives specific to the Endangered YB-BRG Woodland and fauna and flora species that are dependent on woodlands in the ACT and are listed as threatened under the *Nature Conservation Act 2014*. This information is provided as a set of self-contained action plans.

IV. ACTION PLANS AND CONSERVATION ADVICE

The Conservator of Flora and Fauna is responsible for preparing draft action plans or conservation advice for each species or ecological community listed as threatened under the Nature Conservation Act 2014. Action plans and conservation advice are statutory documents and are prepared with expert input from the ACT Scientific Committee.

An action plan for the Endangered YB-BRG Woodland community and action plans for three plants and two birds are included in Part B of this document. These include:

- Canberra Spider Orchid (*Caladenia actensis*)
- Small Purple Pea (*Swainsona recta*)
- Superb Parrot (*Polytelis swainsonii*)
- Scarlet Robin (*Petroica boodang*)
- Tarengo Leek Orchid (*Prasophyllum petilum*).

Each action plan provides a detailed description of the community or species, its conservation status, ecology, key threats, and an outline of the major conservation objectives and intended management actions.

Conservation advice for the following woodland-dependant birds will be available on the ACT Government's Environment website:

- Brown Treecreeper (*Climacteris picumnus victoriae*)
- Hooded Robin (*Melanodryas cucullata cucullata*)
- Painted Honeyeater (*Grantiella picta*)
- Regent Honeyeater (*Anthochaera phrygia*)
- Swift Parrot (*Lathamus discolor*)
- Varied Sittella (*Daphoenositta chrysoptera*)
- White-Winged Triller (*Lalage tricolor*).

LINKS BETWEEN THIS STRATEGY AND ACTION PLANS

Action plans and conservation advice guide actions to benefit threatened species and the Endangered YB-BRG Woodland community. This Strategy provides overarching conservation goals and principles on which to base these actions. It also provides a framework for planning and prioritising actions across the range of woodland sites in the ACT.

DEVELOPMENT AND REVIEW OF ACTION PLANS AND CONSERVATION ADVICE

Since the 2004 Woodland Strategy, action plans for 12 threatened species dependant on woodlands have been reviewed and provided to the ACT Scientific Committee for assessment. The Committee assesses a plan with reference to the objectives and performance indicators in that action plan, and the progress that can reasonably have been expected within the review timeframe. Action plans for a number of species have been converted to conservation advice documents. Specific management actions, outside of those identified in this Strategy for the protection of woodland habitat (including the Endangered YB-BRG Woodland Action Plan), were considered unnecessary for the persistence of these species.

The ACT Government will continue to develop and implement action plans and conservation advice for threatened species and threatened ecological communities, and will regularly review progress towards achieving their conservation objectives.

V. IMPLEMENTATION

The ACT Government is responsible for coordinating and implementing the objectives outlined in this Strategy on ACT Government managed land, and for collaborating with various partners to meet objectives on other land tenures.

The development of the Woodland Conservation Implementation Plan (CIP) is required to ensure the objectives outlined in this Strategy are effectively implemented. The development of the Woodland CIP will involve a review and synthesis of commitments and objectives outlined in this Strategy (including threatened species action plans) and other strategic documents that are relevant to the conservation of woodlands in the ACT. These include reserve management plans (e.g. (ACT Government, 2010b), documented offset commitments, the Woodland Conservation Effectiveness Monitoring Program (CEMP) (in development), and several ACT management strategies (ACT Government, 2007a, 2009, 2012a, 2013a, 2014, 2016a, 2017a). The Woodland CIP will include specific actions to be carried out to meet the priority objectives outlined in these documents. This will guide the development of operational plans for relevant business units within the ACT Government.

LOCAL, REGIONAL AND NATIONAL COOPERATION

Protection and management of woodland in the ACT requires effective collaboration between the ACT Government and a range of stakeholders. This includes sharing knowledge, resources and skills with local, regional and national land managers, environmental authorities, and other knowledge holders (including research institutions, Aboriginal and other community members).

The ACT Government must work closely with rural landholders, and community groups who are active in woodland conservation, to undertake on-ground management and community education activities. There is also a critical need to work with Commonwealth agencies responsible for managing woodland sites in the ACT (i.e. Department of Defence and National Capital Authority). National and regional cooperation is central to considering a broader spatial perspective of woodland and woodland-associated species management.

Snow Gum woodland, Mt Ginini (M. Jekabsons)

This is critical to ensure the persistence of species that are dependent on conservation measures outside of the ACT (e.g. Superb Parrot and Tarengo Leek Orchid) and to support woodlands to successfully adapt to climate change.

Under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (hereafter the EPBC Act), the ACT Government is responsible for ensuring the appropriate management of several woodland-associated 'matters of national environmental significance'. This includes the Endangered YB-BRG Woodland community and several flora and fauna species (see **Table 3** and Section 4.3). Endangered YB-BRG woodland found in the ACT is a component of the White Box–Yellow Box–Blakely's Red Gum Grassy Woodland and Derived Native Grassland community, listed as critically endangered according to the EPBC Act. The action plan for this community (Part B) is in line with the National Recovery Plan (Commonwealth Government, 2010).

As outlined in the ACT Strategic Bushfire Management Plan (ACT Government, 2019), the ACT Government currently undertakes collaborative fire management planning with NSW agencies. Collaboration between the ACT Government and NSW (and ACT) rural landholders and government agencies has also been critical to the success of a number of woodland restoration projects (e.g. the ACT Woodland Restoration and Biodiversity Fund Project [see Section 4]), offset management planning (see TRC Tourism (2016)), research and translocations of woodland species (e.g. New Holland Mouse (*Pseudomys novaehollandiae*) into Mulligans Flat Woodland Sanctuary), and pest animal management. The management of subalpine woodlands is part of the Australian Alps Cooperative Management Program with Commonwealth, NSW and Victorian authorities. This program aims to establish best practice management to protect the natural and cultural values of the Australian Alps National Parks.

VI. WOODLAND COMMUNITIES IN THE ACT

This Strategy provides prescriptions for the ongoing protection and management of twelve woodland communities, including seven subalpine and five lowland systems that cover over 79 000 ha in the ACT (**Figure 1** and Section 5.1).

Subalpine woodlands occur between 730 m and 1910 m above sea level and cover approximately 48 409 ha of the ACT. They occur in the high country in the west and southern parts of the ACT, primarily in Namadgi National Park and Tidbinbilla Nature Reserve. Eucalypt species dominate the canopy of subalpine woodlands and the understorey is dominated by native tussock grasses and a diversity of herbs and forbs. The most widespread subalpine woodland communities in the ACT are those dominated by Snow Gum / Candlebark (U27), Snow Gum / Mountain Gum / *Daviesia mimosoides* (U28), and Mountain Gum / Snow Gum / Robertson's Peppermint (E*ucalyptus radiata*) (U22) (see Section 5.1).

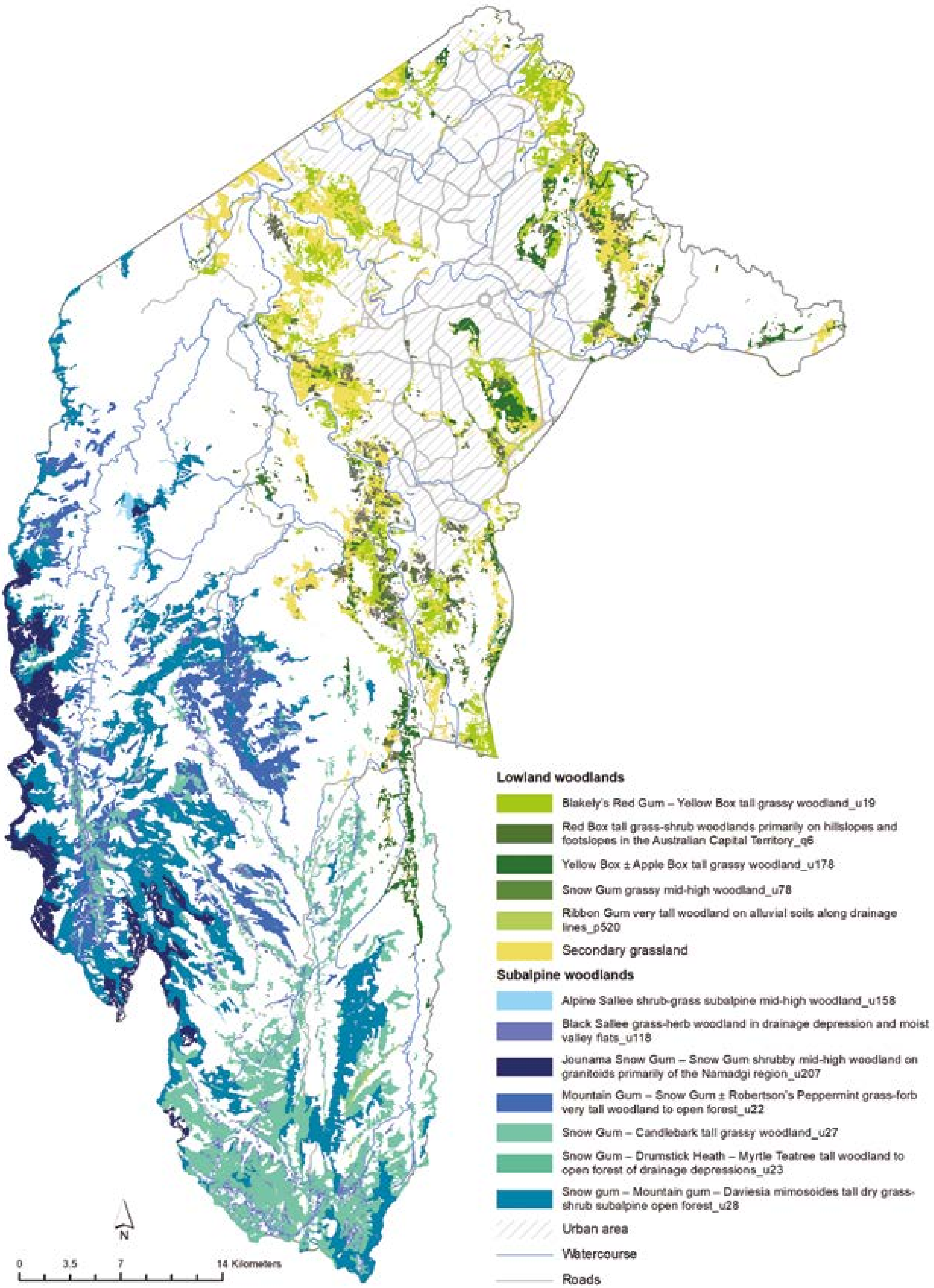
Most subalpine woodland in the ACT is intact and in good condition. Areas subject to clearing for grazing have been confined primarily to the valley floors of the upper Gudgenby River, Tidbinbilla and Uriarra Forest. There has been little clearing of subalpine woodlands dominated by Snow Gum (Carron, 1985; Landsberg, 2000). Subalpine communities have been subject to changes in ecological processes (e.g. fire frequency) and disturbance (e.g. seasonal grazing, invasive plants and pest animals) that influence species composition. For instance, weed species associated with early pastoralism are found in grassy areas of the upper Cotter Catchment. Inappropriate fire regimes are a significant threat to these communities (see Section 1.2 and 5.1).

Lowland woodlands in the ACT occur between 440 m and 1340 m above sea level and cover approximately 13 573 ha of the ACT (excluding secondary grasslands). They are broadly located in a north–south pattern along the hills and ridges that flank the urban and rural areas of the ACT. Eucalypt species dominate the canopy and the understorey is dominated by a range of shrubs, grasses, herbs and forbs. The most widespread lowland woodland communities in the ACT are those dominated by Blakely's Red Gum / Yellow Box (u19) and Yellow Box / Apple Box (u178) (see **Figure 1** and **Section 5.1**).

Clearing for grazing and urban development has resulted in patches of lowland woodland of varying size and condition. While little is understood about the pre-European floristic composition of lowland woodlands, changes to natural disturbance regimes—including grazing—have reduced the height, cover, herbage mass and diversity of the grassy stratum, and dominant native grasses have, in many instances, been replaced by shorter, cool season, perennial native grasses or exotic grasses (Costin, 1954; McIntyre & Lavorel, 1994; Prober & Thiele, 1995; Stol & Prober, 2015).

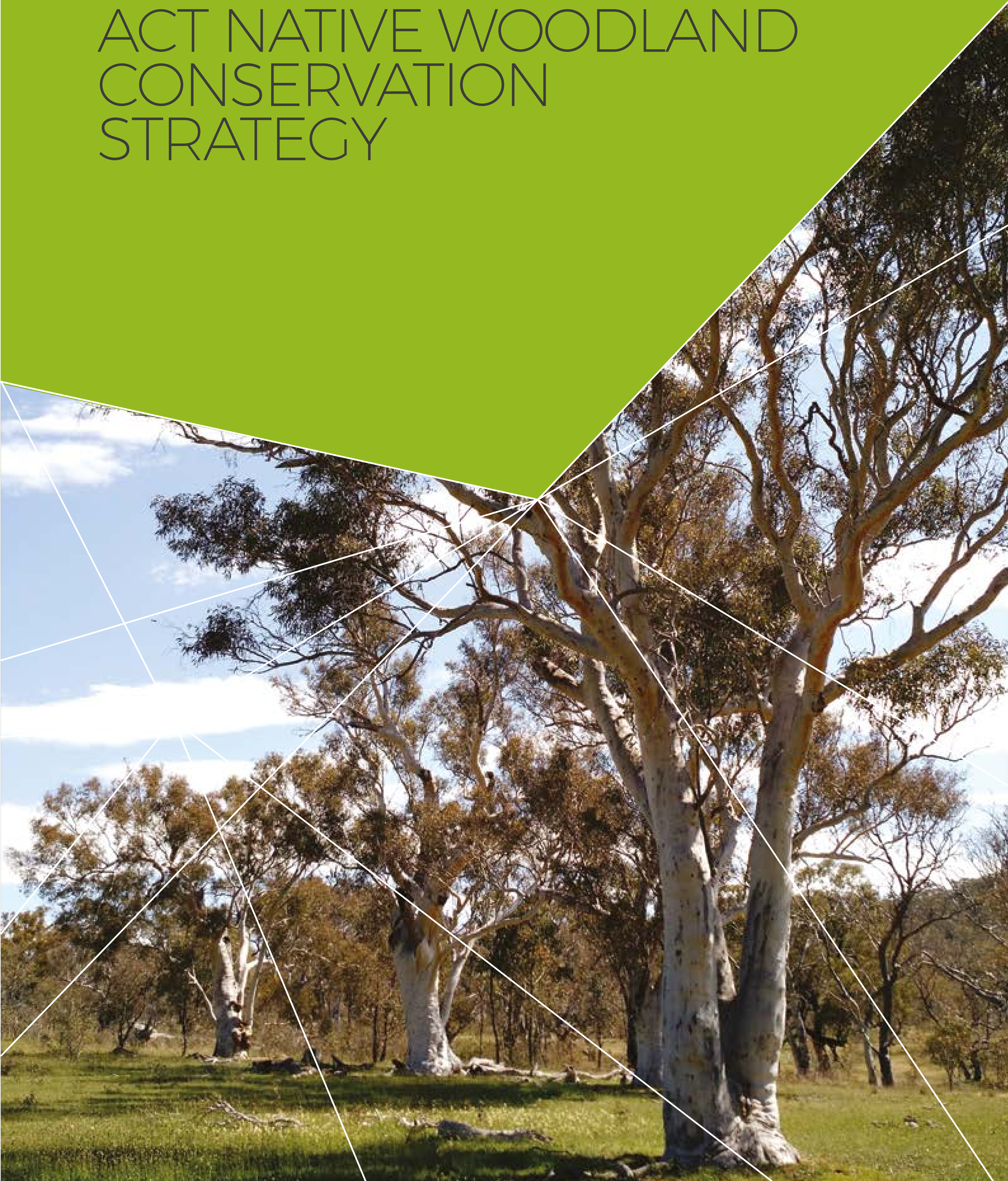
Ongoing management is required to mitigate the impacts of a range of threats to subalpine and lowland woodlands (outlined in Section 1.2).

Figure 1: Distribution of woodland communities across the ACT



PART A

ACT NATIVE WOODLAND CONSERVATION STRATEGY



Sticky Everlasting, Googong Dam (E. Cook)

PART A

1. PROTECT AND MANAGE WOODLAND AND COMPONENT SPECIES

1.1 RETAIN AND PROTECT NATIVE WOODLANDS

The ACT contains some of the most intact woodlands in Australia, including the Endangered YB-BRG Woodland. In terms of size, connectivity, diversity and habitat for threatened species, ACT's woodlands are exceptional. Large patches of subalpine woodland persist across the south and south west of the ACT. The mean size of these woodland areas are over 25 ha and are often contiguous with other associated subalpine and alpine vegetation communities. Over 80% of lowland woodland patches are less than 10 ha in size. Nineteen patches of lowland woodland greater than 100 ha persist in the landscape (see **Figure 2**). More than half of these sites are likely to meet the definition of Endangered YB-BRG Woodland; others are degraded but retain small areas that meet the definition.

Woodlands (including secondary grasslands) cover approximately 34% of the ACT's land area; lowland and subalpine woodlands cover approximately 13% and 21% respectively. Detailed classification and mapping of vegetation in the ACT was completed in 2018 (see Section 4.7). This information has been used to describe and map the distribution of each woodland community by land tenure (see **Table 1** and **Figure 3**). Approximately 70% of the extent of all woodland (including secondary grasslands) is protected within the ACT's formal reserve system. Approximately 85% of this area is in the subalpine region of the ACT. Since the declaration of Namadgi National Park in 1984 and Tidbinbilla Reserve in the early 1960s, the extent of subalpine woodland protected in the ACT has remained stable. Today, approximately 98% of subalpine woodland extent is protected in reserves (see **Table 1**).

In 2004, when the previous Lowland Woodland Strategy was developed, approximately 21% of lowland woodland (including secondary grasslands) was protected in reserves. Since then, an additional 1156 ha has been protected, including areas that contain Endangered YB-BRG Woodland. Today, approximately 29% of the total extent of lowland woodland is protected in reserves and 44% persists on rural lands (**Table 2**). The proportion of each lowland woodland community protected in reserves ranges from 23 - 100%. Lowland Snow Gum grassy woodland (u78), Red Box tall grass-shrub woodland (q6) and secondary grasslands have the lowest representation in the reserve system (23%, 20% and 26% of extent respectively).

Figure 2: Distribution of lowland woodland patches larger than 100 ha in the ACT

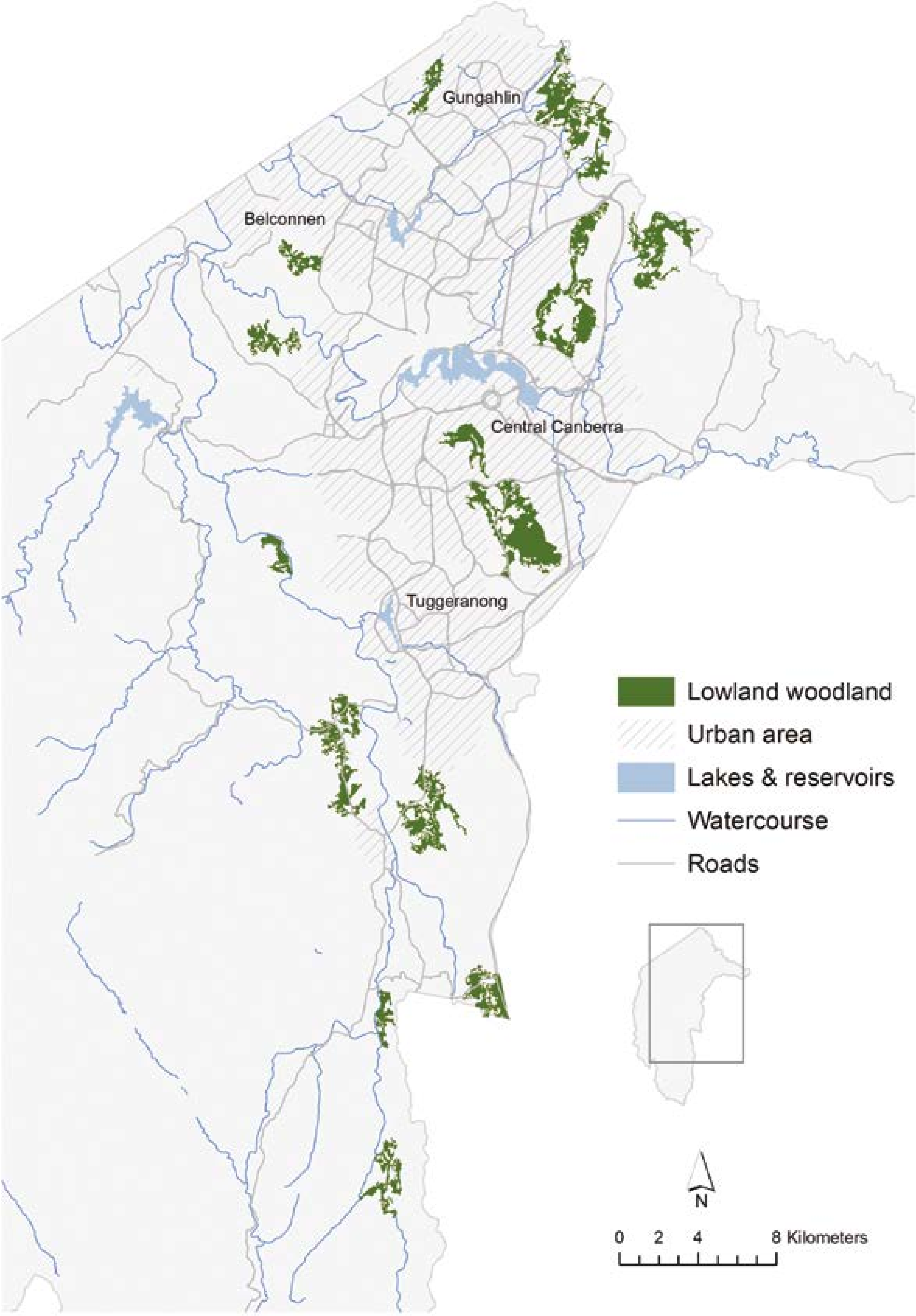
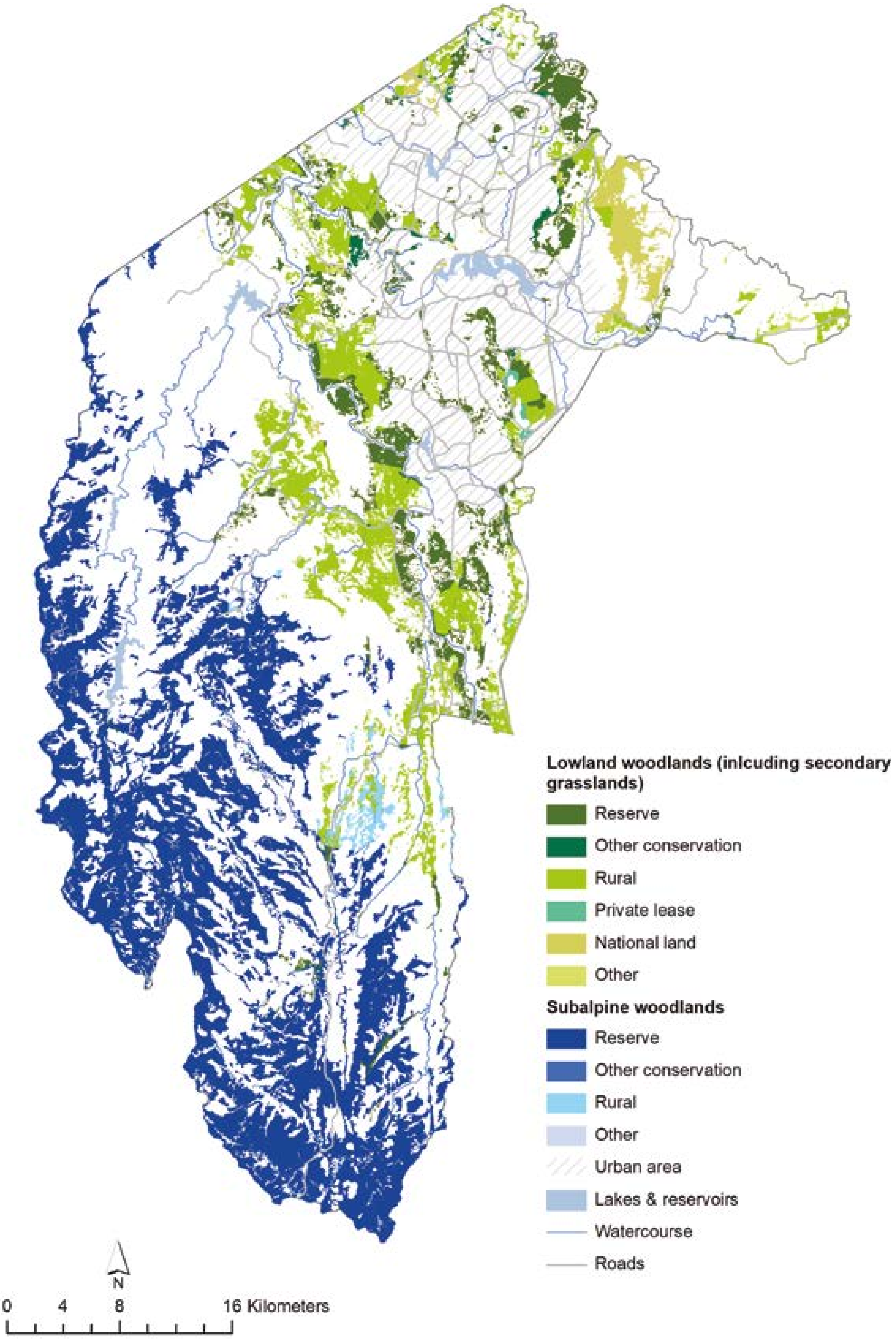


Table 1: Woodland communities across land tenures in the ACT

	Woodland community*	Total extant hectares	Reserve(i) (% of total)	Other conservation(i) (% of total)	Rural lands(i) (% of total)	National land (% of total)	Other(i) (% of total)
LOWLAND	Blakely's Red Gum – Yellow Box (± White Box) tall grassy woodland (u19)	7196	2138 (30)	829 (11)	3129 (43)	621 (9)	477 (7)
	Yellow Box – Apple Box tall grassy woodland (u178)	4334	1289 (30)	251 (6)	2073 (47)	349 (8)	373 (9)
	Red Box tall grass-shrub woodlands (q6)	1776	359 (20)	317 (18)	709 (40)	335 (19)	57 (3)
	Ribbon Gum very tall woodland on alluvial soils along drainage lines (p520)	174	155 (89)	7 (4)	6 (3)	-	6 (4)
	Snow Gum grassy mid-high woodland (u78)	90	21 (23)	3 (3)	61 (68)	-	5 (6)
	TOTAL	**13573**	**3963 (29)**	**1408 (10)**	**5978 (44)**	**1306 (10)**	**801 (7)**
SECONDARY GRASSLANDS		17868	4689 (26)	352 (2)	10813 (61)	1440 (8)	574 (3)
SUBALPINE	Snow Gum – Mountain Gum – Daviesia mimosoides tall dry grass-shrub subalpine open forest (u28)	18235	18077 (99)	72 (<1)	83 (<1)	-	2 (<1)
	Snow Gum – Candlebark tall grassy woodland in frost hollows and gullies (u27)	14442	13533 (94)	-	896 (6)	-	12 (<1)
	Mountain Gum – Snow Gum ± Robertson's Peppermint grass-forb very tall woodland to open forest (u22)	8054	8042 (100)	6 (<1)	6 (<1)	-	-
	Jounama Snow Gum – Snow Gum shrubby mid-high woodland on granitoids (u207)	4677	4677 (100)	-	-	-	-
	Black Sallee grass-herb woodland in drainage depressions and moist valley flats (u118)	2623	2563 (98)	8 (<1)	51 (2)	-	-
	Alpine Sallee shrub-grass subalpine mid-high woodland (u158)	378	378 (100)	-	-	-	-
	Snow Gum – Epacris breviflora – Leptospermum myrtifolium tall woodland to open forest of drainage depressions (u23)	<1	<1 (100)	-	-	-	-
	TOTAL	**48409**	**47272 (98)**	**86 (<1)**	**1037 (2)**	**-**	**14 (<1)**

(i) Reserve: Nature Reserve, National Park. Other conservation: land managed to maintain the natural values of the area (including: urban open spaces, special purpose reserves, hills, ridges and buffers, and unleased areas managed as reserve). Rural lands: rural lease, unleased (grazing licence). Other: Forests, roads, unleased, SPR-Recreation and private leases. * A list of the full community name (as described by Armstrong et al. (2013)) is provided in 5.1.

Figure 3: Distribution of lowland and subalpine woodland across tenures in the ACT



Formal protection of woodland, particularly the long-term conservation of remaining lowland woodland, facilitates functional connectivity, supports the maintenance of a diversity of slow-developing habitat features and supports the persistence of threatened woodland-dependent species. The ACT Government supports the protection of woodlands by gazetting additional land as reserves under the *Nature Conservation Act 2014*. Nevertheless, realising the conservation goals outlined in this Strategy requires an ecosystem management approach that prioritises actions based on need, regardless of tenure.

A range of ACT Government policies aim to protect and enhance the values of woodland outside of the reserve system (e.g. various legislative frameworks [outlined in (Section 4.6)], land use licences and approvals, and Land Management Agreements). This Strategy also identifies priorities and partnerships with a range of land managers (see for example Section 2) to effectively protect woodlands from a range of threats. A Cultural Heritage Management Framework is currently being developed to outline the principles, policies and procedures to manage Aboriginal places in partnership with Traditional Custodians (and in accordance with the *Heritage Act 2004*) within land managed by ACT Parks and Conservation Service.

CONSERVATION OBJECTIVES

RETAIN AND PROTECT NATIVE WOODLANDS

- Ensure no net loss of the ecological and cultural values of woodlands in the ACT.
- Maintain or improve the proportion of each woodland community located within the ACT's formal reserve system (see **Table 1**).
- Identify opportunities to improve representation of lowland Snow Gum woodland (u78) and Red Box tall grass-shrub woodland (q6) in the ACT's formal reserve system.
- All species of woodland flora and fauna should be represented by viable, wild populations that will enable the species to be conserved for perpetuity. The ACT Government will continue to support regional and national effort towards the conservation of these species.
- Improve understanding of the distribution of Endangered YB-BRG Woodland community in the ACT and aim to protect all remaining areas from unintended impacts (see Endangered YB-BRG Woodland action plan, Part B).
- Prioritise the protection and ongoing management of woodland that contributes to threatened species conservation (see action plans, Part B).

1.2 REDUCE THREATS TO NATIVE WOODLAND BIODIVERSITY

Native woodlands and associated fauna across the ACT are subject to a range of impacts that threaten their condition, resilience and survival. Threatening processes include those that impact ecosystems at a regional scale (e.g. climate change) and those that are largely restricted to a single site (e.g. inappropriate grazing disturbance). These threats interact and where possible, should be managed as part of a combined strategy to maintain and enhance the viability of woodlands in the ACT. The extent and severity of threatening processes may differ between lowland and subalpine woodlands.

URBANISATION

Extensive areas of lowland woodland have been cleared across southeast Australia and many now exist as fragmented patches within a landscape of urban and rural development (see Section 4). The development and expansion of new suburbs will be the primary cause of future losses of woodland habitat in the ACT. Future suburbs to accommodate the growth of Canberra in the Molonglo Valley and Gungahlin have been subject to rigorous ACT and Commonwealth statutory environmental assessment processes and approvals to avoid, mitigate or offset the impacts of development on woodland habitats.

The ACT Planning Strategy 2018 outlines a strategic approach to investigate the potential for new residential areas to the west of the city to meet future housing need. A key action is to undertake environmental, infrastructure and planning studies for the western edge of the city (to identify suitable areas for a range of uses) (ACT Government, 2018a). Natural habitat and conservation areas are considered in the urban planning and design processes to promote habitat connectivity and support landscape resilience. Offset areas are also identified and established to offset any unavoidable impacts on the natural environment (ACT Government, 2018a). The western edge investigation area contains patches of Endangered YB-BRG Woodland, and habitat for threatened birds and the vulnerable Pink-tailed Worm-lizard. Woodland patches in this area also have local and regional habitat connectivity value.

While there is significant ecological value in retaining small woodland patches (Eldridge & Wong, 2005; Fischer & Lindenmayer, 2002), scattered and isolated remnant trees (Fischer et al., 2010; Le Roux et al., 2018; Manning et al., 2006; Stagoll et al., 2010), and urban green space (Ikin et al., 2013a; Stagoll et al., 2012), urban areas contain limited habitat structure that support woodland biodiversity (Le Roux et al., 2014b). Habitat features such as hollows, logs and litter are significantly reduced in urban greenspace compared with rural lands and nature reserves in the ACT (Le Roux et al., 2014b). The regeneration of trees in the urban context is also limited, and lower than in nature reserves (Le Roux et al., 2014a; Le Roux et al., 2014b).

The canopy cover of mature trees has declined in urban areas since 2004; however, it has increased across rural lands and nature reserves during the same period (J. Botha 2018, pers. communication). Modelling suggests that while reserves will continue to provide a stable source of hollows, under existing management practices, the availability of hollow-bearing trees in the urban environment is likely to decline over time (Le Roux et al., 2014a). As part of goals to reduce urban heat and retain the natural attributes of our city, the ACT Government aims to achieve a 30% tree canopy cover (or equivalent) by 2045 (ACT Government, 2019a). 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. The importance of mature and hollow-bearing trees is discussed in Section 1.3 (and in ACT Government (2018g)).

Urban development also leads to further fragmentation of woodland, resulting in the loss of structural connectivity that supports landscape permeability for movement of species (see Section 1.3). The state of the landscape-scale urban-woodland matrix has significant impacts on the habitat features and species located in lowland woodland across the ACT. Disturbances to lowland woodlands is greatest proximal to urban areas. These may include:

- increased visitor access resulting in higher rates of removal of rocks and timber for firewood, trampling and other impacts from unmanaged access and activities, and damage to sites of Aboriginal and / or heritage value
- dumping of garden waste, rubble and other rubbish
- changes in nutrient inputs and soil properties
- spread of garden weeds and invasive plants (e.g. Cotoneaster [*Cotoneaster spp.*], Hawthorn [*Crataegus monogyna*]) and Firethorn [*Pyracantha spp.*])
- invasion by aggressive or exotic birds that are prevalent in urban areas
- noise and light pollution
- interactions with native wildlife, including bird feeding (which may change the behaviour and composition of native birds and spread avian disease (Goddard et al., 2017; Jones & Reynolds, 2008)) and predation by domestic cats and dogs
- the need, in some cases, to undertake frequent fuel management activities within asset protection zones to reduce the risk of wildfire to human life and property.

Urban development and low levels of vegetation across the agricultural landscape are likely to influence the composition of birds found within adjacent woodland patches (Ikin et al., 2014a; Ikin et al., 2014b). A number of woodland bird species, some which are declining in the region, avoid habitat that is in close proximity to the urban edge (e.g. Scarlet Robin and Striated Thornbill [*Acanthiza lineata*]). Other species are also impacted by the rate of urban encroachment (e.g. Brown Treecreeper) (Rayner et al., 2015a).

With the development of new suburbs and the growth of Canberra's population, pressure from recreational access is likely to increase. Potential visitor impacts are outlined in Section 2.2.

CONSERVATION OBJECTIVES

MITIGATE THE IMPACT OF URBANISATION

- Mitigate impacts of existing urban development on adjacent woodland habitat, by:
  - protecting, maintaining and improving habitat features across the urban landscape, including mature trees wherever appropriate
  - supporting community-led stewardship of woodlands by facilitating education initiatives and fostering relationships with relevant organisations (including Bush on the Boundary community groups) to improve understanding of the value of woodland and threats to its survival (see Section 2)
  - ongoing maintenance of access tracks, and visitor interpretation and other educational signage
  - maintaining vigilance in detecting and eradicating newly emerged invasive plants.
- Mitigate impacts of future urban development on woodland areas by:
  - assessing the woodland values in and surrounding identified potential future development areas to inform planning and conservation outcomes
  - after feasible and appropriate avoidance and mitigation measures have been undertaken, support the identification, establishment and ongoing management of offset areas according to the ACT Environmental Offsets Policy or Commonwealth approved offset requirements (and associated documents)
  - incorporating consideration of natural habitat and conservation areas into urban planning and design processes to promote habitat connectivity and support the establishment of biodiversity refuges
  - ensuring buffer zones (including inner asset protection zones for bushfire management) are incorporated into the planned urban development area
  - ensuring consideration is given to the impacts of urban development on neighbouring woodland and associated biodiversity during the planning and development process
  - ensuring new residential areas developed in the vicinity of a woodland area with high conservation value, or threatened woodland fauna habitat, are declared cat containment areas.

OVERGRAZING

MACROPODS

Macropods play a central role in grassy ecosystems, modifying their habitat through selective grazing and browsing. They influence herbage mass levels, which determines habitat suitability for a range of fauna species (see Section 1.3). The Eastern Grey Kangaroo is an iconic species often encountered by residents in the ACT. It is the dominant herbivore in grasslands and grassy woodlands, including the plains around Canberra and the foothills and lower elevation valleys of the western and southern ranges. Other macropods, including the swamp wallaby (*Wallabia bicolor*), are also widespread and common in suitable habitat.

The abundance of kangaroos in subalpine areas (including Namadgi National Park and Tidbinbilla Nature Reserve) are regulated primarily by food supply and predation pressures (ACT Government, 2010a). These populations will remain unmanaged unless undesirable impacts are identified or specific ecological (or other) objectives require management intervention (ACT Government, 2017b).

While grassy ecosystems in the ACT evolved under the influence of grazing macropods, densities of macropods in lowland areas have increased considerably since the 1960s (ACT Government, 2010a). Today, macropods exert high grazing pressure across a number of lowland reserves in the ACT (ACT Government, 2017b; McIntyre et al., 2010). Research illustrates that high grazing pressure from Eastern Grey Kangaroos can reduce plant species richness (Driscoll, 2017), simplify grass structure, increase the proportion of short vegetation, and reduce regeneration and herbage mass (Howland et al., 2014; McIntyre et al., 2015; Neave & Tanton, 1989; Stapleton et al., 2017; Vivian & Godfree, 2014). Heavily grazed sites are associated with a loss of topsoil and organic material and the exposure of bare ground. These sites are commonly associated with elevated soil loss and loss of nutrients (ACT Government, 2010a).

Kangaroos grazing, Mulligans Flat Woodland Sanctuary (M. Jekabsons)

Sustained high grazing pressure from macropods also negatively impacts a range of fauna associated with grasslands and grassy woodlands in the ACT. For example, the abundance and diversity of beetles and reptile species at a site is impacted by kangaroo grazing pressure (Barton et al., 2011; Howland et al., 2014; Manning et al., 2013). Kangaroo grazing also influences the presence of a number of bird species reliant on grassy layers for foraging and / or nesting (Howland et al., 2016).

Eastern Grey Kangaroos show a preference for new vegetation growth (Meers & Adams, 2003; Snape et al., 2018) and without intervention their populations in lowland woodlands are limited largely by the seasonal abundance of food. Maintaining a stable population of macropods, which is not limited by its food supply and exerts only a moderate level of grazing pressure, is important for the maintenance of plant species richness (Driscoll, 2017) and for the conservation of fauna that depend on a complex structure of understorey vegetation.

LIVESTOCK

Grazing by livestock can simplify understorey vegetation structure, age and size (including eliminating grazing-sensitive species and reducing native plant species richness), and negatively impact woodland-associated fauna assemblages (Barton et al., 2016; Dorrough et al., 2012; Dorrough et al., 2011; Lindsay & Cunningham, 2009; Morgan, 2015). Grazing by livestock can also negatively impact woodland vegetation by reducing the regeneration and recruitment potential of eucalypts (Sato et al., 2016) and changing the chemistry and condition of soils (Close et al., 2008; Yates & Hobbs, 2000).

Soil compaction from livestock inhibits a plants ability to grow roots and thus to access adequate water and nutrients (Yates & Hobbs, 1997). Disturbance to the soil and increases in some soil nutrients can also facilitate the establishment of invasive plants (Close et al., 2008; Pettit et al., 1995). Furthermore, grazing pressure can prevent the movement and establishment of native, palatable species into an area. This is a significant issue to consider, as some species will need to move to new locations to persist within a changing climate (Morgan, 2015).

The impacts of grazing by livestock are dependent on the frequency, duration, intensity and timing of grazing (Barton et al., 2016; Kay et al., 2017; McIvor et al., 2011; Stol & Prober, 2015), site-level factors (e.g. fertilisation history, exotic plant competition, microsite conditions) and the climate (Dorrough et al., 2011; Prober & Wiehl, 2011).

CONSERVATION OBJECTIVES

MITIGATE THE IMPACT OF OVERGRAZING

- Grazing by macropods also influences densities according to the Controlled Native Species Management Plan for Eastern Grey Kangaroos (ACT Government, 2017b), the Kangaroo Management Plan (ACT Government, 2010a), and other subsidiary documents.
- Continue the trial of dart-delivered GonaCon on kangaroos in Canberra Nature Park (CNP) and continue to assess the long-term effectiveness of dart-delivered GonaCon on fecundity. Ensure future culling programs are informed by the outcomes of this program.
- Undertake activities, including restoration and herbage mass management techniques, to maintain, wherever possible:
  - a heterogeneous mosaic of grazing intensity by native herbivores
  - at least some pasture that is at a level palatable macropods and other native herbivores.
- Continue long-term monitoring of the interaction between vegetation and principal herbivores in grasslands and grassy woodlands to inform ongoing management.
- Consider actions to enhance woody debris (including fine woody components) to reduce browsing pressure in woodland areas where naturally occurring debris is deficient (see: Stapleton et al. (2017)).
- Work with rural landholders to support the maintenance and enhancement of woodland values, including protection from overgrazing (as outlined in Section 2.1).
- Reduce the impact of overgrazing from non-native herbivores according to ACT Government (2012a).

INAPPROPRIATE FIRE REGIMES

Fire is a critical component of a functioning woodland as it influences soil properties, vegetation structure and the regeneration of some plant species (Prober et al., 2008; Stol & Prober, 2015).

Fire regimes are characterised by the season, frequency and intensity of burning. Inappropriate fire regimes can negatively impact ecosystem processes, plant communities and fauna habitat (Driscoll et al., 2010). Fire season has the potential to change fire behaviour due to varied temperature and moisture conditions. Fire will also impact flora and fauna species in different ways when occurring at different stages of their life cycles.

Frequent fires can simplify woodland ecosystems by: limiting regeneration opportunities, eliminating fire-sensitive species, and damaging groundlayer and other habitat features (e.g. tree hollows in subalpine woodlands (Salmona et al., 2018)). Midstorey vegetation cover can also increase in woodlands that are burned too frequently (Dixon et al., 2018b; Foster et al., 2017) or too infrequently (Close et al., 2011; Wilson et al., 2018). If fire is too infrequent, plant species diversity in lowland systems may also decline (Penman et al., 2011).

Research suggests high intensity fires can damage belowground systems and simplify lowland woodland vegetation structure (Foster et al., 2017; Neary et al., 1999). The loss of young trees and seedlings to high intensity fire limits recruitment and creates a more homogenous stand age structure. The loss of mature trees can increase midstorey regeneration and fire fuel loads in lowland systems (Wilson et al., 2018), and decrease habitat availability and diversity in subalpine woodlands and forests (e.g. destroying tree hollows) (Salmona et al., 2018).

Tolerable fire intervals (TFIs) describe an inter-fire interval, between which plant species have optimum time to regenerate between fires. The minimum TFI defines the minimum interval between successive fires that allows species to either regenerate from seed or for resprouters to become fire tolerant, prior to the next fire. The maximum TFI defines the maximum fire-free interval before those species that require fire for regeneration, decline with age and die. Thus, prescribed TFIs define the optimum period within which fire should occur to maintain species diversity and minimize species loss.

Prescribed burning, Hall Cemetery

In January 2003, wildfires burnt 70% (164 914 ha) of the ACT, including pine plantations, rural lands and extensive areas of woodland. The majority of subalpine woodland communities were burnt during these fires and are now below prescribed minimum TFIs (see Section 5.1). Consequently, extensive areas of subalpine woodland currently support young, regenerating vegetation. Conversely, significant areas of lowland woodland remained unburned during the 2003 wildfires and are currently above their prescribed maximum TFI (see Section 5.1).

Fuel reduction activities – including slashing, grazing and prescribed burning – are undertaken to mitigate the impacts of large-scale wildfire and to maintain and/or improve the health of woodlands (and other ecosystems) in the ACT. The ACT Government prepares annual Bushfire Operations Plans (BOPs) that guide the implementation of annual fuel management activities. These plans adopt current best practice management techniques and consider ecological knowledge to establish prescribed minimum and maximum TFIs of vegetation. Where the fire requirements of threatened species are known, annual BOPs also recommend fire management activities that aim to maintain or enhance conditions for these species (see action plans, Part B). Also included in the BOPs are areas identified for cultural burning, to be planned and implemented in collaboration with Traditional Custodians (see Section 2.1).

Box 2: Burning subalpine woodlands to reduce the risk of wildfire

There is limited, but growing knowledge available to inform fire management in subalpine woodlands. Recent research projects provide some insight into the dynamics of fuel loads and the response of fauna and flora to fire.

Fuel loads in subalpine woodland are lowest for the first few years directly after fire. However, as subalpine woodland (and other forest ecosystems) mature, they become less flammable than those burnt frequently (Zylstra, 2018). Fuel increases until between 6 and 12 years after fire and then, in the following decades begins to decline (Dixon et al., 2018b). In some areas of the ACT, long unburned (>96 years old) subalpine woodlands have fuel loads comparable with those areas burned recently in this ecosystem (Dixon et al., 2018b). Land managers should consider this information when planning fuel suppression efforts, as frequent burning is likely to lead to an increase in shrubby understorey and thus, flammability (Dixon et al., 2018b; Zylstra, 2013).

There is evidence that long unburned subalpine woodland is disproportionately more important for mammal richness (K. Dixon 2018, pers. communication), and reptile richness and abundance (Dixon et al., 2018a) than recently burned sites. Less than 8% of subalpine woodland and forest in Namadgi National Park remains long unburned (>96 years old) (Dixon et al., 2018b) and many areas of subalpine woodland in the ACT have burnt within the last 20 years (ACT Government data, unpublished). While supporting strategic prescribed burning in subalpine woodlands, the ACT Government aims to protect patches of long unburned subalpine woodland.

Using fire to conserve woodland-associated biodiversity in the ACT is challenging. The specific responses of most fauna and flora to different fire regimes are unknown (see **Box 2**). Where lowland woodlands are in close proximity to urban areas, ACT land managers must strike the right balance between reducing fuel loads to protect human life and property, and undertaking ecological burning to maintain and enhance biodiversity. Trade-offs are also required in subalpine areas where prescribed burning of corridors is required to slow the spread of unplanned fires. There is also a risk that prescribed burning can result in adverse ecological impacts, such as the collapse and loss of mature, hollow-bearing trees (see discussion in Bluff (2016)). Furthermore, invasive plant species can become established following disturbance from fire (e.g. Cootamundra Wattle [Acacia baileyana] and a range of exotic annuals) (Stol & Prober, 2015). Future challenges for fire management in a changing climate are discussed below.

CONSERVATION OBJECTIVES

MITIGATE THE IMPACT OF INAPPROPRIATE FIRE REGIMES

- Undertake strategic prescribed burning and other fuel reduction activities within woodlands to protect human life and property, maintain species diversity and minimise species' losses according to the ACT Strategic Bushfire Management Plan (ACT Government, 2019).
- Use the best available ecological knowledge to evaluate and make decisions regarding balancing asset protection and woodland biodiversity conservation.
- As part of planning for prescribed burning, take appropriate measures to mitigate potential negative ecological impacts.
- Lead and support research to improve our understanding of the responses of fauna and flora to different fire regimes in the ACT.
- Facilitate and support cross-tenure fire management planning and activities (including with rural landholders and NSW land managers).
- Where it is consistent with objectives to reduce the risk to human life and property, increase the diversity of subalpine woodland post fire age classes. Priority activities include:
  - protecting areas of long unburned subalpine woodlands from fire for the foreseeable future
  - identifying areas of subalpine woodland to transition to older post-fire age classes.
- Develop weed management strategies for fire management when there is a likelihood of invasive species responding positively to burning (e.g. English Broom [*Cytisus scoparius*], African Lovegrass [*Eragrostis curvula*], Cootamundra Wattle, Oxeye Daisy [*Leucanthemum vulgare*] and Nodding Thistle [*Carduus nutans*]).
- Facilitate community education initiatives to improve understanding of the complexities of fire management in the ACT and the use of fire to manage woodland biodiversity.
- Undertake robust monitoring and evaluation to assess the ecological (and human life and property protection) outcomes of planned fire management activities (See Section 3) and unplanned fire events.
- In accordance with ACT Government (2015a), protect cultural sites during fire management activities and work in collaboration with Traditional Custodians and the broader Aboriginal community to plan, implement and monitor cultural burns in woodlands (see Section 2.1).

INVASIVE PLANTS

The spread and infestation of invasive plants are threatening processes that can impact the ecological and cultural values of woodlands across the ACT. Exotic plants can change the structure and function of woodlands (e.g. by altering fire regimes) and can cause a decline in native species (e.g. Yates and Hobbs (1997) and Faithfull (2012)). Furthermore, when large stands of exotic plants establish as thickets or extensive grassy monocultures, they act to further fragment the landscape (Godfree et al., 2017).

Invasion of subalpine and lowland grassy systems by invasive plants is often driven by resource availability and is commonly associated with disturbance (Faithfull, 2012; Johnston & Pickering, 2001; Leigh et al., 1987; McIntyre & Lavorel, 1994). Invasive species found in subalpine woodlands are primarily associated with anthropogenic disturbance such as roadsides, paths and infrastructure. In the ACT, invasive plants are more abundant, diverse and widespread in lowland woodlands than subalpine woodlands (S. Taylor 2018, pers. communication). Lowland woodlands have been subject to a range of historical disturbances (Landsberg, 2000) and the high edge-to-area ratio of many patches increases their susceptibility to plant invasion (Saunders et al., 1991). Some exotic plants, including Pinus sp. (wildlings from former and existing pine plantations) and blackberry (Rubus fruticosus), are currently being managed in both lowland and subalpine woodland patches.

A number of native species, not local to the ACT, pose a current threat to woodlands (primarily within the urban-woodland matrix). The most common species include shrubs (e.g. Cootamundra Wattle, Black Wattle [*Acacia decurrens*], Streaked Wattle [*Acacia lineata*] and Rosemary Grevillea [*Grevillea rosmarinifolia*]) and creepers (e.g. WA Bluebell Creeper [*Billardiera heterophylla*]). Annual grasses, forbs and shrubs are the most common weeds in lowland and subalpine woodlands (see Table 2). Several of these species are identified as Weeds of National Significance (WONS) (see the Commonwealth Government Environment website). Exotic grasses currently pose the biggest threat to woodlands in the ACT. A number of species, including African Lovegrass and Chilean Needle Grass (*Nassella neesiana*), have become so abundant and widespread in lowland woodlands that eradication is not feasible.

Some woodland areas have become so highly degraded and dominated by invasive species that they act as novel ecosystems. Indeed, some species of woody weeds (e.g. blackberry) in woodlands of poor condition provide valuable habitat for native animals, particularly birds (Stagoll et al., 2010). The indirect impact on biodiversity of removing these weeds must be considered during control and follow up activities. Other potential non-target impacts of weed control may result from weed spraying and subsequent colonisation of other invasive species following removal.

There are a number of invasive plants that are not yet established in the ACT but have the potential to cause significant damage to woodlands. For example, Coolatai Grass (*Hyparrhenia hirta*), which can significantly impact the diversity of woodland ground cover (McArdle et al., 2004), was recently discovered in the ACT (and swiftly treated). People, vehicles, animals and machinery pose a significant biosecurity threat to woodland (particularly subalpine woodland) values through the potential introduction of invasive plants (and pathogens). Many invasive plants have a long lag time before they establish at a site. Thus prevention, and early detection and treatment, is essential to effectively and efficiently manage the impacts of plant invasions (Hobbs & Humphries, 1995). The ACT Government is on high alert to detect and eradicate several emerging species outlined in Table 2.

Spraying African Lovegrass, Mt Taylor Nature Reserve

Table 2: Invasive plants present in woodlands in the ACT (WONS are bolded)

PRIORITY SPECIES FOR CONTROL			EMERGING SPECIES		
COMMON NAME	SCIENTIFIC NAME	WOODLAND ASSOCIATION	COMMON NAME	SCIENTIFIC NAME	WOODLAND ASSOCIATION
African Lovegrass	*Eragrostis curvula*	Lowland and Subalpine	**Bridal Creeper**	*Asparagus asparagoides*	Lowland
Blackberry	*Rubus fruticosus*	Lowland and Subalpine	**Chilean Needle Grass**	*Nassella neesiana*	Subalpine
Chilean Needle Grass	*Nassella neesiana*	Lowland	Coolatai Grass	*Hyparrhenia hirta*	Lowland and Subalpine
Cootamundra Wattle	*Acacia baileyana*	Lowland	**Fireweed**	*Senecio madagascariensis*	Lowland
English Broom	*Cytisus scoparius*	Subalpine	Mexican Feather Grass	*Nassella tenuissima*	Lowland and Subalpine
Nodding Thistle	*Carduus nutans subsp. nutans*	Subalpine	Mouse-ear Hawkweed	*Hieracium pilosella*	Subalpine
Pine	*Pinus radiata / Pinus sylvestris*	Lowland and Subalpine	Orange Hawkweed	*Hieracium aurantiacum*	Subalpine
Serrated Tussock	*Nassella trichotoma*	Lowland and Subalpine	Ox-eye Daisy	*Leucanthemum vulgare*	Subalpine
St John's Wort	*hypericum perforatum*	Lowland and Subalpine	Spanish Heath	*Erica lusitanica*	Lowland
Sweet Briar	*Rosa rubiginosa*	Subalpine	Whiskey Grass	*Andropogon virginicus*	Lowland
Sweet Vernal Grass	*Anthoxanthum odoratum*	Subalpine			
Garden escape woody weeds	(various)	Lowland			

CONSERVATION OBJECTIVES

MITIGATE THE IMPACT OF INVASIVE PLANTS

- Manage established invasive species according to the ACT Weeds Strategy 2009 -2019 (ACT Government, 2009) (note, a revised ACT Weeds Strategy is currently in development) and annual Invasive Plants Operations Plans.
- Prevent costly, erratic invasive plant control by ensuring long term, regular funding for targeted management.
- Reduce the likelihood of new plant invasions by prioritising management activities that prevent the introduction of invasive species, and rapidly detect and efficiently eradicate emerging species. Activities include:
  - responding promptly to outbreaks of emerging species and ensuring rigorous follow up control
  - continue to engage the community in reporting weed sightings and infestations through Canberra Nature Map and the Collector Application
  - identify additional strategies to:
    - enhance community education regarding the threat and identification of invasive species (using a variety of media platforms)
    - expand community education regarding the biosecurity risk people and vehicles pose to woodland values, and appropriate hygiene measures to reduce the likelihood of species being unintentionally introduced
    - enhance knowledge sharing between community members and land managers, including the ACT Government.
- Where eradication of a species is not feasible, prioritise management actions to protect significant cultural and ecological assets from further invasion.
- When required, undertake staged removal of woody weeds and plan and implement revegetation (e.g. with fast growing native shrubs) to maintain critical habitat for fauna in the absence of complex habitat structure.
- Facilitate and support cross-tenure management of invasive plants where relevant.
- As part of control programs, monitor the indirect impacts of invasive plant control, and changes in the abundance of invasive plants and their impacts on woodlands.
- Continue to use and promote digital technologies to assist in the systematic recording of invasive species distribution and control activities and use this information to monitor changes in the area and density of infestations.
- Keep up to date with new control methods and emerging technologies to inform best practice invasive plant species management.

PEST ANIMALS

Pest animals cause damage to native species associated with woodland ecosystems in the ACT. Pest species include the European Rabbit (*Oryctolagus cuniculus*), European Red Fox (*Vulpes vulpes*), feral cat (*Felis catus*), feral pig (*Sus scrofa*), feral horses (*Equus caballus*), Indian Myna (*Acridotheres tristis*), European Wasp (*Vespula Germanica*), Honey Bee (*Apis mellifera*) and several species of deer. Threats posed by pest animals do not occur in isolation; the impact of multiple pest species often interact with each other and with a range of other threatening processes that exert pressure on native biodiversity (e.g. fire, grazing and habitat fragmentation) (Molsher et al., 2017; Williams et al., 1995).

The Australian Government lists competition and land degradation caused by European Rabbits as a key threatening process (Commonwealth Government, 2011c). European Rabbits negatively impact ecosystems by disturbing the soil, preventing the regeneration of vegetation, ringbarking trees, promoting weed invasion and competing with native mammals for resources (Commonwealth Government, 2011c; Leigh et al., 1987; Williams et al., 1995; Wimbush & Forrester, 1988). Rabbits are widespread across a range of ecosystems and altitudinal gradients in the ACT. Leigh et al. (1987) found that rabbits in the subalpine woodlands in the ACT increase the risk of erosion and reduce the cover and diversity of forbs.

Deer can damage soils and reduce the abundance of native plants by rubbing against and damaging trees, trampling and eating saplings (Commonwealth Government, 2011b) and wallowing within and around the edges of waterbodies. Three species of deer have been recorded in woodlands and other ecosystems in the ACT. Fallow Deer (*Dama dama*) and Red Deer (*Cervus elaphus*) have scattered populations across a range of ecosystems in the ACT. Sambar Deer (*Rusa unicolor*) are an emerging threat in the ACT. Most sightings of Sambar Deer have been within Namadgi National Park. Monitoring by the ACT Government indicates they have had little impact on vegetation structure and composition to date (Mulvaney et al., 2017).

Predation by the European Red Fox and feral cat are both listed as key threatening processes by the Australian Government (Commonwealth Government, 2008, 2015b). Feral cats prey on a range of birds, reptiles and mammals and have been implicated in the widespread decline of native fauna across the country (Dickman, 1996). Predation by foxes is also believed to have contributed significantly to the decline of native animals in Australia (Commonwealth Government, 2011a). Both cats and foxes threaten the survival and persistence of woodland fauna in the ACT. Domestic cats in Canberra show a preference for mammals, but also kill a range of native birds, reptiles and amphibians (Barratt, 1997).

The Australian Government lists predation, habitat degradation, competition and disease transmission by feral pigs as a key threatening process (Commonwealth Government, 2017). Pigs can alter soil structure, nutrient cycles and water quality, and can alter plant species composition, including the distribution of weeds (Commonwealth Government, 2017). There are resident populations of pigs across the ACT. They are most likely to have an ongoing impact within subalpine ecosystems, including woodlands, which neighbour bogs, wetland areas and creeks.

Feral horses can cause soil compaction, erosion, damage to vegetation, introduction of weeds and damage to water bodies (Commonwealth Government, 2011d). While horses are abundant in Kosciusko National Park bordering the ACT, they are now largely absent from the ACT. The risk of incursions into the ACT (i.e. Namadgi National Park) is high and is likely to change in response to control activities undertaken in NSW. Incursions into Namadgi National Park are monitored and controlled as required.

Box 3: Dingoes (*Canis lupus*), a controlled native species

> Dingoes (*Canis lupus*) have functioned as a higher order predator in Australian ecosystems for approximately 4 000 years. They prey on a range of small, medium and large animals and may help suppress introduced species such as the European Red Fox, feral cat, feral goats and the European Rabbit (Corbett & Newsome, 1987). In the ACT, Dingoes show some hybridisation with domestic dogs and, due to their impact on sheep, are considered a pest by graziers (ACT Government, 2012a; Claridge et al., 2009). They are currently controlled in areas adjoining rural properties to protect livestock, however in core areas of Namadgi National Park they are protected.

Indian Mynas are aggressive and may outcompete native animals for food and limited habitat features such as hollows. In the ACT they are most commonly found in urban areas, along the edges of woodland reserves, and within nature reserves with low densities of trees (Grarock et al., 2014; Pell & Tidemann, 1997). Recent data analysis undertaken by the Canberra Ornithologists Group (COG) indicates that the number of Indian Mynas in the ACT is no longer increasing (Bounds et al., 2010). Community-led culling is likely to have played a role in reducing populations at a local level (Grarock et al., 2014).

Aggressive exclusion of native birds from potential woodland and forest habitat by over-abundant Noisy Miners (*Manorina melanocephala*) is listed as a key threatening process by the Australian Government (Threatened Species Scientific Committee, 2013). Noisy Miners have been implicated in the reduction of abundance and diversity of native birds within woodlands (Bennett et al., 2015; Dow, 1977; Grey et al., 1997; Taylor et al., 2008). The pressure exerted on native fauna is exacerbated by fragmentation and is most pronounced in the most productive areas (Bennett et al., 2015; Montague-Drake et al., 2011; Oldland et al., 2009; Taylor et al., 2008). Analysis of woodland bird data by COG indicates that the number of Noisy Miners in the ACT is increasing (Bounds et al., 2010; Canberra Ornithologist Group, 2018).

In addition to being a social nuisance, European Wasps may impact woodland and other ecosystems by preying on and competing with native invertebrates (Kenis et al., 2009). European Wasps are found throughout the ACT, including the most remote areas of Namadgi National Park. Competition from feral Honey Bees is listed as a key threatening process by the NSW Government (NSW Government, 2002). Honey Bees compete with native species for tree hollows and flora resources (NSW Government, 2002). Many woodland-associated birds (including the Superb Parrot) are dependent on tree hollows and may be affected by competition for hollows from European Wasps and Honey Bees. In addition, other hollow-dependent fauna, including Sugar Gliders (*Petaurus breviceps*), Brushtail Possums (*Trichosurus vulpecula*), Greater Gliders (*Petauroides volans*) and Yellow-bellied Gliders (*Petaurus australis*), may also be affected by European Wasps and Honey Bees.

CONSERVATION OBJECTIVES

CONTROL PEST ANIMALS

- Prevent costly, erratic pest animal control by ensuring long-term, regular funding for targeted pest management, according to the ACT Pest Animal Strategy 2012-2022 (ACT Government, 2012a).
- Reduce the impact of pest animals by prioritising management activities that detect and efficiently manage emerging pest species. Activities include:
  - responding promptly to emerging pest species and ensuring rigorous follow-up control (see ACT Pest Animal Strategy 2012-2022 (ACT Government, 2012a) and ACT Biosecurity Strategy 2016-2026 (ACT Government, 2016a))
  - identifying additional strategies to expand community education regarding the threats and identification of pest animals
  - enhancing knowledge sharing between community members and land managers, including the ACT Government.
- Where eradication of a species is not feasible, prioritise management actions to protect significant cultural and ecological assets from further impacts.
- Facilitate and support cross-tenure management of pest animals.
- Consider the interactions between ecosystem processes, threatening processes and management activities during the development and implementation of control programs.
- Lead and support research to improve our understanding of the relationship between pest animal abundance/density and environmental impacts. Based on research findings, develop management actions that target actual, rather than perceived, impacts.
- For all control programs, develop and maintain a robust monitoring program to track changes in the abundance of pest animals and the impact they cause to woodland values.
- Develop management triggers for the control of pest animals that are informed by both the abundance of an animal and its environmental impact.
- Facilitate community education and participation in pest animal management to maintain community support for pest animal control and to improve efficiencies of control work through cross-tenure management.
- Lead and support research to identify and test innovative control methods and emerging technologies in the space of pest animal control to inform best-practice management.
- Maintain local, regional and national research collaborations (including the Centre for Invasive Species Solutions).

DIEBACK

Dieback refers to the long-term decline in the health of trees, often leading to death. Symptoms of dieback include thinning of the canopy, regeneration of the crown from epicormic shoots, reduction in growth rate, increase in dead branches, and other symptoms of stress that may render the trees more susceptible to damage from insects and disease. The primary drivers of *Eucalyptus* dieback are usually fungal pathogens (Ciesla & Donaubauer, 1994; Jurskis & Turner, 2002; Scott et al., 2009) or high rates of defoliation by insects (Edwards et al., 1993; Gherlenda et al., 2016; Hall et al., 2015; Lowman & Heatwole, 1987; Ross & Brack, 2015; Steinbauer et al., 2015; Stone & Bacon, 1994; Wardell-Johnson et al., 2005).

A number of research projects link insect outbreaks to changes in weather and water stress (Clark, 1962; Clark & Dallwitz, 1974; White, 1969). Whether dieback is related to an increased susceptibility of trees to these drivers, and the potential reasons for this, is less well understood. Researchers have postulated that nutrient enrichment of woodland systems through pasture improvement has played a significant role in dieback on rural lands (Landsberg et al., 1990). Other suggested causes include fewer low intensity fires (Jurskis & Turner, 2002), higher rainfall and / or water logging (Gherlenda et al., 2016; Hall et al., 2015), climate change and plant stress due to changed soil conditions (Jurskis & Turner, 2002), and increased pest mobility associated with urbanisation (Hall et al., 2015).

Dieback is becoming an increasing threat to trees and associated flora and fauna in woodlands in the ACT and more broadly. For example, across the Monaro region of NSW, approximately 2000 km^2 of woodland is affected by dieback. The decline in condition, particularly of Ribbon Gum (*Eucalyptus viminalis*), is consistent across all land use types and has no relationship with fire regime or habitat complexity (Ross & Brack, 2015). Within the ACT, dieback has been described across all age classes and land tenures. It is most common in Eucalyptus trees across the lowlands (e.g. Blakely's Red Gum [*Eucalyptus blakelyi*] and Apple Box [*E. bridgesiana*]). However, it also has been noted in a number of species that occur in subalpine communities including Snow Gum (*E. pauciflora*), Ribbon Gum, and Candlebark (*E. rubida*). Blakey's Red Gum, a key component of the Endangered YB-BRG Woodland community, is particularly susceptible to dieback (Cowood et al., 2018).

Blakely's Red Gum, Isaac Ridge

In the ACT, affected trees show signs of foliar damage from insect herbivory, especially psyllids (*Cardiaspina albitextura* and *Lasiopsylla rotundipennis*) and the scarab beetle (*Anoplognathus* spp.). Dieback of Ribbon Gum and Apple Box noted in the southern regions of the ACT appears to be correlated with the presence of the native weevil (*Gonipterus* spp.). Preliminary analyses indicate fungal pathogens (*Phytopthora* spp.) are present in ACT woodlands, but further investigation is required to confirm their contribution to dieback in the ACT (ACT Government, 2017 unpublished data).

The cause (or interacting factors) leading to an increase in the abundance of psyllids or the scarab beetle that may cause dieback in the ACT is not known. Similarly, limited information is available to identify causative factors of eucalypt susceptibility to insect attacks (or other drivers) that cause dieback. However, recent modelling indicates that the change in condition (as a measure of dieback) of Blakely's Red Gum and lowland box gum grassy woodland (u178 and u19) 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). Specifically, declining condition of lowland box gum grassy woodland is associated with elevated maximum temperatures during the warmest month of the year and high rainfall in the wettest month. Poor condition is also correlated with fewer fires since 1900 and with increasing distance between trees. The overall condition of trees on rural land is higher than on reserve land (Cowood et al., 2018). It is important to note that the health of trees in lowland woodland changes from year to year, and the relationship between condition and variables also changes.

CONSERVATION OBJECTIVES

MITIGATE THE IMPACTS OF DIEBACK

- Continue to lead and support research and modelling to improve our understanding of the relationship between dieback and:
  - fire (including prescribed burning)
  - the abundance and impact of insects and fungal pathogens
  - soil moisture and condition
  - vegetation density
  - land use.

  This will require the collection of additional field data.
- Building on the work undertaken by Cowood et al. (2018), continue to map tree canopies using remote sensing methods and undertake associated modelling and analysis to track changes in the condition of trees in lowland woodland communities (e.g. Blakely's Red Gum, Yellow Box [*Eucalyptus melliodora*] and Apple Box) over time. Expand modelling and analysis to include subalpine woodland species (e.g. Snow Gum, Ribbon Gum and Candlebark).
- Lead and support research to improve our understanding of the susceptibility of individual Eucalyptus trees to dieback (including investigations into genetic variability and seed provenance trials [see Section 4]).
- Undertake and support restoration activities that enhance a system's resilience to climate change and other disturbances (see Section 1.3), and encourage regeneration and establishment of *Eucalyptus* trees.
- Management actions that aim to mitigate the impacts of dieback are informed by emerging ideas and research undertaken in the ACT and in Eucalyptus woodland communities across Australia.

CLIMATE CHANGE

Over the past 60 years Australia has experienced a shift in rainfall patterns, a warming climate, and rising sea levels (Timbal et al., 2015). With continued emissions of greenhouse gas, changes to the climate are likely to continue. Future projections for the ACT and the broader region (i.e. the 'Murray Basin Cluster', identified in Timbal et al. (2015)) include: warmer temperatures (including an increase in the average mean temperature and the number of extremely hot days), a reduction in snowfall and fewer frost days, an increase in the occurrence and duration of extreme drought, an increase in the number of severe fire danger days, and a reduction in cool-season rain (and high variability of warm-season rainfall) (Timbal et al., 2015). These changes will alter the structure and floristic composition of woodlands in the ACT and likely compromise their function and resilience. While changes to lowland and subalpine woodlands are inevitable, understanding these changes will help us develop realistic and achievable goals, and prioritise and implement strategies to maintain biodiversity.

Overall plant productivity and the persistence of some species across the landscape will be limited by changes in the availability of soil moisture (Prober et al., 2014b; Timbal et al., 2015). Warming temperatures are likely to impact the life history strategies of some species (Timbal et al., 2015), including a number of threatened lowland woodland species (see Wilson et al. (2016)). The future climatic suitability of the local area for some species may also change. For instance, climate refugia modelling undertaken by the ACT Government predicts the persistence of Snow Gum at lower elevations is at risk, however, there will continue to be suitable climate conditions at high elevations (Mackenzie et al., 2018). Modelling also suggests there will continue to be climatically suitable habitat for a number of other common subalpine woodland canopy and midstorey species (including Mountain Gum (*Eucalyptus dalrympleana*), Candlebark, Black Sallee (*E.stellulata*) and *Daviesia mimosoides*) in the near (2020-2039) and far (2060 -2079) future (Mackenzie et al., 2018).

The climate suitability of areas across the ACT in the near or far future is predicted to remain stable for many common lowland woodland canopy species in the ACT, including Blakely's Red Gum, Yellow Box, Apple Box and Ribbon Gum (Mackenzie et al., 2018). The climate suitability for many common midstorey and understorey species in lowland woodland is also likely to be maintained in the near future. The local climate is predicted to become increasingly unsuitable for some species associated with woodlands. For instance, the persistence of *Themeda triandra* is likely to be confined to small refuges in the ACT (Mackenzie et al., 2018).

Increasing temperatures and changes to concentrations of atmospheric CO2 are likely to impact both lowland and subalpine woodland plant species in different ways, and thus alter the composition of woodland communities (Hovenden & Williams, 2010; Jarrad et al., 2009; Prober et al., 2012a). Increased CO2 leading to increased growth rates and improved water use efficiency of woody plants may also result in denser midstorey and canopies (Hovenden & Williams, 2010; Prober et al., 2012a). However, some woodland species (including the Snow Gum), may experience increased susceptibility to damage from frosts when grown at higher atmospheric CO_2 concentrations (Lutze et al., 1998).

Research suggests warming and drying conditions are likely to change the availability of soil nutrients in subalpine systems (White-Monsant et al., 2015). Furthermore, the effects of climate change will interact with, and potentially exacerbate the impacts of other threatening processes, such as fire, fragmentation and invasive plants (and animals). The impacts of climate change are also a potential cause of widespread Eucalypt dieback (see Dieback discussion above). The increased growth of woody vegetation in grassy woodlands could result in changes to fuel loads and the response of woodland communities to different fire intervals and intensity. Lack of habitat connectivity across the landscape is likely to impede the successful migration and adaptation of native species to changed environmental conditions. In particular, poor dispersers (e.g. native perennial herbs) and those species that lack long-lived seed banks will have limited capacity to recover after extreme climatic events and to otherwise distribute to climatically suitable areas (Prober et al., 2012a). These species may require assistance to colonize new areas (see McIntyre (2011)). As habitat becomes unsuitable for native species and disturbance events increase, the encroachment and establishment of invasive plant species are likely to increase and further compromise the resilience of woodland vegetation under new conditions (Prober et al., 2012a).

Yellow Box at Mulligans Flat Woodland Sanctuary (M. Jekabsons)

Changes in local temperatures are likely to impact the physiology and development of a number of fauna species (Hughes & Westoby, 1994). As woodland vegetation structure, function and resources change, the suitability of current habitat for some woodland-associated fauna species will also decline. For instance, the availability and nutritional content of food for herbivores (i.e. leaf nitrogen concentrations and secondary metabolites) is likely to be lower with higher atmospheric CO2 concentrations (Hovenden & Williams, 2010). A lack of connectivity across the landscape will impede the migration of fauna species to habitat with suitable nesting, food and shelter. Fauna species most at risk include those with a long time to maturity, poor mobility, narrow ranges, specific host relationships, isolated and specialised species, and those with large home ranges (Hughes & Westoby, 1994).

CONSERVATION OBJECTIVES

MITIGATE THE IMPACT OF CLIMATE CHANGE

- Improve understanding of:
  - the predicted impacts of climate change on woodland-associated fauna and flora
  - future climate refugia for woodland communities and potential colonisation sites for associated biodiversity
  - which species are likely to require assistance to migrate to suitable areas and how translocations could be used to ensure the survival of populations of species
  - changes in the invasion potential of high-risk invasive plants
  - changes to woodland soil condition with drying conditions.
- Identify management priorities and protect sites identified as significant refugia (and potential colonisation sites) for woodland species.
- As outlined in Section 1.3, woodland restoration activities will consider future climate impacts and will aim to enhance a system's ability to adapt to changing conditions.
- Collaborate with local, regional, state and federal stakeholders to undertake research, management activities, and facilitate community awareness raising and knowledge sharing between all parties.
- Monitor the long-term response of species (that are characteristic of woodland communities) to climate change. Use monitoring data to inform the selection of thresholds above or below which management actions should be triggered.

1.3 ENHANCE RESILIENCE, ECOSYSTEM FUNCTION AND HABITAT CONNECTIVITY

Stol and Prober (2015) describe high quality box-gum grassy woodland as having effective ecological processes, a diverse ground-layer with patches of shrubs, a range of tree sizes (with an open canopy), and hollows, fallen timber, and vegetation structure that provides habitat for fauna. Across eastern Australia, few lowland grassy woodlands are of high quality; they are frequently in poor to moderate ecological condition.

To enhance the resilience, function and overall condition of woodland across the ACT, restoration works must aim to maintain (or improve) a range of habitat features. Maintaining heterogeneous understorey structure and intermediate herbage mass are critical components of the restoration of our lowland woodland systems. Habitat connectivity is also a critical consideration in ensuring the long-term resilience and function of woodland and associated biodiversity.

MAINTAIN AND IMPROVE WOODLAND CONDITION

The most important consideration in seeking to enhance the function of woodland ecosystems is to maintain the extent, integrity and habitat features of existing woodland in the ACT. Where woodland areas are in an altered, but relatively good condition, removing the source of degradation, and thus facilitating natural regeneration, can be effective (Standards Reference Group, 2017). In low quality sites, activities to assist natural regeneration (e.g. planting, pest animal control, and introducing habitat features) may be required. Principles guiding the maintenance and improvement of woodland condition in the ACT are derived primarily from research undertaken in lowland woodlands of the region. Little research has been undertaken to inform this work in subalpine woodlands.

Natural regeneration is often more cost effective than planting, and typically results in the establishment of healthy plants, well-adapted to site-specific conditions (Rawlings et al., 2010; Spooner et al., 2002). Research indicates that vegetation within restoration sites are genetically poorer than remnant trees and thus may not be able to adapt to environmental change as well as sites with natural regeneration (Broadhurst, 2013). Remnant vegetation also provides important habitat for fauna that plantings may not provide for many years (Lindenmayer et al., 2016).

Fallen timber, Mulligans Flat Woodland Sanctuary (M. Jekabsons)

Large, mature trees enhance critical ecosystem functions (e.g. carbon storage and water production) (Keith et al., 2017), and also encourage movement of fauna, which facilitates pollination and seed dispersal of woodland vegetation (Doerr et al., 2014a). They provide breeding, roosting and foraging habitat that smaller trees or artificial structures may not provide (Ikin et al., 2013b; Le Roux et al., 2016b; Le Roux et al., 2015, 2018) and are a critical source of leaf litter (McElhinny et al., 2010), seed for recruitment (Vesk et al., 2008), and fallen debris (Killey et al., 2010).

Coarse woody debris takes a long time to accumulate and significantly influences the function of woodland ecosystems (Manning et al., 2007). Coarse woody debris may help protect understorey plants from moisture loss, and play a role in enhancing plant growth and cover in woodlands (Goldin & Brookhouse, 2015). It may also improve soil nutrition (Goldin & Hutchinson, 2013) and facilitate natural regeneration by reducing browsing pressure in grassy systems (Stapleton et al., 2017). Research also indicates coarse woody debris plays a role in enhancing overall soil microbial diversity (Hamonts et al., 2017), maintaining beetle diversity (Barton et al., 2009) and increasing reptile abundance (Manning et al., 2013). Research from the Mulligans Flat-Goorooyarroo Woodland Experiment has been instrumental in guiding the scale and placement of coarse woody debris to enhance the function of woodland ecosystems across the ACT. Maintaining other key habitat features such as mistletoe (see Ikin et al. (2014b); Watson (2002)) and a variable ground cover (Snape et al., 2018) is also critical to maintain woodland ecosystem function.

Plantings and other assisted natural regeneration activities are important for the restoration of woodland sites with compromised ecosystem function (e.g. see Box 4). For instance, undertaking plantings is necessary for the restoration of lowland woodland sites with poor natural regeneration (due, at least in part, to past grazing and associated soil enrichment) (Dorrough et al., 2012; Dorrough et al., 2011; Spooner et al., 2002; Windsor, 2000). In some instances, revegetation may also enhance the resistance of some systems to invasion by exotic plants (Prober & Lunt, 2009). Successful revegetation of some woodland areas support fauna assemblages otherwise absent from a system (Ikin et al., 2014b) and can support higher fauna species diversity when plants of different ages are established (Lindenmayer et al., 2016). Enhancing the diversity of flora at some woodland sites is likely to require the addition of seed, as well as the management of biomass and competition (Johnson et al., 2018).

High-density regeneration or plantings can reduce the growth rate of woodland trees; this delays the creation of large boughs, tree hollows and fallen timber (Killey et al., 2010; Vesk et al., 2008). Recent modelling also suggests that management actions must be tailored to specific areas, for example different systems may require planting and / or thinning of vegetation (as well as efforts to enhance germination and recruitment) to create optimal stand densities (see Gibbons et al. (2010)).

The management of site level threats such as grazing pressure (Manning et al., 2013; Stapleton et al., 2017), inappropriate fire regimes and exotic plant invasion (Yates & Hobbs, 1997), is critical to facilitate natural regeneration and / or ensure the success of restoration activities. In some cases, this requires an improved understanding of the impacts of these threats to biodiversity and the mechanisms that enhance a system's resilience to them. Processes operating at the landscape scale that threaten the success of restoration activities, such as weather and natural events (Hagger et al., 2018), dieback, vegetation clearing and climate change, must also be considered.

The functioning of soil microbial communities is responsive to the quality and quantity of organic matter input by plants (Hamonts et al., 2017), and thus disturbance that threatens woodland plant communities is likely to have a major negative impact on soil microbial communities. Soil communities, including fungi and bacteria, are a critical ecosystem resource; they are an essential component of plant nutrient uptake systems and food webs of many animals (Tommerup & Bougher, 2000). A number of woodland plants, including the threatened Tarengo Leek Orchid and Canberra Spider Orchid, are reliant on associations with mycorrhizal fungi for successful reproduction and the provision of adequate nutrients (see Part B). Given the direct link between soil communities and above ground plant communities (Hamonts et al., 2017), restoration of woodland is likely to be improved by an enhanced understanding of belowground community and trophic relationships (Kardol & Wardle, 2010).

Box 4: Barrer Hill restoration project

In 2014 the ACT Government commenced the Barrer Hill restoration project. The project aims to restore a 50 ha former pine plantation back to a box-gum grassy woodland community. To date, works have included:

- Planting of over 50,000 native trees, shrubs, grasses and wildflowers as habitat and a vital movement corridor for wildlife
- Placement of 80 tonnes of salvaged rock to extend and enhance habitat for the pink-tailed worm-lizard
- Placement of over 1000 tonnes of salvaged coarse woody debris to enhance groundstorey condition and provide habitat for declining woodland birds and other fauna species
- Construction of three forb enhancement sites to enhance groundstorey diversity
- Installation of 10 vertical habitat structures to mimic habitat functions of mature trees
- Installation of a habitat sculpture designed to create a living artwork that engages the public and provides critical habitat, including natural hollows, peeling bark and perch sites

Before and after of forb enhancement site

Barrer Hill and the surrounding area has also been the site of several research programs (Hannan et al., 2019; McDougall et al., 2016; Smith et al., 2018). The site now serves as an outdoor laboratory where students and the community can see and learn about restoration practices first hand.

(a)

(b)

Vertical habitat sculpture (a) and tree plantings and coarse woody debris placement (b)

Changing climatic conditions pose challenges for the success and sustainability of restoration efforts. Species that are unable to adapt or evolve to new environmental conditions as fast as the climate changes will rely on dispersal to more suitable areas to persist in the future. Hence, maintaining and increasing connectivity of woodlands at a local and regional scale will support species to persist, and is critical to ensure the long-term resilience of woodland. Sites with a poor ground layer condition, including nutrient depleted topsoil, exhibit characteristics that are likely to exacerbate the impacts of a drying climate (Prober et al., 2014a). Restoration efforts to improve ground layer and vegetation-soil water feedback, including water infiltration and retention, will enhance the resilience of these systems to increased moisture stress (Prober et al., 2014b). Sourcing non-local seed may enhance the potential for revegetation areas to adapt to a changing climate by incorporating a broader gene pool that may be adapted to different climatic conditions (e.g. genotypes sourced from drier areas) (Prober et al., 2012b; Prober et al., 2015). The ACT Government is undertaking an investigation into biodiversity refugia and, in collaboration with the Commonwealth Scientific and Industrial Research Organisation (CSIRO), a seed provenance trial (see Section 4); these projects will inform restoration projects under predicted climate change.

CONSERVATION OBJECTIVES

MAINTAIN AND IMPROVE HABITAT FEATURES AND HABITAT HETEROGENEITY

- Enforce policy and undertake management action to retain large, mature trees and other critical woodland habitat features (e.g. mistletoe) across all tenures.
- Undertake plantings and introduce habitat elements to restore soil health, increase woodland extent, enhance functional woodland connectivity and enhance habitat for target fauna species.
- The prioritisation and planning of restoration projects should:
  - define site and landscape-scale goals
  - evaluate the appropriateness and cost-effectiveness of assisted natural regeneration to meet objectives otherwise addressed through revegetation and other active regeneration activities
  - be informed by the best available knowledge of the local system and the most appropriate management techniques
  - consider the best available science regarding the future implications of climate change
  - consider the likely impacts of past land use practices on the success of intervention
  - create opportunities to partner with community groups, including Traditional Custodians, local landholders and research organisations (see Section 3)
  - consider how landscape-scale restoration is best achieved across multiple tenures (e.g. control measures coordinated with adjoining tenures)
  - consider opportunities to enhance connectivity through improved habitat quality (see below)
  - consider the habitat and resource requirements of threatened species.
- Work closely with rural landholders and other local land managers to plan and undertake restoration activities to maintain and improve habitat features and contribute to landscape-scale restoration, as outlined in Section 2.1.
- Ensure long term funding for ongoing management and / or monitoring of restoration sites.
- Continue to support the work of community groups (see Section 2), and undertake and support research that informs restoration activities (see Section 3.1 and 4.8).
- If there is conflict between habitat management for two or more threatened species, consideration must be given to abundance, habitat specialisation, functional traits, mobility, adaptability and the ACT and National conservation status of the species. The nature of ongoing threats, and how important the site is to the conservation of the species must also be considered.

- Seek to improve our understanding of aboveground-belowground linkages to inform effective restoration techniques. This includes:
  - knowledge of species-specific symbiotic relationships
  - management actions that are advantageous to soil communities and soil community structure
  - potential for re-establishing mutualistic species relationships through direct introduction of soil organisms.

IMPLEMENT ECOLOGIC ALLY APPROPRIATE HERBAGE MASS MANAGEMENT

Native grasses and forbs play an essential role in maintaining the structure and function of grassy systems and provide important resources for a range of fauna species associated with woodland. Principles guiding the implementation of ecologically appropriate herbage mass management in woodland in the ACT are derived primarily from research in the lowland woodlands of the region.

The natural processes that influence herbage mass levels are usually disrupted in modified vegetation communities and, as a result, herbage mass levels can become too high, too low, or too homogeneous to support a diverse flora and / or fauna community (ACT Government, 2017a). In open lowland woodlands that have not been subject to disturbance such as grazing, fire or slashing, tussock grasses grow large and can create a dense floor canopy and increase overall biomass. The spaces between grass tussocks are important for the establishment of native forbs (Morgan, 1998); thus with increasing herbage mass, plant diversity often declines. As time since disturbance increases, dead leaf matter also accumulates and can smother native grasses; this may facilitate exotic species establishing in the system (Morgan, 2015). Furthermore, if grasses are left to grow long, they are no longer a preferred food resource for native herbivores such as macropods (Snape et al., 2018), which changes the dynamic between herbage mass and natural control agents in the system.

Ideally, grazing pressures from native herbivores contribute to the creation and maintenance of intermediate herbage mass and heterogeneous understorey structure (e.g. average grass height, grass height variability and the proportion of bare ground). However, many lowland woodland patches in the ACT are highly modified and fragmented and are subject to high levels of grazing by macropods (and non-native herbivores such as rabbits). This leads to lower herbage mass and increased homogeneity of understorey structure (see discussion above). A change in plant species composition through invasion by non-native plants can also substantially change the herbage mass and structure of grassy systems (ACT Government, 2017a).

The need for active herbage mass management at a lowland woodland site depends on a range of site-specific factors (e.g. species composition, productivity, time since last disturbance and grazing pressure) and climatic conditions. Where native herbivores are unable to maintain the desired herbage mass and structure, there are a number of tools available to manage herbage mass in woodlands including fire management, manipulation of grazing regimes (including stock and macropods), mowing and slashing. Each technique has a different effect on herbage mass and biodiversity. The history of disturbance and past management practices at a site is likely to influence the response of woodland communities to different herbage mass management techniques applied today (Stol & Prober, 2015) and thus it is an important consideration when implementing a disturbance regime. Additional considerations as part of planning the implementation of herbage mass management are outlined below.

Fire removes herbage mass of dominant grasses (providing space for the establishment of less competitive species) and promotes flowering of some species (Morgan, 2015). The influence fire has on species diversity is, at least in part, determined by the fire history (Stol & Prober, 2015) and the productivity of a site (i.e. fire maintains or increases plant diversity in highly productive Themeda grasslands) (Lunt et al., 2012). Other considerations for implementing fire as a tool for herbage mass reduction include the: frequency and intensity of burning (and the likely impacts on the life-cycle of understorey species), season and weather conditions, topography, presence and sensitivity of rare and threatened species, risk of weed establishment and erosion following burning, and the proximity to urban or other built assets.

Kangaroo Grass (Themeda triandra), Mulligans Flat Woodland Sanctuary (M. Jekabsons)

Grazing removes herbage mass of palatable understorey species. In lowland woodlands research indicates that where heavy grazing by Eastern Grey Kangaroos leads to low herbage mass, a reduction in the density of Eastern Grey Kangaroos will recover herbage mass (McIntyre et al., 2015). Other restoration activities, including the addition of coarse woody debris, will also support the recovery of herbage mass (McIntyre et al., 2015).

The impact stock grazing has on plant species diversity is, at least in part, determined by the grazing history of a site. While there is some evidence that pulse grazing can reduce the abundance of exotic annual grasses (Cole et al., 2016), there is no consensus on its use to enhance biodiversity or its effectiveness in reducing fire severity in some woodland systems (Williamson et al., 2014). However, stock grazing may effectively manage herbage mass (without negatively impacting plant species diversity) at lowland woodland sites with a history of grazing, and where grazing intolerant species have already been excluded (leaving palatable grazing-tolerant species) (McIntyre et al., 2015; Morgan, 2015). In lowland woodland sites containing abundant exotic annuals, strategic grazing may be useful to deplete the cover of exotic annuals and promote native perennials (Lunt, 2005).

Other considerations for introducing stock grazing as a tool for herbage mass management include: frequency, duration and timing of grazing, recent rainfall, stocking rates, quarantine procedures (to reduce the introduction of exotic plants), presence of rare and threatened species, palatability of desirable and undesirable understorey species, and the need and ability to control stock movements at a site (see discussion in Stol and Prober (2015), Morgan (2015) and Lunt (2005)).

When burning or grazing are not viable options to manage herbage mass, **slashing and mowing** can be considered to remove some of the bulk of grasses in lowland woodlands. This can be a particularly useful tool to manage herbage mass for non-conservation purposes in urban reserves. Different species respond differently to slashing and many are sensitive to regular slashing (Morgan, 2015). Other considerations for using slashing and mowing to manage herbage mass in woodlands include: timing (i.e. avoiding active growing, flowering and seeding season), frequency, removal of clippings, the risk of introducing exotic plants, height of slashing, the presence of rare and threatened species, and the size of the area where management intervention is required (see discussion in Stol and Prober (2015) and Morgan (2015)).

CONSERVATION OBJECTIVES

MANAGE HERBAGE MASS

- In the absence of knowledge regarding species-specific understorey habitat requirements, aim to maintain intermediate levels of herbage mass and a heterogeneous (or 'patchy') grassland structure at the reserve and / or landscape scale.
- Evaluate the risk and appropriateness of implementing different herbage mass techniques (fire, grazing or slashing / mowing) at a site, and compare with the risk of inaction.
- Develop ACT Government guidelines for the management of herbage mass within lowland woodlands. Consistent with the Grassland Herbage Mass Management Guidelines; this will include a process for making decisions at a site, which considers:
  - understorey thresholds and requirements for species associated with, or dependant on understorey habitat
  - the historic land use and management at a site
  - the maintenance and / or enhancement of habitat for threatened species and the Endangered YB-BRG Woodland
  - the prescriptions and priorities of existing conservation management plans for the area.
- Manage macropods densities (according to the guidelines outlined above) at sites where heavy macropod grazing is resulting in a substantial decline in herbage mass and structural heterogeneity.
- Undertake and support research and ongoing monitoring to evaluate the ecological, social and economic outcomes of controlled grazing by native herbivores and livestock.
- If there is conflict between herbage mass management for two or more threatened species, consideration must be given to abundance, habitat specialisation, functional traits, mobility, adaptability and the ACT and national conservation status of the species. The nature of ongoing threats, and how important the site is to the conservation of the species must also be considered.
- **Livestock grazing for conservation purposes** should only be used to manage herbage mass on ACT Government managed land where the following criteria are met:
  - native herbivore populations are unable to maintain the desired herbage mass and structure
  - other herbage mass management techniques are deemed too hazardous or otherwise not appropriate
  - the site is outside of a reserve / is not of high quality within a reserve
  - the site has a history of grazing and palatable, grazing tolerant species account for a large proportion of the understorey herbage mass
  - stock movement can be controlled and fertilisers or exotic pastures are not required to maintain animal health
  - the site has not been identified as potential habitat for an understorey threatened species (that is sensitive to grazing pressure) or as climatic refugia for any significant woodland-associated species.

ENHANCE HABITAT CONNECTIVITY

Fragmentation of woodland can have complex effects on remnant vegetation (including a reduction in plant diversity) (Ramalho et al., 2014) and can reduce structural connectivity that facilitates the dispersal of plants and animals across the landscape. This reduces population gene flow, which increases inbreeding and reduces genetic variability; this can ultimately reduce the viability of plant and animal populations (Amos et al., 2014; Doerr et al., 2014a). Importantly, small, isolated populations with low genetic variability will be less able to adapt to new conditions under a changing climate.

Improving habitat connectivity improves population viability by allowing small populations to interact and function as larger, more resilient populations. Connecting woodland patches through the development and maintenance of woodland corridors or isolated 'stepping stone' trees facilitates dispersal of fauna to locations with more favourable climatic conditions and critical habitat resources, and assists pollen dispersal (Doerr et al., 2014a). However, a species' ability to effectively disperse and persist in the landscape is also influenced by factors such as its dispersal mode and efficiency (Amos et al., 2014), habitat condition (Schutz & Driscoll, 2008) and overall habitat loss across the landscape (Mortelliti et al., 2010). Efforts to improve landscape connectivity for particular species could be ineffective if these factors are not considered in restoration initiatives.

CONSERVATION OBJECTIVES

ENHANCE HABITAT CONNECTIVITY

- Projects aiming to maintain or enhance connectivity should:
  - prioritise the protection and effective management of woodland patches
  - identify target species, and consider their requirements for functional connectivity
  - consider habitat connectivity at both a local and landscape scale (within reserves and outside of reserves)
  - consider links between woodland patches and between woodland and other ecosystems across the landscape (e.g. grassland, forest, riparian communities)
  - link large patches of habitat as a first priority
  - be informed by the best available local and regional connectivity models.
  - assess the value and regional context of habitat patches (see Barrett and Love (2012) and Love et al. (2015)).
- Maintain isolated trees on and off reserve as 'stepping stone' connectivity, especially when revegetation is not feasible.
- Ensure the key east – west and north – south wildlife corridors across the ACT are maintained and where required, restored.
- Work with rural landholders and other land managers to improve connectivity of woodland habitat at a landscape scale.

2. COLLABORATE WITH THE COMMUNITY

Meaningful collaboration between the ACT Government and various stakeholders including rural landholders, community members and groups, Traditional Custodians and research institutions will enhance our ability to mitigate current threats to native woodlands in the ACT (see Objective 2). Sharing resources, information and skills between all interest groups will provide the best opportunity to protect and manage woodlands into the future.

Collaboration with the community should be based on the premise that no single agency or group holds all the information to successfully manage woodlands. Knowledge held by interest groups and the broader ACT community can and should contribute to the conservation of woodlands in the ACT as we have a mutual obligation to look after our environment.

2.1 PROMOTE COMMUNITY PARTICIPATION IN WOODLAND CONSERVATION

COLLABORATE WITH RURAL LANDHOLDERS

Lowland woodland or grassland once covered much of the area now designated as rural land. Today, more than 40% of lowland woodland remains on rural land across the ACT.

Recent research illustrates the importance of maintaining a diversity of woodland habitat features as part of the rural landscape. Management activities including revegetation, fencing remnant and regrowth vegetation, reducing grazing pressure, retaining old trees and controlling invasive species, are effective in improving woodland habitat for biodiversity within agricultural areas (Briggs et al., 2008; Ikin et al., 2015; Kay et al., 2013; Lindenmayer et al., 2016; Spooner et al., 2002; Tulloch et al., 2016). Maintaining even small patches of remnant woodland vegetation such as scattered trees, can benefit a range of taxa including invertebrates (Le Roux et al., 2018; Ng et al., 2018), reptiles and frogs (Pulsford et al., 2018; Pulsford et al., 2017), woodland birds (Fischer & Lindenmayer, 2002; Le Roux et al., 2018; Rayner et al., 2014) and bats (Le Roux et al., 2018; Reid & Landsberg, 2000). Maintaining scattered trees can also improve soil conditions (Barnes et al., 2009; Barnes et al., 2011) and may benefit production in a range of other ways, including providing shelter and shade for livestock (Reid & Landsberg, 2000).

To contribute to a whole of landscape approach to woodland conservation, the ACT Government aims to support rural landholders to undertake conservation and sustainable agricultural practices on their properties. Land Management Agreements, required under the Planning and Development Act 2007, are administered by the ACT Government and aim to establish a cooperative management regime that supports the objectives of both the lessee and the ACT Government. They provide a tool that the ACT Government can use to work together with landholders to manage woodland vegetation to preserve its conservation value, retain or enhance the condition of remnant woodland and preserve populations of threatened species.

In 2018, the ACT Government received funding from the Australian Government to implement a five-year collaborative project to enhance and connect woodland in the ACT. Working across the landscape, the ACT Government will join with Greening Australia and Molonglo Conservation Group to facilitate a range of activities with rural landholders and community groups. Specifically, funding will support rural landholders to develop a detailed understanding of the conservation values of their properties, and to plan and implement a range of activities to maintain or enhance these values. These include but are not limited to: revegetation and other rehabilitation activities, strategic grazing of restoration areas (including fencing and incentive payments to offset stock exclusion), management of large paddock trees, threat management, and advice on improving land management practices.

Ongoing opportunities for landholders to manage or improve the condition of their land, as well as its production and conservation value, exist through programs such as the ACT Environment Grants (ACT Government funded), ACT Rural Grants program (supported under the National Landcare Program), and other grant schemes administered by the ACT Government. These on-ground incentives are supported by community groups (such as Friends of Grasslands [FOG] and Greening Australia) and catchment groups.

Blakely's Red Gum – Yellow Box tall grassy woodland (u19) on a Rural property

CONSERVATION OBJECTIVES

COLLABORATE WITH RURAL LANDHOLDERS

- Work closely with rural landholders and their representative body, the Rural Landholders Association (RLA), to identify additional strategies to collaborate on projects and support landholders to protect and / or enhance woodland values on rural land.

  In identifying priority locations for collaboration with rural landholders, consideration should be given to:
  - the presence of lowland snow gum woodland (u78), red box tall grass-shrub woodland (q6) and the Endangered YB-BRG Woodland
  - the connectivity value of woodland on the property (e.g. property is adjacent to a reserve or it has landscape connectivity value)
  - known biodiversity value of the property (e.g. records of threatened or woodland-dependant birds)
  - potential for restoration activities to enhance the biodiversity values of the property
  - willingness of landholder to implement and maintain management recommendations.

  Priority activities include:
  - maintaining remnant vegetation were possible, in particular, the maintenance of regeneration, large old trees and scattered trees
  - maintaining a diversity of habitat features across the rural landscape, including woody debris, vegetation cover, leaf litter and rocks
  - planting and maintaining stands of native woodland species
  - targeting the protection and enhancement of lowland snow gum woodland (u78), red box tall grass-shrub woodland (q6) and the Endangered YB-BRG Woodland
  - controlling invasive plants
  - restoration projects that contribute to improved landscape-scale connectivity (see Objective 3)
  - monitoring results of management activities to inform future management.
- To effectively work with rural landholders, consideration must be given to:
  - the diversity of priorities rural landholders have regarding the management of their properties, including the need to manage for production and profitability
  - mechanisms to maintain open communication and effective relationships, including ensuring appropriate levels of on-ground staff to support initiatives
  - prioritising work on properties that have high biodiversity value and / or significant potential to mitigate landscape scale threats.

Parkcare activity, Mt Taylor

SUPPORT COMMUNITY PARTICIPATION AND RAISE COMMUNITY AWARENESS

There are many community groups (and conservation organisations) interested and active in woodland conservation in the ACT, including:

- Bush on the Boundary
- Canberra Ornithologists Group
- Capital Woodland and Wetlands Conservation Trust
- Conservation Council
- Friends of Grasslands
- Grassy Woodland Stakeholder Group
- Greening Australia
- Kosciuszko to Coast
- Molongolo, Ginninderra and Southern ACT Catchment Groups
- National Parks Association of the ACT
- Parkcare and Landcare Groups.

These groups are instrumental in advocating for native woodland conservation, undertaking management, monitoring and restoration projects, and raising public awareness of the values and threats to woodlands in the ACT (see **Box 5**). The knowledge held by the members of these groups and the work they undertake is critical to the ongoing conservation of woodlands in the ACT (see Section 4.7 for an outline of projects undertaken since the previous Strategy). Seeking to work collaboratively with community groups will improve community ownership of woodland protection and enhance the value of projects.

Community members who participate in on-ground activities with others who are knowledgeable and passionate about woodland conservation develop emotional connections to woodlands and may develop feelings of stewardship over areas. While the benefits to woodland conservation from work undertaken by community members are significant, participants are also likely to experience physical, mental and social health benefits, including developing positive relationships with like-minded people (Townsend, 2006).

Around 3% of ACT residents are currently engaged in volunteering within the reserve system and an additional 13-20% have expressed interest in becoming a volunteer (MARS, 2017). There is significant opportunity to raise the awareness of woodland values and conservation by engaging with community members, particularly young people and residents at the urban-reserve interface, who are not actively involved in its protection. Education initiatives with this broader community group may lead to an increased perceived value of woodlands and participation in conservation activities or other behavioural changes that reduce the ongoing threats to woodlands (e.g. improved vigilance in managing domestic plants and animals).

CONSERVATION OBJECTIVES

SUPPORT COMMUNITY PARTICIPATION AND RAISE COMMUNITY AWARENESS

- Collaborate with community groups to deliver woodland conservation activities (e.g. restoration activities) to address the priorities outlined in this Strategy.
- Support community groups to undertake on-ground and other projects through the provision of grants, advice and access to research and other knowledge. Agreements between the ACT Government and community groups to undertake shared management of sites may also be considered.
- Provide opportunities for community members to engage in volunteer activities, through for example the ParkCare program. Training and access to other ACT Government resources is critical to ensuring the sustainability of the ParkCare program and other volunteer activities as they are identified.
- Facilitate, and collaborate with external groups to deliver community education programs that engage the broader community. Priority topics include:
  - the value of lowland and subalpine woodlands, including the conservation significance of box-gum woodlands in the ACT and the threats to these values
  - the implications of climate change on woodland biodiversity
  - opportunities for community members to support the conservation of woodland biodiversity through management of residential risks and participation in volunteer opportunities
  - the management priorities and challenges of effective woodland conservation in the ACT (e.g. native species control and balancing multiple priorities such as fire risk, biodiversity and community amenity within lowland woodland reserves)
  - promoting the use of grassy woodland species in residential plantings
  - disseminating the outcomes of relevant research and the outcomes and achievements of community activities.
- Facilitate information and knowledge sharing between ACT Government staff, research institutions and community groups to encourage best practice management of woodlands through, for example:
  - workshops and seminars
  - on-ground activities
  - training opportunities
  - online resources (e.g. ACTMAPi and ACT Government – Environment website)
  - presentations
  - production of educational resources and user-friendly publications.
- Develop and maintain appropriate interpretative signage and other educational materials in reserves and other open spaces.

Box 5: Collaborative management of Stirling Park

In 2009, FOG entered a contractual agreement with the National Capital Authority to undertake collaborative management of Stirling Park woodland (and nearby Yarramundi Reach and Scrivener's Hut). Stirling Park is 52 ha of woodland reserved by the Commonwealth Government and managed by the National Capital Authority. It includes Endangered YB-BRG Woodland and a large population of the endangered Button Wrinklewort (*Rutidosis leptorhynchoides*). It is also of cultural significance to Traditional Custodians as it forms part of a ceremonial pathway and contains a number of recorded Aboriginal places.

A Conservation Management Plan was developed in 2009 (Sharp, 2009) and was reviewed and updated in 2016 (Sharp, 2016). Together with a number of stakeholder groups (including traditional knowledge holders, Greening Australia, Yarralumla Residents Association and Molonglo Catchment Group), FOG has improved the condition of Stirling Park through on-ground management work including revegetation, fire management, and control and mapping of invasive plants. Collaborative management across Stirling Park and a neighbouring woodland property (managed by the ACT Government) has enhanced the local connectivity of woodland habitat in the area. FOG continues to play an advocacy role to ensure the protection of the site and to encourage its dedication to nature conservation.

Stirling Park (M. Jekabsons)

ENHANCE AND PROMOTE CITIZEN SCIENCE

Monitoring and research activities undertaken by community members and organised groups make a significant contribution to our knowledge of woodlands; the breadth of data gathered by these groups is unattainable by research institutions and the ACT Government alone. Groups such as COG have long term monitoring projects that contribute large amounts of data to our shared understanding of woodland biodiversity (see Box 7). Resources developed by community groups (such as the Vegwatch Manual) provide guidance to community members to undertake monitoring using a consistent methodology.

New technologies enable community groups to collect data with accuracy and precision. Parkcare and other groups use GIS mapping tools to record and report on management issues such as invasive plants and pest animals. Canberra Nature Map, and the corresponding NatureMapr Application, allows community members to report the location of plants, fungi, animals, insects and fish species that they observe across the Canberra region. NatureMapr is very popular and public submissions have vastly improved the understanding of the distribution of threatened and uncommon species (including the identification of new populations of rare plants), allowed early intervention against high risk early invader environmental weeds (following records of new weed outbreaks) and has contributed to an increased public awareness of the flora and fauna of the ACT region.

As with other community-led on-ground environmental projects, citizen science projects do not simply achieve environmental outcomes. As the participants and breadth of citizen science activities continue to expand, there is also significant opportunity for these projects to contribute to the broader community understanding of the threats to and values of woodlands across the ACT. Citizen science projects can also benefit the community through educational outcomes, increased awareness of environmental issues and changes in behaviour of community members (Roetman et al., 2014).

CONSERVATION OBJECTIVES

ENHANCE AND PROMOTE CITIZEN SCIENCE

- Explore opportunities for citizen science initiatives to meet conservation objectives outlined in this Strategy. Provide support to relevant community groups to plan projects and implement them.
- Encourage the systematic collection and effective use of data collected through citizen science projects by:
  - supporting the management and use of digital information tools (e.g. ACTMapi and Canberra Nature Map / NatureMapr Application)
  - ensuring data collected is subject to appropriate quality control (e.g. through expert screening of data and developing and disseminating data collection protocols)
  - supporting community groups to access grants, professional and technical advice, training and equipment.

ENHANCE THE PARTICIPATION OF ABORIGINAL PEOPLE

While Traditional Custodians no longer rely on traditional resources found throughout the landscape for survival, retaining a connection to traditional lands remains important in defining and maintaining cultural identity. This includes accessing the landscape for cultural and social purposes (e.g. ceremonies, gatherings, fishing, cooking, healing, resource collection and knowledge transfer) and protecting significant places and features of the landscape from threatening processes (see **Box 6**).

Traditional Custodians of the Canberra region view all Aboriginal places and objects as an important part of their history and want to ensure their appropriate maintenance and protection. The ACT Parks and Conservation Service, including Aboriginal staff, work to improve participation of Traditional Custodians in identifying the traditional uses and values of the land, and to plan for, and manage the cultural landscape according to contemporary Aboriginal aspirations. The ACT Government is currently working together with Traditional Custodians to establish the Traditional Custodians Caring for Country Committee. This Committee will support the integration of cultural knowledge in the management of Country and will provide support to ACT Government staff (within the Environment, Planning and Sustainable Development Directorate) to engage effectively and appropriately with Traditional Custodians.

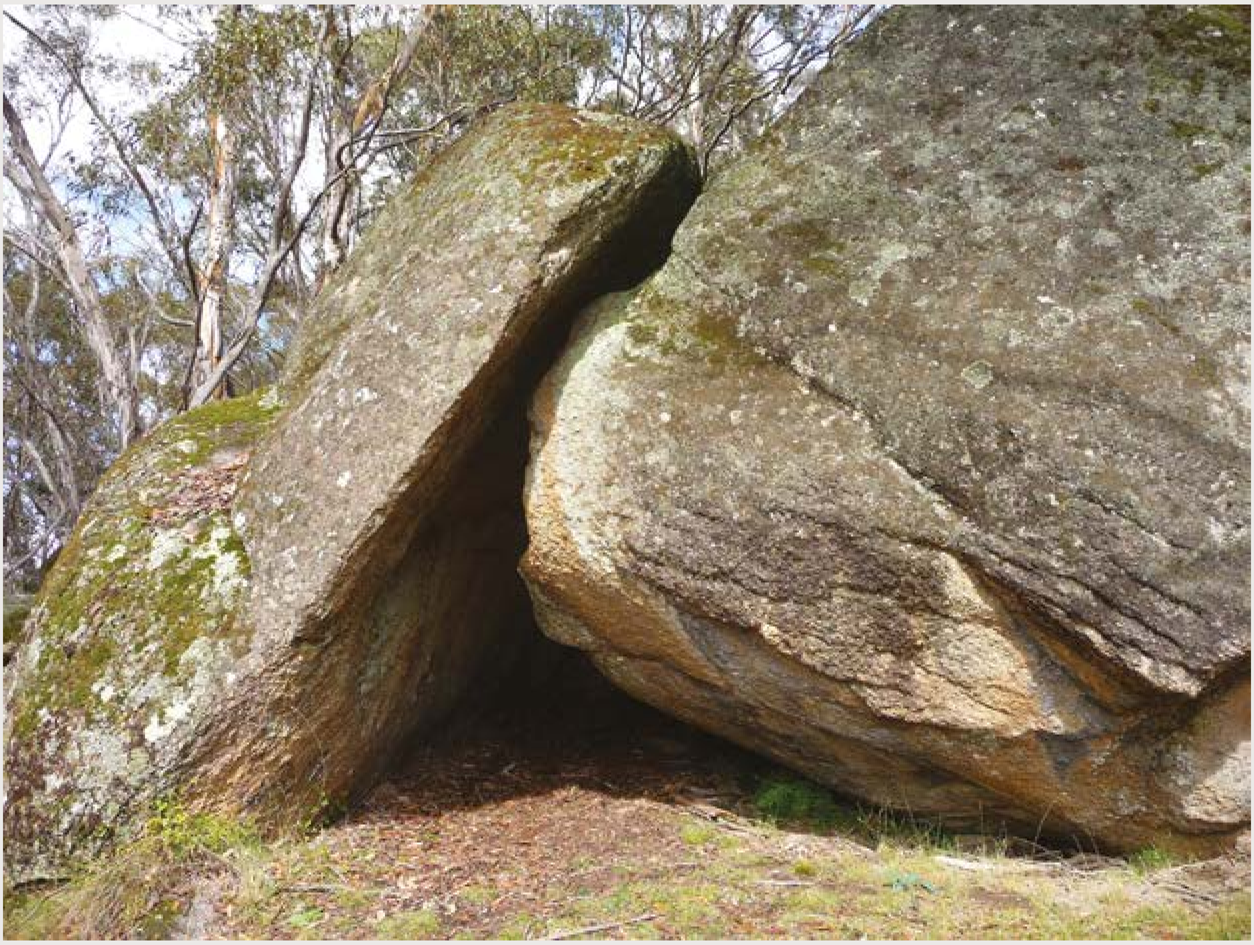
Aboriginal staff work in various roles across the ACT Parks and Conservation Service and come together as the Murumbung Yurung Murra Rangers. The Murumbung Rangers aim to better involve Traditional Custodians in identifying the traditional uses, values and connections to fire, land and water and to capture the contemporary aspirations for management of the cultural landscape. The Murumbung Rangers also provide invaluable peer support, mentoring and advocacy within the Parks and Conservation Service and support the Representative Aboriginal Organisations and Traditional Custodians in the protection and interpretation of heritage sites for the enrichment of future generations.

Through the Murumbung Ranger program, and in collaboration with Traditional Custodians, the ACT Government aims to facilitate Aboriginal cultural burning practices to meet objectives defined by Traditional Custodians. Staff work with Traditional Custodians to undertake cultural burns and associated land management treatments in areas (identified in annual BOPs) to meet a range of objectives. These may include the encouragement of bush tucker, production of fibre for weaving, or the maintenance of a desirable vegetation structure. By accessing Country for land management treatments, Traditional Custodians are provided an opportunity to maintain connections to Country and access a range of resources including bark, medicines and other materials. The primary purpose of facilitating cultural burns is cultural renewal, however they may also complement ecological and / or hazard reduction objectives or the protection of culturally significant sites.

Box 6: Impacts on Aboriginal cultural sites within woodlands

Cultural sites include sites that have physical remains or are significant to Aboriginal people due to their connection with traditional stories. Sites, regardless of whether physical remains exist, are afforded the same level of protection and priority for management.

A range of land management issues and natural processes threaten the integrity of cultural sites throughout the ACT region. For example, weeds can cause the decline of native plant species, including traditional food resources, provide fuel for fire and reduce access to important places. Significant sites and objects are threatened by inappropriate fire regimes and disturbance caused by nearby development or management activities. Rock art sites are also threatened by natural processes such as intrusion by native vegetation, growth of lichen / moss, nesting invertebrates such as termites and wasps, and erosion from wind and water runoff. Community groups (including the Mullangang Traditional Aboriginal Landcare Group) and the ACT Government are working to maintain and restore these sites and the surrounding areas.



Aboriginal rock shelter, Namadgi National Park

CONSERVATION OBJECTIVES

ENHANCE PARTICIPATION OF ABORIGINAL PEOPLE

- Work in collaboration with Aboriginal community members to manage and monitor woodlands and fill knowledge gaps regarding their long-term conservation. Initiatives may include:
  - employment of Aboriginal and Torres Strait Islander people in a broad range of natural resource management roles
  - planning, implementing and monitoring of cultural burns
  - planning and / or implementing the maintenance of cultural sites in accordance with the Cultural Heritage Management Framework (in development) and the Heritage Act 2004.
- Support Traditional Custodians to access and use the landscape in accordance with Aboriginal Access to Country Cultural Guidelines (in development). Wherever possible, and with the permission and support of Traditional Custodians, collaborative activities should:
  - provide opportunities for two way knowledge sharing between Aboriginal and non-Aboriginal people
  - facilitate the rediscovery of cultural knowledge, including Indigenous Ecological Knowledge (IEK)
  - facilitate the adoption of IEK in the management of woodlands.
- Implement and / or collaborate with RAOs and other community groups to deliver activities that:
  - improve broad community understanding of the cultural significance and traditional responsibilities for caring for lowland and upland woodlands. Strategies include formalising Aboriginal place names and reserve interpretation that features language and cultural knowledge
  - facilitate Traditional Custodians to access woodlands and reconnecting with Country
  - support Aboriginal people to gain employment and training relevant to the conservation of woodland and other ecosystems in the ACT
  - identify and map cultural values of woodlands and develop appropriate management actions
  - facilitate two way knowledge sharing between natural resource managers and researchers, and Aboriginal people
  - identify opportunities to assist Aboriginal people to rediscover and adopt IEK in woodland conservation.

2.2. SUPPORT SUSTAINABLE RECREATIONAL USE OF WOODLANDS

Woodland reserves offer Canberra residents and tourists a range of recreation opportunities, including walking, running, bird and wildflower appreciation, orienteering, rogaining, cycling and mountain biking, dog walking, horse riding and geocaching. The proximity of CNP to residential areas facilitates regular access by community members and thus encourages many Canberra residents to maintain a healthy lifestyle.

The number of visitors to woodland areas within CNP is steadily increasing. Areas containing subalpine woodland, including Namadgi National Park and Tidbinbilla Nature Reserve, also have a steady flow of visitors, although at lower rates than lowland woodland within CNP (MARS, 2017). Community members who regularly access woodland areas for recreation are likely to feel a sense of ownership over areas. As different users are likely to value different aspects of the reserves they access, engaging with a wide section of interest groups through reserve visitation provides a great opportunity to broaden support for woodland conservation.

Visitation to reserves can negatively impact woodlands but should, wherever possible, be compatible with the natural and cultural values of woodlands. Factors such as the number and frequency of visitors, type of activity, visitor behaviour and specific site characteristics will influence how the values of woodlands are impacted and the management approach required to mitigate impacts. Potential impacts include:

- vegetation clearing and soil changes through maintaining access tracks and the creation of unofficial tracks
- introduction of non-native plant species
- removal or damage to sites, vegetation or other habitat
- illegal collection of plants, animals, timber and rocks
- rubbish dumping and deliberate damage
- changes in fauna species composition.

CONSERVATION OBJECTIVES

SUPPORT SUSTAINABLE RECREATIONAL USE OF WOODLANDS

- Undertake effective monitoring of visitor impacts to inform a proactive and adaptive approach to visitor management.
- Undertake effective visitor management, as outlined in Reserve Management Plans, to minimise detrimental impacts on the natural and cultural values of woodlands.
- Effectively communicate with visitors to:
  - promote responsible and respectful use of woodland reserves
  - promote an understanding of woodland systems and their values, threats and required management
  - advise visitors of community safety concerns such as wildfires and native animals
  - interpret Aboriginal values and cultural sensitivities of areas to encourage respectful behaviour within woodland reserves.
- Promote the appropriate use of woodland reserves and, where practical, reduce physical barriers to community access.

3. MONITORING AND RESEARCH

The ACT Government is committed to the ongoing collection of data and information to contribute to our understanding of woodland ecosystems. The ACT Government supports a research and monitoring process where relevant information is collected, interpreted, disseminated and applied operationally, with monitoring and evaluation in place.

A range of projects aimed at addressing knowledge gaps and monitoring woodland condition since the 2004 Lowland Woodland Strategy are published online (ACT Government, 2018h) and are outlined in Section 4.7. These projects, as well as evidence from other literature relevant to lowland and / or subalpine woodland conservation and management, guide the strategies and objectives outlined in this Strategy.

3.1 MONITOR WOODLAND CONDITION

Monitoring the condition of ecosystems and the flora and fauna associated with them is critical to recognise change, including gradual change that happens steadily over time (Lindenmayer et al., 2015). Observing and quantifying changes to ecosystems is required to better understand the processes driving these changes and to identify the appropriate management action to address the negative impacts on ecosystems. In this way, monitoring underpins an adaptive management approach to support the protection and conservation of woodlands across the ACT.

The ACT Government undertakes regular monitoring of many of its threatened flora and fauna species. These programs are outlined in the respective action plans and conservation advice for threatened species and the Endangered YB-BRG Woodland (Part B). Other monitoring programs are established to measure changes in environmental values within a range of ecosystems across the ACT reserve system and offset areas (see SMEC (2016)). Ecological consultants, research institutions and various community groups also undertake monitoring of woodland condition and collect relevant information that can inform management decision making (see **Box 7**).

The ACT Government recently developed the CEMP as a way to systematically and comprehensively monitor the condition of ecosystems across the ACT reserve system. The CEMP identifies a range of indicators, including ecological values and stressors (imposed by threatening processes), to measure ecosystem condition. Information gathered from monitoring projects and qualitative sources, from both government and non-government agencies, is used to assess an ecosystem's conditions and the effectiveness of relevant management programs. The ACT Government is currently developing a CEMP for ACT woodlands that will, in addition to providing a framework to monitor changes in woodland condition over time and assess the efficacy of management actions, identify knowledge gaps and prioritise future research projects to inform woodland conservation.

COLLECT BASELINE INFORMATION

To undertake effective monitoring and management of woodlands requires a detailed understanding of the distribution and characteristics of woodland communities and associated species. Baseline information facilitates the adaptive management of woodlands by enabling managers to monitor changes to woodland ecosystems arising from threatening processes and to track the impact of management interventions.

Data has been collected and documented that describes the distribution and characteristics of woodlands in the ACT, including a range of surveys undertaken by the ACT Government prior to the publication of the 2004 Lowland Woodland Strategy. Recent survey and mapping projects outlined in Section 4.7 contribute to this knowledge. However, baseline knowledge gaps exist, providing an opportunity for projects to support informed decision making into the future.

Box 7: Canberra Ornithologists Group undertakes critical monitoring of woodland birds

The COG has been surveying bird abundance at a number of locations in lowland woodland since 1995. Surveys commenced in Mulligans Flat (then a grazing leasehold) and monitoring locations had been added progressively since. The Woodland Bird Monitoring Project now includes 142 sites at 15 locations across lowland reserve and leasehold areas. Sites include areas of Endangered YB-BRG Woodland, and other woodland areas in a range of conditions, including secondary grasslands. Surveys are undertaken seasonally, four times a year.

An analysis of long term trends in occupancy of woodland-associated birds, including a number of species in decline, was undertaken recently (Bounds et al., 2010). An analysis to better understand the relationship between habitat change and bird occupancy has also been undertaken (Taws et al., 2011). Species records have been used by the ACT Government to inform management decisions (e.g. fire and reserve visitor management). Importantly, data also informs priority actions for threatened bird species in the ACT.

The Woodland Bird Monitoring Project is ongoing and will continue to be a valuable dataset that informs the work of researchers, community groups, and Government and private agencies.

Woodland condition monitoring at Goorooyarroo Nature Reserve

CONSERVATION OBJECTIVES

MONITOR WOODLAND CONDITION

- Employ the Woodland CEMP (in development) to guide monitoring priorities. Monitor changes in ecological condition, including the impacts of threats and the effectiveness of management actions within reserves across the ACT.
- Continue to plan and implement monitoring programs to address ecological and management-related questions within woodlands across the ACT by:
  - establishing monitoring programs with well-defined objectives, sound experimental design and effective data management and assessment standards
  - seeking collaboration with ecological consultants, researchers and community groups with an interest in undertaking monitoring programs within and outside of Territory-owned land
  - designing and implementing targeted monitoring programs designed to measure the impact of management actions such as pest animal and invasive species control and restoration works
  - designing and implementing targeted, long-term, cross-tenure monitoring to detect environmental drivers of change (e.g. climate change and agents of dieback) and their impacts on woodland condition at an appropriate scale.
- In line with action plans and conservation advice (Part B), monitor threatened, declining and rare species, and the Endangered YB-BRG Woodland community to:
  - detect short-term changes in distribution or abundance that may require management intervention
  - determine long-term trend and status in the ACT and broader region
  - identify changes in species composition in threatened ecological communities
  - evaluate whether management activities are producing desired results.
- In planning monitoring programs, ensure long-term investment and sustained funding and resourcing beyond short-term cycles.
- Collaborate with community groups to collect and use monitoring data systematically and effectively by providing, for example:
  - professional and technical advice
  - training
  - screening and analysis of data
  - data collection protocols
  - support to access grants and equipment.
- Priority projects to improve baseline information include:
  - on-ground assessment of the condition of large patches of lowland woodland and those that make a significant contribution to the integrity of the Endangered YB-BRG Woodland across the ACT
  - improve knowledge of fauna distribution and abundance in subalpine and lowland woodland and associated ecosystems, particularly in relation to habitat preferences and response to disturbance
  - develop methods to improve mapping of secondary grasslands and to monitor changes to its extent, and improve knowledge of the ecological values of this community
  - condition mapping of lowland Snow Gum woodland to monitor the change in extent and condition of the community in response to climate change and land use practices.

3.2 ADDRESS KNOWLEDGE GAPS IN WOODLAND CONSERVATION

The ACT Government undertakes a range of activities aimed at addressing knowledge gaps and research questions. Wherever possible, collaboration with research institutions, community groups and cross-border agencies provides further opportunity to improve our understanding the flora and fauna associated with woodlands and the ecological processes operating within these ecosystems. A key aim of these projects is to inform the management of woodlands in the ACT and broader region. They also provide information that can be integrated with traditional ecological knowledge and employed by Traditional Custodians when working on Country. A number of current and recently completed research projects are outlined in Section 4.7.

Research priorities to improve our understanding and management of threatened species and the Endangered YB-BRG Woodland are outlined in action plans and conservation advice (Part B). Knowledge gaps that the ACT Government seek to address with dedicated research are listed below.

THREATS

- Effects of climate change on lowland and upland woodlands and the best management techniques to improve the resilience of biodiversity to a changing climate (including climatic refugia locations for woodland communities).
- Relationships between pest animal and invasive plant abundance and impacts on woodland values.
- Impacts of fragmentation, and management actions aimed at increasing connectivity, on woodland dependant species.
- Response of fauna to aspects of fire regimes in subalpine and lowland woodlands.
- Drivers of dieback and management actions to effectively mitigate its impact.
- Potential impacts on woodland biodiversity located at or near the urban fringe, and trials of innovative solutions.

WOODLAND BIODIVERSITY

- Ecology and diversity of invertebrates associated with woodlands in the region.
- Biology of woodland understory plant species (such as rare orchids and forbs).

ECOSYSTEM PROCESSES

- Impact of dense regeneration on biodiversity in woodland reserves.
- Habitat restoration techniques for areas in poor or declining condition (due to invasive plants and pest animal impacts).
- Ecological and conservation outcomes of controlled grazing by livestock.
- Links between woodland vegetation condition and soil microbial communities.
- Effect of disturbance and management on subalpine woodland.

A critical outcome for research undertaken or supported by the ACT Government is maintaining strong links with end users of the knowledge generated. Wherever relevant, end users such as ACT Government land managers, private land holders and community groups, should inform the priorities of the research and be involved in various stages of a research project. Correspondingly, the dissemination of research findings back to end users is critical to support land managers to make informed decisions regarding the management of woodland across all tenures. The Mulligans Flat – Goorooyarroo Experiment is an excellent example of multiple stakeholders working together to undertake research that is improving our understanding of woodlands, and is directly informing management activities for woodland restoration across the ACT (see Box 8).

Box 8: Mulligans Flat – Goorooyarroo Woodland Experiment

The Mulligans Flat – Goorooyarroo Woodland Experiment commenced in 2004 and is a collaboration between The Australian National University, the ACT Government and James Cook University. The site, which includes both Mulligans Flat and Goorooyarroo Woodland Nature Reserves, incorporates approximately 1145 ha of Yellow Box – Blakey's Red Gum grassy woodland. It is the largest and most intact example of its type in the ACT. The predator proof fence, which was constructed around Mulligans Flat in 2009, will soon be expanded to include the Goorooyarroo Woodland.

The project aims to undertake long term research to understand ways of restoring the structure and function of temperate woodlands for biodiversity (Manning et al., 2011). Current research includes monitoring the ecological impact and restoration value of techniques in herbage mass management (including manipulation of fire), grazing impacts, addition of coarse woody debris, feral species exclusion, species introductions within a predator proof sanctuary, and other woodland restoration techniques. Recent highlights include the successful breeding of reintroduced Eastern Bettongs (Bettongia gaimardi) (Portas et al., 2016), New Holland Mouse, Eastern Quoll (*Dasyurus viverrinus*) and Bush Stone-curlew (*Burhinus grallarius*).

Research findings are building a strong evidence base that is informing restoration and management activities undertaken within woodlands across the region. Importantly, the benefits of retaining and adding coarse woody debris to woodlands (Barton et al., 2011; Manning et al., 2013) has resulted in on ground changes to restoration works and management in the region.

Mulligans Flat Woodland Sanctuary (M. Jekabsons)

CONSERVATION OBJECTIVES

DELIVER RESEARCH OUTCOMES

- Implement and support research projects to address knowledge gaps and answer ecological questions (priorities outlined above) to inform the adaptive management of woodlands.
- Continue to support the Mulligans Flat – Goorooyarroo Woodland experiment as a key research and learning site for woodland restoration and management throughout the ACT.
- Identify opportunities to partner with Traditional Custodians to develop research projects that can inform land management, resource use and other activities undertaken by Traditional Custodians in woodlands.
- In line with action plans and conservation advice (Part B), undertake and support research into the ecology and conservation requirements of threatened species and communities, including:
  - habitat requirements and key resources, including distribution of key habitats
  - effects of habitat modification, land use practices and key threats
  - movement patterns, particularly in relation to the availability of key resources and habitat connectivity
  - breeding success, survival and recruitment rates of breeding populations.
- In planning and implementing research projects, maintain open dialogue between ACT Government policy, research and land management staff and when appropriate seek collaboration with non-government organisations to:
  - identify and prioritise knowledge gaps for future research
  - inform research questions and project design
  - implement and review projects and share skills and knowledge
  - ensure project outcomes are appropriate, accessible and can contribute effectively to the adaptive management of woodlands
- Communicate research results to land managers, including non-government organisations through:
  - research and technical reports published on ACT Government website and in scientific journals
  - social media platforms (e.g. ACT Environment, Planning and Sustainable Development and ACT Parks and Conservation Service Facebook pages)
  - workshops and seminars
  - presentations and meetings
  - the production of educational resources.

4. BACKGROUND INFORMATION

4.1 WHAT IS A WOODLAND?

Woodland is a general term to describe ecosystems that contain widely spaced trees with crowns that do not overlap and with less than 30% projected foliage cover. Woodland communities vary structurally from low open woodland (trees up to 10 m high with up to 10% projective foliage cover) to tall woodland (trees up to 35 m high with between 10-30% projective foliage cover) (Specht, 1970; Yates & Hobbs, 2000). The understorey of woodlands vary considerably in form, but include a combination of low trees, shrubs, grasses, herbs and graminoids (Yates & Hobbs, 2000). Ground layer vegetation constitutes most of the plant diversity in a woodland. High quality grassy woodlands have an especially diverse range of native ground-layer species (including orchids, lilies, wildflowers, sub-shrubs and grasses) (Stol & Prober, 2015).

The structure of a woodland is determined, at least in part, by influences operating at a local level (e.g. disturbance and regeneration). This can result in a structure that is more characteristic of other associated ecosystems. For example, patches of woodland dominated by Snow Gum in the ACT have dense regeneration following the 2003 wildfires and resemble forests. Furthermore, former woodland habitat that has been subject to widespread clearing of canopy trees and woody mid-storey vegetation, but maintains a relatively intact, diverse understorey of native grasses and forbs, is termed a 'derived' or 'secondary' grassland and, where appropriate, is managed as a woodland community according to this Strategy.

WOODLANDS IN THE REGION

Lowland and subalpine woodland in the ACT occur within the South Eastern Highlands (SEH) Bioregion and Australian Alps Bioregion respectively (Environment Australia, 2000; Thackway & Cresswell, 1995).

The SEH Bioregion covers approximately 80% of the ACT and includes the ranges and plateaus of the Great Dividing Range within southern NSW and eastern Victoria. It is characterised by sclerophyll forests, woodland, grassland and cool rainforests (Environment Australia, 2000). Located at a higher altitude and surrounded by the SHE Bioregion, the Australian Alps Bioregion has a restricted extent within NSW, Victoria and southwest ACT. It is characterised by treeless communities, Eucalyptus woodlands and alpine ash forests (Environment Australia, 2000).

4.2 A BRIEF HISTORY OF WOODLAND IN THE ACT AND SURROUNDING REGION

TRADITIONAL CUSTODIANS

For over 25 000 years, the life of Aboriginal people was directly connected with the ecosystems that sustained them and the health of the people was dependent on the health of the Country. The lowland and foothill areas of the ACT provided reliable resources for Traditional Custodians at particular times of the year, including food (e.g. Yam Daisy [*Microseris sp.*]) and materials for tools and weapons (e.g. Blakely's Red Gum). Subalpine woodlands and associated ecosystems also provided some seasonal (e.g. Bogong Moth [*Agrotis infusa*]) and reliable (e.g. *Lomandra longifolia*) resources, which allowed Aboriginal people to exploit the subalpine areas (Bowdler, 1981; Coyne, 2000). Of particular nutritional and cultural significance was the Bogong Moth, which breeds on the plains and moves to the mountains to aestivate during summer. While Traditional Custodians no longer rely on traditional resources to survive, retaining a connection to traditional lands remains important in defining and maintaining cultural identity.

The use of woodlands by Traditional Custodians has shaped the structure and function of woodlands and other ecosystems. For instance, lowland woodlands have evolved with relatively frequent burning as fire was a tool used by Traditional Custodians to stimulate green pick for marsupial grazers and to promote the growth of favoured plant resources (Stol & Prober, 2015). While Traditional Custodians used fire quite extensively in the foothills and lower tablelands, there is no evidence or known reason that fire was used to manipulate the landscape across the higher altitudes (Coyne, 2000). Thus fires, primarily ignited by lightning strikes, were likely to be less frequent in upland woodlands. While details about the historic severity, extent and frequency of traditional burning in the region is unknown, the discovery and occupation of the local area by European settlers resulted in significant modification to traditional burning regimes.

Snow Gum woodland, Namadgi National Park

EARLY EUROPEAN EXPLORATION AND SETTLEMENT

The Canberra district and broader region was first visited by European explorers in the 1810s and early 1820s. Early explorers reported prime grazing country, including expanses of grassland and open woodland with a variety of grasses and herbs. By the mid-1820s the region was colonised by those keen to secure land for grazing.

The earliest landholdings within what is present-day ACT were clustered around rivers and creeks and initial stocking was possible without the need to undertake extensive tree felling (Costin, 1954; Moore, 1970). The ensuing expansion and intensification of pastoralism in the region led to large scale clearing (and ringbarking) of trees, converting what were continuous tracts of lowland woodland to fragments of various sizes. The introduction of pasture species and selective grazing (often at high densities) also significantly modified the ground cover vegetation of these areas. Fire became a tool which was used or suppressed to improve and maintain pasture value (Costin, 1954). Summertime grazing in the subalpine and alpine tracts of grasslands and grassy woodlands commenced in the 1830s. Woodlands and forests in the valley areas were cleared for both grazing and small-scale farming.

Minor infrastructure, including homes, roads and drainage, was established in association with the pastoral industry. Native trees were used as a major source material for fencing, buildings and fuel (Carron, 1985).

Fortunately, the establishment of the ACT in 1911 and associated leasehold tenure and planning policies discouraged the adoption of intense pasture improvement techniques commonly adopted in the region from the 1950s onwards (e.g. increased mechanisation, use of sown pastures and fertilisers) (Stol & Prober, 2015). The termination of grazing leases in the highlands during this time also limited the long-term impacts of grazing within subalpine systems.

HISTORICAL DISTRIBUTION

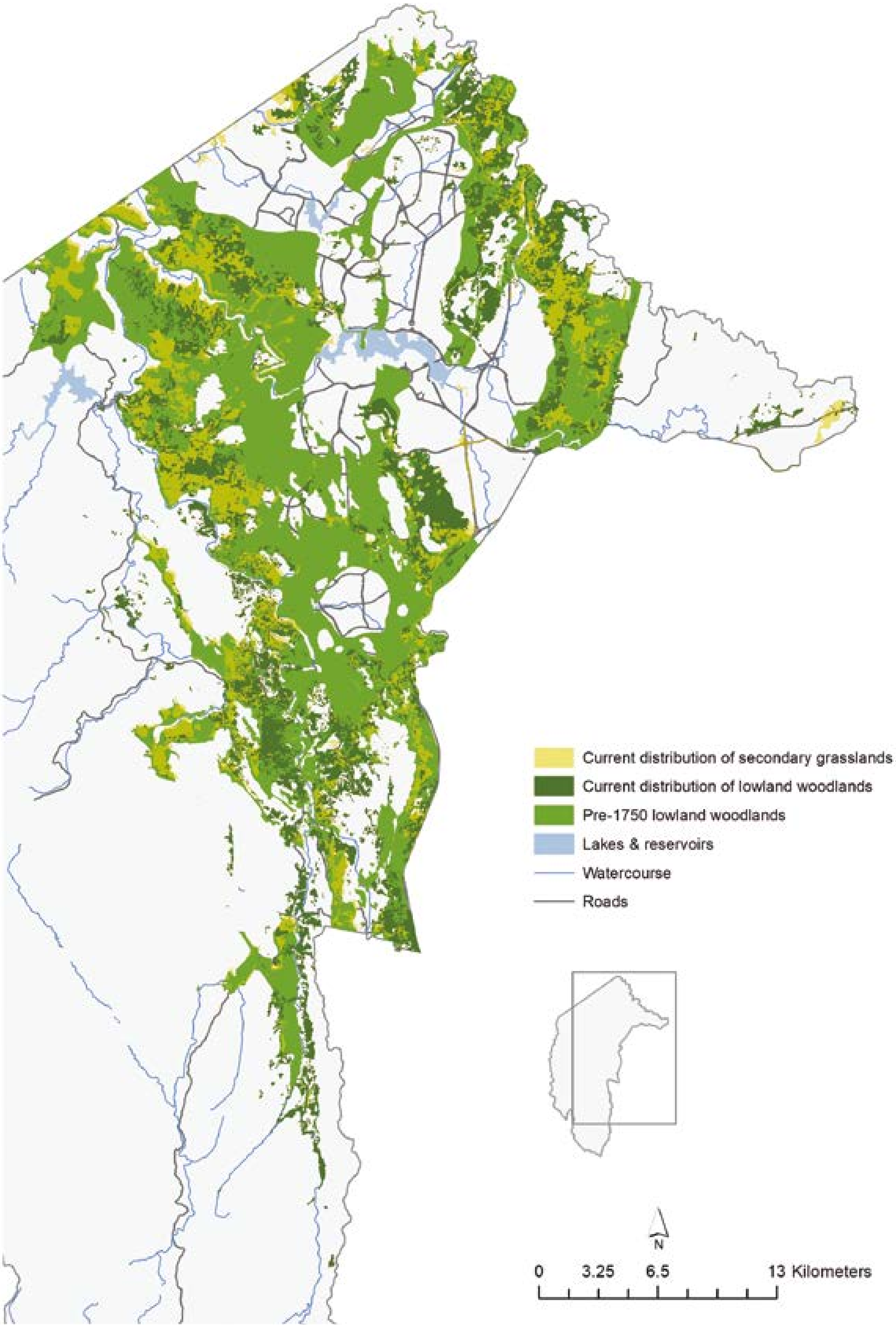
Prior to European settlement temperate woodlands were widespread; their distribution was driven primarily by responses to environmental conditions (e.g. climate, topography, hydrology and soil type), disturbance (e.g. storms and fire) and biotic interactions (e.g. with native grazers) (Yates & Hobbs, 2000). In the south east, woodlands were the dominant vegetation type inland of the Great Dividing Range, from southern Queensland through NSW, Victoria and into South Australia (Yates & Hobbs, 2000). While woodlands remain geographically widespread, the current distribution of temperate lowland woodland reflects the preferential clearing of the most fertile areas in plains, lower slopes and stream valleys. Today, many woodlands persist as degraded, often small, remnants amongst forests and grasslands.

Approximately 96% of the Yellow Box - Apple Box Grassy Woodlands vegetation class has been lost from its former distribution across the South-East Highlands bioregion in NSW. Other modelling estimates that more than 90% of lowland woodland (dominated by Yellow Box, Blakely's Red Gum, White Box [*Eucalyptus albens*] and / or Apple Box) has been cleared in the Tumut region in NSW (bordering the ACT and Victoria) (Landsberg, 2000). Other areas in NSW have approximately 1 – 7% of the pre 1750 extent of White Box–Yellow Box–Blakely's Red Gum Woodland community remaining (Austin et al., 2000; Gibbons & Boak, 2002).

Modelling undertaken by Gellie (2005) predicts the Southern Tablelands Yellow Box-Apple Box Grassy Woodlands vegetation class (which comprises four widespread lowland woodland communities in the ACT) covered an area of approximately 47 000 ha in the ACT prior to 1750 (see **Figure 4**). Comparison of this historic distribution with mapping of extant vegetation across the ACT illustrates approximately 11 568 ha or 25% of this vegetation class exists across its former distribution (note, this excludes derived grasslands and woodland that exists outside of the pre-1750 distribution modelled by Gellie (2005)). Comparatively, there has been little clearing of upland woodland in the ACT and broader region. It is estimated that 99% of the historic distribution of woodlands dominated by Snow Gum in the ACT exists today (Landsberg, 2000).

Yam Daisy

Figure 4: Historic (pre 1750)* and current (2018) distribution of lowland woodlands** in the ACT



* Modelled by (Gellie, 2005) ** Southern Tablelands Yellow Box-Apple Box Grassy Woodlands vegetation class (incorporating u178, u19, q6 and u78)

Hoary Sunray, Mt Majura (E. Cook)

4.3 THREATENED AND UNCOMMON WOODLAND SPECIES IN THE ACT

THREATENED SPECIES

Native woodlands in the ACT provide critical habitat for a range of threatened flora and fauna species. This includes three plant species and nine bird species that are listed as threatened under the *Nature Conservation Act 2014* and several species listed as threatened in other jurisdictions (**Table 3**). Other threatened species found in the ACT are associated with both woodlands and other ecosystems (such as grasslands or forests). These species are listed in **Table 3**.

The ACT Government is working to align the method for assessing and listing threatened species with those categories and criteria adopted under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This will ensure the consistent use of threat categories with the Australian Government, and thus contribute to the development of a single operational list of nationally threatened species (see Commonwealth Government (2015a)).

The Mulligans Flat Woodland Sanctuary also provides critical habitat for several species that have been reintroduced to the ACT. This includes established populations of: New Holland Mouse, Eastern Bettong, Eastern Quoll and Bush Stone Curlew.

Table 3: Threatened flora and fauna species found in woodlands. V = vulnerable, E = endangered, CE = critically endangered

		COMMON NAME	SPECIES	ACT	NSW/VIC*	C'WLTH	SUBALPINE / LOWLAND
THREATENED IN THE ACT (WOODLAND DEPENDENT)	FAUNA	Brown Treecreeper	*Climacteris picumnus*	V	-	-	Lowland
		Hooded Robin	*Melanodryas cucullata*	V	-	-	Lowland
		Painted Honeyeater	*Grantiella picta*	V	V (VIC, NSW)	V	Lowland
		Regent Honeyeater	*Anthochaera phrygia*	V	CE (VIC, NSW)	CE	Lowland
		Scarlet Robin	*Petroica boodang*	V	V (NSW)	-	Lowland
		Superb Parrot	*Polytelis swainsonii*	V	V (NSW) E (VIC)	V	Lowland
		Swift Parrot	*Lathamus discolor*	V	E (NSW, VIC)	CE	Lowland
		Varied Sittella	*Daphoenositta chrysoptera*	V	V (NSW)	-	Lowland
		White-Winged Triller	*Lalage sueurii*	V	-	-	Lowland
	FLORA	Canberra Spider Orchid	*Arachnorchis actensis*	E	-	CE	Lowland
		Small Purple Pea	*Swainsona recta*	E	E (VIC, NSW)	E	Lowland
		Tarengo Leek Orchid	*Prasophyllum petilum*	E	E (NSW)	E	Lowland
THREATENED IN THE ACT (ASSOCIATED WITH WOODLAND)	FAUNA	Pink Tailed Worm Lizard	*Aprasia parapulchella*	V	E (VIC)	V	Lowland
		Spotted-tailed Quoll	*Dasyurus maculatus*	V	V (NSW), E (VIC)	E	Lowland
		Little Eagle	*Hieraaetus morphnoides*	V	V (NSW)	-	Lowland
		Pink-tailed Worm-lizard	*Aprasia parapulchella*	V	V (NSW, E (VIC)	V	Lowland
		Glossy Black Cockatoo	*Calyptorhynchus lathami*	V	V (NSW, VIC)	-	Lowland
		Perunga Grasshopper	*Perunga ochracea*	V	-	-	Lowland
		Golden Sun Moth	*Synemon plana*	E	E (NSW), CE (VIC)	CE	Lowland
		Striped Legless Lizard	*Delma impar*	V	V (NSW), E (VIC)	V	Lowland
		Northern Corroboree Frog	*Pseudophryne pengilleyi*	E	CE (NSW)	CE	Subalpine
		Smoky mouse	*Pseudomys fumeus*	E	CE (NSW), E (VIC)	E	Subalpine
		Button Wrinklewort	*Rutidosis leptorhynchoides*	E	E (NSW)	E	Lowland

		COMMON NAME	SPECIES	ACT	NSW/VIC*	C'WLTH	SUBALPINE / LOWLAND
THREATENED OUTSIDE THE ACT	FAUNA	Barking Owl	*Ninox connivens*	-	V (NSW), E (VIC)	-	Lowland
		Black Falcon	*Falco subniger*	-	V (NSW, VIC)	-	Lowland
		Broad-toothed Rat	*Mastacomys fuscus*	-	V (NSW), E (VIC)	V	Subalpine
		Diamond Firetail	*Stagonopleura guttata*	-	V (NSW), NT (VIC)	-	Lowland
		Dusky Woodswallow	*Artamus cyanopterus*	-	V (NSW)	-	Lowland
		Flame Robin	*Petroica phoenicea*	-	V (NSW)	-	Lowland / Subalpine
		Gang Gang Cockatoo	*Callocephalon fimbriatum*	-	V (NSW)	-	Subalpine / Lowland
		Greater Glider	*Petauroides volans*	-	V (VIC)	V	Subalpine
		Speckled Warbler	*Chthonicola sagittata*	-	V (NSW, VIC)	-	Lowland
	FLORA	Austral Toadflax	*Thesium australe*	-	V (VIC, NSW)	V	Lowland
		Black Gum	*Eucalyptus aggregata*	-	V (NSW), E (VIC)	V	Lowland
		Blue-tongued Greenhood	*Pterostylis oreophila*	-	CE (NSW), E (VIC)	CE	Subalpine
		Hoary Sunray	*Leucochrysum albicans var. tricolor*	-	E (VIC)	E	Lowland
		Kydra Dampiera	*Dampiera fusca*	-	E (NSW, VIC)	-	Subalpine
		Mountain Spider Orchid	*Caladenia montana*	-	V (NSW)	-	Subalpine
		Pale Pomaderris	*Pomaderris pallida*	-	V (NSW)	V	Lowland
		Summer Leek Orchid	*Prasophyllum canaliculatum*	-	CE (NSW)	-	Subalpine

*As listed under the Victoria Threatened Species Advisory List and / or under the Victorian Flora and Fauna Guarantee Act 1988

RARE AND DATA DEFICIENT SPECIES

Woodlands in the ACT provide critical habitat for a number of flora and fauna species that, although not listed as threatened species under ACT or Commonwealth legislation, are of conservation concern (see **Table 4**). These species may be susceptible to local extinction because of their small overall population size and / or restricted distribution within the ACT. Several species (considered to be rare in the ACT) are listed as 'Data Deficient'; more information (e.g. distribution and abundance) is required to determine the conservation status of these species.

Table 4: Rare flora and fauna species found in woodlands in the ACT

		COMMON NAME	SPECIES	SUBALPINE / LOWLAND
RARE	FAUNA	Alpine Darner Dragonfly	*Austroaeschna flavomaculata*	Subalpine
		Alpine Redspot Dragonfly	*Austropetalia tonyana*	Subalpine
		Bronze Ant-blue Butterfly	*Acrodipsas brisbanensis*	Subalpine
		Golden Ant-Blue Butterfly	*Acrodipsas aurata*	Lowland
		Harriss's Peacock Spider	*Maratus harrissi*	Subalpine
		Key's Matchstick Grasshopper	*Keyacris Scura*	Lowland
		Montane Grass-Skipper	*Anisynta monticolae*	Subalpine
		Moonlight Jewel	*Hypochrysops delicia*	Lowland
		Rosernbergs Monitor	*Varanus rosenbergi*	Lowland
		Silky Hairstreak	*Pseudalmenus chlorinda*	Subalpine
		Small Alpine Xenica	*Oreixenica latialis*	Subalpine
		Small Ant-blue Butterfly	*Acrodipsas mymecophila*	Lowland
		Springtail – undescribed	*Australotomurus sp.*	Lowland
		-	*Tomocerus militum*	Lowland
RARE	FLORA	Alpine Starbush	*Asterolasia trymalioides*	Subalpine
		Simple-leaved Dwarf Boronia	*Boronia nana var. hyssopifolia*	Subalpine
		Moonwort	*Botrychium lunaria*	Subalpine
		Cunningham's Gentian	*Chionogentias cunninghamii*	Subalpine
		Late Forest Gentian	*Chionogentias sylvicola*	Subalpine
		Coprosma	*Coprosma nivalis*	Subalpine
		Erect Midge Orchid	*Corunastylis arrecta*	Subalpine
		Billy buttons	*Craspedia aurantia*	Subalpine
		Kydra Dampiera	*Dampiera fusca*	Subalpine
		Small Snake Orchid	*Diuris subalpina*	Subalpine
		Tiny Willowherb	*Epilobium curtisiae*	Subalpine
		Mountain Willowherb	*Epilobium sarmentaceum*	Subalpine
		Argyle Apple	*Eucalyptus cinerea subsp. triplex*	Subalpine
		Tingaringi Gum	*Eucalyptus glaucescens*	Subalpine
		Spinning Gum	*Eucalyptus perriniana*	Subalpine
		Brindabella Potato Orchid	*Gastrodia entomogama*	Subalpine
		Small Royal Grevillea	*Grevillea diminuta*	Subalpine
		-	*Logania granitica*	Subalpine
		Smooth Nardoo	*Marsilea mutica*	Subalpine
		Kangaroo Fern	*Microsorum pustulatum subsp. pustulatum*	Subalpine
		Thyme Mitrewort	*Mitrasacme serpyllifolia*	Subalpine
		Sweet Forget-me-not	*Myosotis exarrhena*	Subalpine
		Daisybush	*Olearia rhizomatica*	Subalpine

		COMMON NAME	SPECIES	SUBALPINE / LOWLAND
RARE	FLORA	Silver Caraway	*Oreomyrrhis argentea*	Subalpine
		Scaly Everlastingbush	*Ozothamnus cupressoides*	Subalpine
		Swamp Everlastingbush	*Ozothamnus rosmarinifolius*	Subalpine
		Parantennaria	*Parantennaria uniceps*	Subalpine
		Austral Pillwort	*Pilularia novae-hollandiae*	Subalpine
		Hairy Pomaderris	*Pomaderris phylicifolia subsp. ericoides*	Subalpine
		Brindabella Leek Orchid	*Prasophyllum montanum*	Subalpine
		Subalpine Leek Orchid	*Prasophyllum sphacelatum*	Subalpine
		Mountain Greenhood	*Pterostylis alpina*	Subalpine
		Dwarf Buttercup	*Ranunculus millanii*	Subalpine
		Big Bird Orchid	*Simpliglottis turfosa*	Subalpine
		Shining Westringia	*Westringia lucida*	Subalpine
DATA DEFICIENT	FLORA	Alpine Wattle	*Acacia alpina*	Subalpine
		Velvet Wheatgrass	*Australopyrum velutinum*	Subalpine
		Yellow-leaved Sedge	*Carex rara subsp. capillacea*	Subalpine
		Snow Daisy	*Celmisia pugioniformis*	Subalpine
		Mountain Correa	*Correa lawrenceana var. lawrenceana*	Subalpine
		Grey Billy Buttons	*Craspedia canens*	Subalpine
		-	*Deyeuxia crassiuscula*	Subalpine
		Alpine Native Cherry	*Exocarpos nanus*	Subalpine
		-	*Geranium obtusisepalum*	Subalpine
		Mountain Needlebush	*Hakea lissosperma*	Subalpine
		Alpine Clubsedge	*Isolepis crassiuscula*	Subalpine
		-	*Juncus alexandri*	Subalpine
		Matted Water Milfoil	*Myriophyllum pedunculatum subsp. pedunculatum*	Subalpine
		Kosciuszko Rose	*Pimelea ligustrina subsp. ciliata*	Subalpine
		Tall Riceflower	*Pimelea ligustrina subsp. ligustrina*	Subalpine
		Mountain Plum Pine	*Podocarpus lawrencei*	Subalpine
		Sickle Orchid	*Pterostylis falcata*	Subalpine
		-	*Simpliglottis sp. aff. valida*	Subalpine
		Mountain Triggerplant	*Stylidium montanum*	Subalpine
		Mountain Dandelion	*Taraxacum aristum*	Subalpine
		Mountain Hooksedge	*Uncinia flaccida*	Subalpine
		Thyme Speedwell	*Veronica serpyllifolia*	Subalpine

4.4 TRADITIONAL AND CONTEMPORARY ABORIGINAL VALUES

Ngunnawal people participated in trade with neighbouring language groups such as Wiradjuri, Walgalu, Yuin, Ngarigo, Gundungurra and Ngambri. Ceremonies, corroborees and the collection of seasonal foods such as Bogong Moths brought large gatherings of Aboriginal people from the greater region to Ngunnawal Country. These gatherings facilitated the exchange of knowledge between groups and maintained connectivity between them.

The stories and corresponding traditional rights and responsibilities to manage certain places are complex and are handed down primarily through family lines. The stories associated with the Dreaming not only determine custodianship of Country, they also impart important knowledge related to the environment and its management. This includes information about the relationships between all living organisms (including the interactions between humans and the environment), information about seasonal changes, the ecology and use of many organisms, and the effect of fire and other disturbances on the landscape.

For Aboriginal people being 'on Country' provides an opportunity to maintain connections with the spirits of the land and to uphold traditional responsibilities to care for the Country. This includes maintaining cultural sites and their associated stories that link places to people. There are 580 recorded Aboriginal sites in woodlands across the ACT. Sites that are associated with Dreaming stories include notable landforms such as hills, mountains, ridgelines and water places. For example, Mt Ainslie and Mt Majura, which comprise several woodland communities, are important men's and women's sites.

Numerous archaeological sites are located within woodlands in the ACT; they provide evidence of Ngunnawal people and other language groups occupying and undertaking ceremonial activities in the ACT region for thousands of years. Sites within lowland woodland include scarred trees, and artefact (knapping or camp), burial, corroboree and rock art sites. While there are fewer known sites located in subalpine woodlands, very significant stone arrangement sites, which mark important ceremonial locations, are found at the top of a number of hills and mountains amongst woodland dominated by Snow Gum. Known Bogong Moth aestivation sites on exposed rock shelters and caves are also associated with several subalpine woodland communities.

Sites within the ACT reserve system continue to be uncovered opportunistically by visitors and land managers. Disturbance events that expose the landscape (e.g. the 2003 wildfires) have facilitated the discovery of many sites. The Cultural Heritage Management Framework (in development) will identify a number of priorities that will guide future survey effort and provide advice on the ongoing management and conservation of Aboriginal heritage values.

4.5 WOODLAND MANAGEMENT PLANS

Management plans set prescriptions for the effective management of woodland sites. Management plans in place for native woodland areas in the ACT are outlined in Table 5. Incorporating flexibility into plans to account for underlying uncertainty is a key component of an adaptive management approach.

The woodland located in ACT Government Horse Holding Paddocks is managed according to a Business Plan and Service Agreement agreed to by Territory Agistment and the ACT Government. Through the provision of advice and educational materials, collaborative management opportunities and grants, Land Management Agreements, and through enforcement of the *Nature Conservation Act 2014*, the ACT Conservator of Flora and Fauna will continue to encourage rural lessees to manage native woodland on their lands to maintain and improve their condition as outlined in this Strategy. A number of travelling stock reserves contain woodland and are actively managed without strategic management plans in place (i.e. Hall, Hume, Kowen, Paddy's River, Tharwa, Uriarra Rd, Melrose and Williamsdale). The Suburban Land Agency also recently acquired land parcels in the Molonglo – Murrumbidgee area that contain large areas of lowland woodland. No conservation management plans are in place to protect the ecological values of this area.

Table 5: Management Plans for areas that include woodland in the ACT

	NAME	MANAGEMENT PLAN
Nature Reserve	Namadgi National Park	(ACT Government, 2010b)
	Tidbinbilla Nature Reserve	(ACT Government, 2012b)
	Canberra Nature Park	To be finalised
	Lower Cotter Catchment Reserve	(ACT Government, 2018e)
Offset	Molongolo Valley	(ACT Government, 2013c)
	Kinlyside Horsepark North Jacka Taylor	(ACT Government, 2015c, 2015d)
	Throsby Kenny Broadacre	(ACT Government, 2015b, 2015d)
	Isaacs Ridge	(ACT Government, 2017c)
	Justice Robert Hope Park	(ACT Government, 2018d)
	The Pinnacle	(ACT Government, 2016c)
	Bonner	(ACT Government, 2016b)
	Williamsdale	(Eco Logical Australia, 2010)
	Ginninderry Development / Conservation Corridor	(TRC Tourism, 2018) (SMEC, 2018)
ACT Government Land (other)	Gunghalin Region	(ACT Government, 2007b)
	Hughes Garran Woodland	(Fearnside et al., 2012)
	Hall Cemetery	(ACT Government, 2013b)
National Capital Authority Conservation Areas	Stirling Park, Yarralumla, State Circle Woodland and O'Malley Diplomatic Estate	(Sharp, 2016)
	Majura Federal Police Training Facility	(Commonwealth Government, 2012)
Australian Government Department of Defence Land	Majura Training Area	(Commonwealth Government, 2016a)
Icon Water pipeline corridor	Murrumbidgee to Googong water transfer	(Icon Water, 2017)

4.6 RELEVANT POLICY AND LEGISLATION

Management of threatened species and ecological communities is guided by international and national agreements, policy and legislation. Several legislative instruments in the ACT also recognise, and provide for the protection of the ecological and cultural values of woodlands.

INTERNATIONAL AND NATIONAL CONTEXT

The United Nations Convention on Biological Diversity is an international legal instrument for the conservation and sustainable use of biological diversity. Australia ratified the Convention in 1993 and, in line with the Convention, prepared the first national biodiversity strategy in 1996

- (ANZECC, 1996). This document has since been reviewed and replaced by Australia's Strategy for Nature 2018 – 2030 (Commonwealth Government, 2018) and the Strategy for Australia's National Reserve System 2009–2030 (Commonwealth Government, 2009).
- The International Union for Conservation of Nature (IUCN) establishes criteria for assessing the conservation status of a species. The ACT Scientific Committee (a statutory committee under the *Nature Conservation Act 2014*) is guided by the IUCN criteria when assessing the conservation status of species in the ACT.
- The *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* includes criteria for environmental impact assessments and provides for the protection of 'matters of national environmental significance'. The Endangered YB-BRG Woodland is part of the EPBC-listed White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland. Several woodland-dependant species listed as threatened in the ACT are also listed as matters of national environmental significance under the EPBC Act. An ACT Environmental Offsets Policy is required by the Commonwealth Government under the EPBC Act. To date, all offsets in the ACT have been assessed according to the EPBC Act environmental offset policy.
- In accordance with the *ACT Planning and Land Management Act 1988*, the National Capital Plan seeks to ensure Canberra and the ACT are planned and developed in accordance with their national significance. This includes conserving and enhancing the landscape features that give the national capital its character and that contribute to the integration of natural and urban environments (Commonwealth Government, 2016b).

ACT LEGISLATION

- The *Nature Conservation Act 2014* provides for the protection and management of native plants and animals in the ACT. This includes the identification and management of threatened species and ecological communities and authority of the ACT reserve network. The *Nature Conservation Act 2014* prescribes the statutory functions of a number of government staff, including the Conservator of Flora and Fauna, Conservation Officers, and Parks and Conservation Service roles. It also includes provisions for offences against native species.
- The *Planning and Development Act 2007* has provisions for sustainable development. Development proposals that may significantly impact a threatened species or ecological community require an environmental impact assessment under this Act.

  This Act includes requirements for environmental offsets in the ACT. The ACT Environmental Offsets Policy outlines a consistent way in which environmental compensation must be made to offset the impact of development or other activities that have a significant adverse impact on natural (and other protected) assets. The ACT Environmental Offsets Policy is supported by an environmental offsets calculator, which determines whether a protected matter will be subject to a significant adverse environmental impact and the minimum acceptable environmental offset required. The calculator also identifies when the impact on a species or ecological community requires the Conservator of Flora and Fauna to consider whether offsets are appropriate.

  The *Planning and Development Act 2007* requires a Territory Plan to ensure, in a manner not inconsistent with the National Capital Plan, the planning and development of the ACT provide the people of the ACT with an attractive, safe and efficient environment in which to live, work and have their recreation. The Territory Plan is the key statutory planning document in the ACT. The Act also requires a planning strategy for the ACT that sets out long term planning policy and goals to promote the orderly and sustainable development of the ACT, consistent with the social, environmental and economic aspirations of the people of the ACT. The ACT Planning Strategy is the key strategic document for managing growth and change in the Territory.

Land Management Agreements between rural landholders and the ACT Government are required under this Act.

- The *Tree Protection Act 2005* protects trees in urban areas of the ACT that have exceptional natural or cultural value. This legislation protects trees that are not otherwise protected under the Nature Conservation Act 2014.
- The *Pest Plants and Animals Act 2005* identifies pest plants and animals in the ACT. It prescribes approaches to manage pest species, including the development of pest plant and animal management plans.
- The *Emergencies Act 2004* requires the development of a Strategic Bushfire Management Plan which guides the management of fire in the ACT.
- The *Human Rights Act 2004* acknowledges that Aboriginal and Torres Strait Islander people hold distinct cultural rights and must not be denied the right to maintain, protect and develop their culture. The Act recognises their material and economic relationship with the land, waters and other resources.
- The *Heritage Act 2004* establishes a system for the recognition and conservation of places and objects of natural, historic and Aboriginal cultural significance through, for example, the development of Conservation Management Plans. All Aboriginal places, such as trees culturally modified by Traditional Custodians, are afforded protection by the *Heritage Act 2004*, and a number of woodland areas that provide habitat for threatened species are also registered on the ACT Heritage Register. Representative Aboriginal Organisations are also declared under the *Heritage Act 2004*, and these groups have a statutory role in the assessment and management of Aboriginal heritage in the ACT.
- The *Domestic Animals Act 2000* includes provisions for declaring cat containment areas.

4.7 PROGRESS SINCE THE 2004 LOWLAND WOODLAND CONSERVATION STRATEGY

The 2004 Woodland Strategy identified three primary conservation objectives. These objectives, and progress made towards meeting them, is briefly summarised below. Note, these objectives are not commitments under the 2019 Woodland Conservation Strategy. A more detailed summary of progress against meeting these objectives is available in the Woodlands For Wildlife: ACT Lowland Woodlands Conservation Strategy Progress Report 2018 (ACT Government, 2018h).

- *Conserve in perpetuity all types of lowland woodland communities in the ACT, as viable and well-represented ecological systems*.

With the addition of several new reserves and extensions to existing reserves, over 1100 ha of woodland (including secondary grasslands) have been added to the reserve network. This includes approximately 600 ha of lowland box gum woodland that contain some Endangered YB-BRG Woodland community. Other woodland areas are now managed as environmental offset areas or have been re-zoned to other tenures managed by the ACT Government for conservation.

- *Conserve in perpetuity, viable, wild populations of all lowland woodland flora and fauna species in the ACT and support regional and national efforts towards conservation of these species (including declared threatened species)*.

Research and monitoring undertaken by the ACT Government, community groups and research institutions has improved our understanding of the distribution and habitat requirements of threatened woodland plants and birds, and the processes threatening their survival. Particularly noteworthy is the Mulligans Flat – Goorooyarroo Woodlands Experiment, which has enhanced our knowledge of a range of management techniques including herbage mass management, pest animal control, native fauna reintroductions and habitat restoration techniques. The ACT Government continues to trial Eastern Grey Kangaroo fertility techniques while undertaking an active control program to maintain sustainable wild populations.

Mulligans Flat Woodland Sanctuary (M. Jekabsons)

Monitoring undertaken by the ACT Government indicates that current management is ensuring the persistence and viability of a number of woodland dependant species, including the sole population of the threatened Tarengo Leek Orchid at Hall Cemetery.

- *Manage and rehabilitate lowland woodlands across all tenures with appropriate regeneration, restoration and reinstatement practices.*

There has been significant investment by the Australian Government, ACT Government and non-government organisations to implement management and restoration activities, and to undertake research projects to improve our understanding of restoration techniques. Relevant initiatives of the ACT Government are listed below; details of major projects are provided in Section 4.8.

- ACT Woodland Restoration Project (Greater Goorooyarroo region) and Biodiversity Fund Projects (2011 - 2017).
- Investment and support provided to National and ACT Landcare Program
- One Million Trees Project (2008 - 2018).
- Management and restoration activities undertaken at conservation offset areas (including Barrer Hill, Molonglo Valley, Throsby, Isaac and Watson).
- Research illustrating the benefits of adding coarse woody debris to woodland and the subsequent addition of over 4 000 tonnes of coarse woody debris to woodland in the ACT.

4.8 WOODLAND CONSERVATION AND RESEARCH ACTIVITIES IN THE ACT SINCE 2004

Many conservation activities that aim to protect, manage and restore woodlands have been undertaken since the 2004 Lowland Woodland Strategy was released. Community groups, research institutions and the ACT Government have also sought to better understand woodland ecosystems through research, mapping and monitoring of woodland sites and woodland biodiversity (including threatened species). An outline of these activities is provided below.

RESTORATION AND CONSERVATION ACTIVITIES

Since the 2004 Strategy, a number of projects that aimed to enhance and restore woodland have been undertaken throughout the ACT. Major projects included:

- The ACT Woodland Restoration Project and Biodiversity Fund Project, which aimed to enhance woodland connectivity and condition using a whole of landscape approach, engage the community in woodland restoration, introduce missing habitat elements and undertake invasive species control. The projects were funded by the Commonwealth and ACT Governments and delivered by Greening Australia Capital Region and the ACT Government, in collaboration with rural landholders and other community and volunteer groups. The projects were implemented across all land tenures in the ACT; major achievements included:
  - engagement of 18 rural landowners, and 43 schools / community groups
  - over 900 ha of revegetation, including 28 548 tube stocks planted and 101 km of direct seeding
  - enhancement and protection of 844 ha of remnant woodland (including the distribution of 4 415 tonnes of coarse woody debris)
  - invasive species control over an area of 4 494 ha
  - feral animal control over an area of 9 555 ha
  - establishment of 10 monitoring sites to review different treatment types and techniques.
- Preparation of a woodland restoration plan for Barrer Hill and Misery Point (together encompassing approximately 50 ha in the Molonglo Valley) (SMEC, 2014). Restoration activities included: revegetation, addition of rock and coarse woody debris, scraping topsoil at a site dominated by exotic species and reseeding with native flora, direct seeding, interpretative signage and the planned addition of vertical habitat structure.
- Planting box-gum woodland trees and understorey species (approximately 2000 plants) at 15 plots within and adjacent to the National Arboretum to improve connectivity between Black Mountain and the Molonglo River corridor. One hundred logs have also been added throughout the plots.
- Trialling forb enhancement techniques in Kama Nature Reserve. The project has illustrated that native forb enhancement via direct seeding is a viable technique where there is appropriate soil fertility and when biomass is reduced (Johnson et al., 2018)
- Large-scale restoration program (including soil erosion works and replanting) within the Lower Cotter Catchment (LCC) following extensive loss of vegetation during the wildfires in 2003. Restoration activities will be maintained to support natural regeneration of forest and woodland communities.
- Collaboration between the Australian National Botanic Gardens (ANBG) and the ACT Government to collect and store the seed of a number of understorey species, including several rare and threatened species. Seed of the Canberra Spider Orchid and Tarengo Leek Orchid are banked at the ANBG and a translocation plan is currently being developed for the Canberra Spider Orchid (see action plans, Part B).
- One Million Trees Project: as outlined in the ACT Government's Climate Change Strategy 2007 – 2011 (ACT Government, 2007a), the ACT Government, with funding support from the Commonwealth Government, aimed to plant one million trees between 2007 and 2017. Plantings occurred in the LCC, the Murrumbidgee River Corridor (MRC) and within urban areas. The LCC and MRC plantings were undertaken strategically to increase the connectivity of woodland patches across multiple tenures (including rural lands), increase riparian and woodland habitat for fauna, stabilise soils and provide future carbon sequestration.

- 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 and monitored in the Molonglo Valley.
- Activities towards restoring woodland areas as part of environmental offset requirements have been undertaken at Isaacs Ridge, Gungahlin Strategic Assessment Areas and Justice Robert Hope Park (for woodland locations see: ACT Government (2017c), ACT Government (2015c) and ACT Government (2018b) respectively). Activities include, but are not limited to, weed and pest animal monitoring and control, monitoring threatened species and the Endangered YB-BRG Woodland, the addition of coarse woody debris, macropod monitoring and control, and revegetation.
- The declaration of the Scarlet Robin as Vulnerable in May 2015, under the *Nature Conservation Act 1980* (and later, the *Nature Conservation Act 2014*). An associated action plan was developed and is included in Part B of this Strategy.

EASTERN GREY KANGAROO MANAGEMENT

Since 2009 the ACT Government has actively monitored and managed Eastern Grey Kangaroos in the ACT. The control program aims to maintain wild populations of kangaroos while managing their environmental, economic and social impacts. Culling for conservation purposes is undertaken across sixteen reserves (and some adjacent properties), many of which contain areas of the Endangered YB-BRG Grassy Woodland community or natural temperate grassland communities.

The program is managed in accordance with the Controlled Native Species Management Plan for Eastern Grey Kangaroos (ACT Government, 2017b), and the ACT Kangaroo Management Plan (ACT Government, 2010a). Culling numbers are determined according to the Nature Conservation (Eastern Grey Kangaroo) Conservation Culling Calculator (ACT Government, 2018f). Where possible, conservation culling is also managed cooperatively with land managers of surrounding properties, including the Commonwealth Government and rural landholders (as outlined in ACT Government (2017b) and ACT Government (2017d)).

Culling of Eastern Grey Kangaroos on rural properties is permitted to mitigate the economic impacts of grazing. It may also contribute to managing long-term sustainable densities of kangaroos and meeting the conservation objectives outlined in the Controlled Native Species Management Plan for Eastern Grey Kangaroos (see: ACT Government (2017b)).

MULLIGANS FLAT – GOOROOYARROO WOODLAND EXPERIMENT

The Mulligans Flat – Goorooyarroo Woodland Experiment commenced in 2004 and is a collaboration between The Australian National University, the ACT Government, James Cook University and the CSIRO. The site incorporates approximately 1145 ha of Yellow Box – Blakey's Red Gum Grassy Woodland. It is the largest and most intact example of its type in the ACT.

The project aims to undertake long term research to understand ways of restoring the structure and function of temperate woodlands for biodiversity (Manning et al., 2011). Current research includes monitoring the ecological impact and restoration value of techniques in biomass management (including manipulation of fire), grazing impacts, coarse woody debris, feral species exclusion, species introductions within a predator proof sanctuary, and other woodland restoration techniques (including fauna reintroductions). Research findings are building a strong evidence base that is informing restoration and management activities undertaken within woodlands across the region (see: www.mfgowoodlandexperiment.org.au).

COMMUNITY CONSERVATION WORK

Through education, advocacy and on-ground initiatives, community groups play a key role in the protection and conservation of native woodlands in the ACT. Below are a number of major projects and initiatives implemented by community groups since 2004.

- Educational forums and workshops (e.g. Friends of Grassland's 2004 'Grass half full or grass half empty? Valuing native grassy landscapes' forum).
- Contributions to, and maintenance of, Canberra Nature Map, which provides a comprehensive, accessible and educational map of fauna and flora across the ACT.
- On-ground management and engagement activities undertaken by ParkCare groups. These include: weed treatment, ecological surveys and monitoring, grazing and erosion control, tree and shrub planting, interpretive walks for the public, and running information stalls.
- On-ground management and restoration projects facilitated by Landcare ACT and the Molonglo, Ginninderra and Southern ACT Catchment Groups.
- Production of community education resources, including newsletters (e.g. Canberra Bird Notes and the Gang-Gang newsletter published by COG) and resources to assist community members to undertake regular and consistent woodland management activities.
- The Canberra Indian Myna Action Group was formed in 2006 to reduce the impact of Indian Mynas in and around Canberra.
- The Southern Tablelands Ecosystems Park (STEP), established within the National Arboretum, represents the major forest and woodland communities in the region, including the Endangered YB-BRG Grassy Woodland community.
- 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) engages Ngunnawal people in the restoration of a culturally and ecologically important site at Yarralumla called *Bullan Mura*.
- The expansion of COG's long-term monitoring program of woodland birds to include 142 sites at 15 locations across reserve and leasehold areas. The long term data set was analysed by COG in 2010 (see Bounds et al. (2010)) and an analysis of the relationship between habitat change and bird occupancy was undertaken in 2011 (Taws et al., 2011). An updated analysis of long-term woodland bird data (and an associated report) is currently underway.
- The establishment of the Grassy Woodlands Stakeholder Group: a consultative committee comprised of representatives from several community groups engaged in conservation and land management within the ACT. The group meets to discuss a range of issues and exchange ideas and information with the ACT Government regarding the conservation of lowland woodlands. This includes providing input into the development of this Strategy.
- A recommendation to list the "Loss of Native Hollow-bearing Trees" as a threatening process was submitted by several community groups in 2017. The *loss of mature native trees (including hollow bearing trees)* and a lack of recruitment has since been listed as a key threatening process under the *Nature Conservation Act 2014*.
- Vegwatch, a monitoring program run by the Molonglo Catchment Group since 2012, adopts consistent techniques outlined in Sharp and Gould (2014) to monitor the effects of change such as weed control, burns and other management activities. Currently ten woodland (including secondary grassland) sites are monitored as part of this program.
- Publication of *Woodland Flora, a Field Guide for the Southern Tablelands (NSW and ACT)*, which covers 444 Southern Tableland species across the broader ACT region (Sharp et al., 2015).

BASELINE INFORMATION

Survey and mapping projects since the 2004 Strategy have improved our understanding of the distribution of a range of vegetation types across the ACT. Major projects are listed below.

- Classification of 41 vegetation communities in the ACT according to the classification system developed by Armstrong et al. (2013).
- A comprehensive map of vegetation in the ACT was completed in 2018 using aerial photography. Structural attributes of the vegetation (e.g. tree height, crown cover and shrub cover) were added using data derived from Light Imaging Ranging and Detection. Mapped vegetation communities include those described by Armstrong et al. (2013), one previously

undescribed woodland community (see Baines et al. (2013)), and 20 modified vegetation types. The mapping was completed between 1:3 000 and 1:10 000 scale. It is available to the public on ACTMapi and is being used to inform management activities and modelling of ecological processes.

- Weed infestation and control work within reserves mapped using the Collector Application. Weed mapping undertaken by community members using the Weed Spotter website and associated application has also contributed to the knowledge of the distribution of weeds.
- Surveys undertaken as part of Environmental Offset requirements have improved distribution maps of a range of woodland biodiversity values, including threatened species. These surveys aim to track the extent and condition of communities, and the occurrence / abundance of threatened species through time.
- Description and mapping of soil landscapes across the ACT by the NSW Office of Environment and Heritage. Fifty five soil landscapes were described (see Cook et al. (2016)) and a digital map was produced for use by land managers, planners and researchers.

RESEARCH, MODELLING AND MONITORING

Research projects undertaken in the ACT and surrounding region have improved our understanding of the function and value of woodlands and their primary threats in the ACT. Key research projects are listed below.

DISTURBANCE, BIOMASS MANAGEMENT AND WOODLAND RESTORATION

- Several local research projects investigating the impact of high intensity grazing by native herbivores on:
  - vegetation structure and species diversity and abundance (Driscoll, 2017; Manning et al., 2013; McIntyre et al., 2015; McIntyre et al., 2010; Snape et al., 2018; Vivian & Godfree, 2014)
  - birds (Howland et al., 2016)
  - invertebrates (Barton et al., 2011)
  - reptiles (Howland et al., 2014).
- Research illustrating the importance of coarse woody debris in reducing the impacts of browsing pressure on vegetation in woodlands in the ACT (Stapleton et al., 2017).
- Research trials to develop an effective and efficient method for fertility control of Eastern Grey Kangaroos (ACT Government, 2018c).
- Trials of disturbance and restoration regimes to inform management of grasslands (and grassy woodlands), including improving habitat for threatened species. Management techniques include fire, grazing, slashing, rock placement and complementary weed and pest animal control.
- Research in Namadgi and other National Parks within the Australian Alps investigating fuel hazard and flammability in subalpine woodland and forests (Dixon et al., 2018b; Zylstra, 2018).
- Research investigating the interaction between dieback severity of Blakely's Red Gum and time since fire, landscape position and stand structure (i.e. regeneration density) in the ACT.
- As part of a PhD thesis, Darren Le Roux investigated the future availability of large old trees around Canberra (Le Roux et al., 2014a) and policy options to retain habitat structures in urban areas (Le Roux et al., 2014b), the impact on bird diversity of replacing single large trees with several small trees (Le Roux et al., 2015), factors influencing use of artificial nest boxes (Le Roux et al., 2016a) and the failure of nest boxes to attract native hollow nesting birds to small- and medium-sized trees (Le Roux et al., 2016b).

THREATENED SPECIES

- Monitoring and on-ground activities undertaken by the ACT Government to better understand and conserve threatened woodland vegetation species, as detailed in respective action plans (Part B). These include:
  - Monitoring of Small Purple Pea and Tarengo Leek Orchid populations since 2001 and 1991, respectively. Long-term data will allow for the effective analysis of population trends and identification of relationships with management activities and other impacts (including climate change).
  - Monitoring threats to Canberra Spider Orchid populations and implementing management interventions when required.
- Research into a failed reintroduction of the Brown Treecreeper and implications for woodland restoration (Bennett et al., 2012a; Bennett et al., 2012b, 2013a; Bennett et al., 2013b)

WOODLAND BIRDS

- Analysis of long term monitoring data and population trends for woodland birds, including the seven species listed as threatened in the ACT (Barrett et al., 2007; Rayner, 2014).
- Research investigating the response of woodland birds to various habitat features (Stagoll et al., 2010), the urban interface (Ikin et al., 2014a; Ikin et al., 2013a; Ikin et al., 2013b) and large trees in urban areas (Stagoll et al., 2012).
- Intensive nest monitoring of Superb Parrots in Canberra to assess the number of pairs displaying breeding behaviour within the Gungahlin and Molonglo Strategic Assessment Areas and to monitor competitive interactions with other hollow nesting species (Rayner et al., 2015b, 2016). This research contributes to our understanding of site fidelity, breeding success, and the habitat and breeding requirements of the Superb Parrot.

CLIMATE CHANGE

- Modelling by the ACT Government to identify climate refugia for vegetation across the ACT (Mackenzie et al., 2018). The model-predicted future distribution of vegetation is informing current management activities undertaken by the ACT Government (e.g. such as fire management and restoration activities).
- A spatial multi-criteria analysis, which aims to improve understanding of the factors associated with dieback across the ACT, was recently completed for the ACT Government (Cowood et al., 2018).
- Research and modelling into the likely impacts of climate change on structure, processes and biodiversity of temperate grasslands and grassy woodland communities across southeast Australia (Prober et al., 2012a).
- Research illustrating the importance of several factors for successful ecological restoration in a changing climate (Prober et al., 2014a; Prober et al., 2014b).
- Analysis of genetic variability in Yellow Box remnant and restoration sites (including sites in northern ACT and north of the ACT border) (Broadhurst, 2013). Broadhurst's (2013) paper discusses the relationship between the genetic variability of vegetation at these sites and the likelihood they will successfully adapt to the impacts of climate change.
- The genetic diversity of two Yellow Box seed production areas were evaluated to determine if the harvestable seed contains sufficient genetic diversity to supply effective future restoration projects (Broadhurst et al., 2015).
- Development of a trial by CSIRO (for the ACT Government) to test the suitability of seeds of Blakely's Red Gum, sourced from local populations and the broader region, to ACT's present and predicted future climate conditions. Information from the provenance trial will inform potential management activities to mitigate the impact of climate change and dieback on Blakely's Red Gum. This may include the selection and breeding of dieback resistant individuals, assisted migration and genetic enrichment of natural populations

HABITAT CONNECTIVITY

- Landscape modelling, undertaken by Manning et al. (2010), to identify priority places to improve habitat connectivity across the ACT. The analysis mapped the location of habitat links across the region, identified key considerations and issues for land planning and management and proposed a range of remedial and future actions. Habitat connectivity models and guidelines to ensure adequate connectivity for species (including woodland specialists) within the ACT were further developed by (Barrett & Love, 2012) and later by Doerr et al. (2014b). Mapping products and recommendations produced from these projects have been used in town planning and have guided revegetation projects.
- Love et al. (2015) identified areas across the South East Local Land Services region (including the ACT) where maintaining or improving connectivity of native vegetation will best support woodland dependant (and other) species most sensitive to landscape fragmentation.

MONITORING

- The development of the CEMP in 2017 as a framework for monitoring the condition of ecosystems across the ACT network. The program gathers information from various monitoring programs and qualitative sources across government and non-government groups to make assessments of reserve condition and to evaluate the effectiveness of management actions in achieving conservation outcomes. The CEMP ensures information is available to support adaptive, evidence-based decision making into the future. A monitoring plan for native woodlands is currently under development.
- The impact of Sambar Deer on vegetation structure and composition in montane forests and woodlands in the Cotter Catchment is being monitored by the ACT Government. Surveys commenced in 2014-2015 and data collected will inform future management decisions (see Mulvaney et al. (2017)).
- The ACT Government is monitoring the effects of thinning (according to benchmark densities outlined in Gibbons et al. (2010)) on the structural diversity and growth rates of woody species within a lowland woodland site at Isaacs Ridge offset area.
- The ACT Government has undertaken long-term monitoring of lowland grasslands and woodlands since 2009. This includes measuring species richness and structural characteristics. As part of the 5 year collaborative woodland enhancement and connectivity program, additional monitoring sites are being developed to identify management priorities and track changes in habitat condition.
- The ACT Government is undertaking research to better understand the response of subalpine woodland ecosystems to fire. Vegetation structural dynamics and patterns of fauna diversity are being recorded at monitoring plots throughout Namadgi National Park that have experienced different fire regimes. Ecological insights from this research informs fire management activities undertaken by the ACT Government.
- Monitoring is undertaken at all offset sites, which together include over 650 ha of box-gum woodland, to understand if management objectives are being achieved and if changes to management are required. This includes monitoring the ecological condition of box-gum woodland and monitoring the population status of threatened species.
- The ACT Government undertakes annual monitoring of feral pig populations in Namadgi National Park to estimate local populations to inform control activities
- Biannual surveys to monitor rabbit populations across a number of grassland and woodland sites within Canberra Nature Park. Monitoring tracks long term trends in rabbit abundance and informs rabbit control activities.

5. APPENDICES

5.1. LOWLAND AND SUBALPINE WOODLAND COMMUNITIES IN THE ACT

	NAME	STRUCTURE	CONDITION AND THREATS	LOCATION	CONSERVATION SIGNIFICANCE
SUBALPINE	u22. Mountain Gum – Snow Gum ± Robertson's Peppermint grass-forb very tall woodland to open forest of the Australian Alps and South Eastern Highlands bioregions	Tall dense canopy (grading to open forest) dominated by *Eucalyptus dalrympleana* and *Eucalyptus pauciflora* subsp. pauciflora. Midstorey variable (may be absent) with dense grass and herbaceous ground cover, usually dominated by *Poa sieberiana*.	→ Most of this community is below its prescribed minimum tolerable fire interval → Extensive areas burnt in 2003, resulting in a dense cover of vegetation in the 1-3 m height class → Well represented in the ACT reserve system	→ 865 – 1588 m asl → Widespread on ridges and slopes of the Gugdgenby, Corin, Bendora, Paddy's River and Cotter catchments	
	u23. Snow Gum – Drumstick Heath – Leptospermum myrtifolium tall woodland to open forest of drainage depressions primarily of the South Eastern Highlands bioregion	Mid-high dense canopy (grading to open forest) dominated by *E. pauciflora* subsp. *pauciflora*, *E. dalrympleana* and *Eucalyptus stellulata*. Well-developed shrub layer (including *Epacris breviflora*, *Leptospermum myrtifolium* and *Hakea macrocarpa*) and diverse ground cover.	→ Most of the community is below its prescribed minimum tolerable fire interval → Primary current threats include invasive plants → Well represented in the ACT reserve system	→ 931-1707 m asl → Very patchy distribution on lower slopes and sheltered areas, including the Paddy's River, Bendora, and Gudgenby catchments	
	u27. Snow Gum – Candlebark tall grassy woodland in frost hollows and gullies of the South Eastern Highlands bioregion	Tall canopy dominated by *E. pauciflora* subsp. *pauciflora* often with *Eucalyptus rubida*, and occasionally with *Eucalyptus dives*, *Eucalyptus bridgesiana* or *Eucalyptus viminalis*. Dense grass and herbaceous ground cover.	→ Most of the community is below its prescribed minimum tolerable fire interval → Approximately 70% of extent was burnt in 2003, resulting in a dense cover of vegetation in the 1-3 m height class → Well represented in the ACT reserve system	→ 890-1558 m asl → Mid to lower slopes and valley floors on ranges and frost hollow depressions, including Gudgenby, Naas and Corin catchments	→ This community is part of an Endangered Ecological Community (*Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland in the South Eastern Highlands, Sydney Basin, South East Corner and NSW South Western Slopes bioregions*) listed under the *NSW Threatened Species Conservation Act 1995*
	u28. Snow Gum – Mountain Gum – Daviesia mimosoides tall dry grass-shrub subalpine open forest of the Australian Alps and South Eastern Highlands bioregions	Tall canopy (grading to open forest) dominated by *E. pauciflora* subsp. *pauciflora* and *E. dalrympleana*. Shrubby, diverse midstorey (often dominated by *D. mimosoides* and *Oxylobium ellipticum*). Diverse groundcover dominated by *P. sieberiana*.	→ Approximately 90% of this community is below its prescribed minimum tolerable fire interval → Extensive areas burnt in 2003, resulting in a lower canopy height than less disturbed systems → Well represented in the ACT reserve system	→ 978-1582 m asl → Widely distributed on ridges, summits and slopes, including the Corin, Gudgenby, Bendora, Lower Cotter, Naas and Paddy's River catchments	
	u118. Black Sallee grass-herb woodland in drainage depressions and moist valley flats in the South Eastern Highlands and Australian Alps bioregions	Tall canopy dominated by *E. stellulata* and occasional *E. rubida* and/or *E. pauciflora* subsp. *pauciflora*. Moderate shrub layer (often including *Hakea microcarpa* and *Leptospermum* spp.) and dense groundlayer with a diversity of forbs and low shrubs between grass tussocks.	→ Approximately 70% of this community is below its prescribed minimum tolerable fire interval → Well represented in the ACT reserve system	→ 972-1400 m asl → Narrow bands on the footslopes of drainage depressions and valleys in the Naas, Gudgenby, Corin and Paddy's River catchments	→ This community is part of an Endangered Ecological Community (*Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland in the South Eastern Highlands, Sydney Basin, South East Corner and NSW South Western Slopes bioregions*) listed under the NSW Threatened Species Conservation Act 1995

	NAME	STRUCTURE	CONDITION AND THREATS	LOCATION	CONSERVATION SIGNIFICANCE
SUBALPINE	u158. Alpine Sallee shrub-grass subalpine mid-high woodland of the Australian Alps bioregion	Low to tall canopy dominated by *E. pauciflora* subsp. *niphophila*, *E. pauciflora* subsp. *debeuzevillei* and *Eucalyptus glaucescens*. Shrubs, grasses and forbs create a diverse groundlayer, often including *Hovea montana*, *Acrothamnus hookeri*, *Acrothamnus montanus*, *Poa phillipsiana* and *Stellaria pungens*.	→ Much of this community is below the prescribed minimum tolerable fire interval → Majority of extent burnt in 2003, resulting in a very dense shrub layer → Entire distribution protected within ACT reserve system	→ 1005-1553 m asl → Very patchy distribution on exposed and rocky summits and ridges, primarily along the Tidbinbilla Range in the Lower Cotter, Bendora and Paddy's River catchments. → Isolated patches occur in the Gudgenby catchment	
SUBALPINE	u207. Jounama Snow Gum – Snow Gum shrubby mid-high woodland on granitoids primarily of the Namadgi region	Low to tall canopy dominated by *E. pauciflora* subsp. *debeuzevillei* and *E. pauciflora* subsp. *pauciflora*. Diverse, shrubby midstorey including *Tasmannia xerophila*, *Podolobium alpestre*, *Daviesia ulicifolia*, *Oxylobium ellipticum* and *Hovea montana*. Groundlayer includes a diverse suite of grass and herb species.	→ Majority of extent burnt in 2003 and is likely to be well below its prescribed minimum tolerable fire interval → Entire distribution protected within ACT reserve system	→ 1297-1910 m asl → Primarily located on the highest ridges of the Brindabella Range, including the Corin and Bendora Catchments	
LOWLAND (INCLUDING HILLSLOPES AND FOOTHILLS)	q6. Red box tall grass-shrub woodlands	Tall canopy dominated by *E. polyanthemos* with occasional *E. blakelyi*, *E. melliodora*, *E. bridgesiana* and *E. nortonii*. Midstorey ranges from diverse to sparse (including species such as *Bursaria spinosa*, *Kunzea ericoides* and *A. dealbata*). Ground layer varies from moderate to sparse.	→ Approximately 50% of the community is above its prescribed maximum tolerable fire interval → Historic grazing has resulted in a simplified mid and ground cover and inhibited recruitment of canopy species → Many old trees have been removed for use as firewood → Some areas have been converted to derived grasslands → Current threats include invasive plants	→ Largely confined to the ACT → Fragmented distribution across hills, ridges and mid-slopes, primarily within the Kambah, Tharwa, Woolshed, Fyshwick and Kowen catchments	
LOWLAND (INCLUDING HILLSLOPES AND FOOTHILLS)	u19. Blakely's Red Gum – Yellow Box ± White Box tall grassy woodland of the Upper South Western Slopes and western South Eastern Highlands bioregions	Tall canopy dominated by *E. blakelyi* and/or *E. melliodora*. Sparse or absent shrub layer often comprised of regenerating Eucalypts, *Acacia* species or *B. spinosa*. Groundlayer includes a range of grass and forb species. Undisturbed sites have a greater diversity of forbs; degraded areas are dominated by less palatable, robust species.	→ Approximately 40% of the community is above its prescribed maximum tolerable fire interval → Historic grazing has resulted in a simplified mid and ground cover and inhibited recruitment of canopy species → Few areas remain in good, intact condition and some areas have been converted to derived grasslands → Extensive areas suffer from dieback and have sparse to very sparse canopy cover → Current threats include dieback, grazing (native and non-native), urbanisation and invasive plants	→ Widespread across gently sloping country in most catchments north of Mt Tennent and north-east of the Murrumbidgee River	This community is part of the: → *Yellow Box/Red Gum Grassy Woodland* listed as endangered under the Nature Conservation Act (ACT) 1980 → *White Box Yellow Box Blakely's Red Gum Grassy Woodland and Derived Native Grassland* listed as Critically Endangered under the EPBC Act 1999. → *White Box Yellow Box Blakely's Red Gum Woodland* listed under the NSW TSC Act 1995.

	NAME	STRUCTURE	CONDITION AND THREATS	LOCATION	CONSERVATION SIGNIFICANCE
LOWLAND (INCLUDING HILLSLOPES AND FOOTHILLS)	**u178.Yellow Box – Apple Box tall grassy woodland of the South Eastern Highlands**	Tall canopy dominated by *E. melliodora* and/ or *E. bridgesiana*, occasionally with *E. blakelyi* or *E.rubida* along creeklines and in moist depressions. Sparse (or absent) shrub layer primarily comprised of *Acacia* spp., *B. spinosa* and *K. ericoides*. Dense groundlayer of grasses and forbs.	→ Approximately 40% of the community is above its prescribed maximum tolerable fire interval → Historic grazing has resulted in a simplified mid and ground cover and inhibited recruitment of canopy species → Few areas remain in good, intact condition → Extensive areas suffer from dieback and have sparse to very sparse canopy cover → Current primary threats include dieback, grazing (native and non-native), urbanisation and invasive plants	→ A significant proportion of extent is within the ACT → Widespread across variable topography, from valley floors to ridges, including the Naas Kowen and Uriarra and Coppins catchments	This community is part of the: → *Yellow Box/Red Gum Grassy Woodland* listed as endangered under the Nature Conservation Act (ACT) 1980 → *White Box Yellow Box Blakely's Red Gum Grassy Woodland and Derived Native Grassland* listed as Critically Endangered under the EPBC Act 1999. → *White Box Yellow Box Blakely's Red Gum Woodland* listed under the NSW TSC Act 1995.
	p520. Ribbon Gum very tall woodland on alluvial **soils along drainage lines of the eastern South Eastern Highlands bioregion**	Very tall canopy dominated by *E. viminalis* and occasionally *E. bridgesiana, E. rubida* or *E. pauciflora*. Sparse to moderate shrub layer (often comprised of *A. dealbata, A. melanoxylon* or *K. ericoides*) and grassy groundlayer. Areas that have suffered severe disturbance have little to no native ground cover	→ Most of this community is below its prescribed maximum tolerable fire interval → Historic grazing has resulted in a simplified mid and ground cover, altered hydrology and inhibited recruitment of canopy species → Most areas are in low to moderate condition → Current primary threats include invasive plants and dieback → Well represented in the ACT reserve system	→ Fragmented distribution along alluvial flats adjacent to larger drainage lines, primarily in the Naas, Gudgenby and Tharwa catchments	→ This community is part of an Endangered Ecological Community (*Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland in the South Eastern Highlands, Sydney Basin, South East Corner and NSW South Western Slopes bioregions*) listed under the NSW Threatened Species Conservation Act 1995
	u78. Snow Gum Grassy mid-high woodland of the South Eastern Highlands bioregion	Low to tall canopy dominated by *E pauciflora* subsp. *pauciflora* occasionally with *E. bridgesiana* and / or *E. rubida*. Sparse to moderate shrub layer (including *K. ericoides, B. spinosa* and *A. delabata*) and dense groundlayer including a variety of grasses and forbs. Heavily grazed remnants are dominated by less-palatable species such.	→ Over 70% of the community is the same fire age class → Historic grazing has resulted in a simplified mid and ground cover, altered hydrology and inhibited recruitment of canopy species → Current primary threats include invasive plants and grazing	→ Rare → Over 60% of this community is within rural lands → Fragmented distribution across areas where cold air accumulates overnight (varied topography). → Largest remnants are located in the Paddy's River catchment in the Tidbinbilla Valley, Mt Ainslie-Majura and Aranda bushland	→ This community is part of an Endangered Ecological Community (*Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland in the South Eastern Highlands, Sydney Basin, South East Corner and NSW South Western Slopes bioregions*) listed under the NSW Threatened Species Conservation Act 1995

5.2. CONSERVATION OBJECTIVES IDENTIFIED IN THIS STRATEGY RANKED BY CONSERVATION IMPERATIVE*

H = High M = Medium L = Low ⊘ = Not currently applicable

*Considers extent and severity of threat / issue, emerging issues, conservation goals, and data deficiencies.

CONSERVATION OBJECTIVE	CONSERVATION IMPERATIVE		
	LOWLAND	SECONDARY GRASSLANDS	SUBALPINE
RETAIN AND PROTECT NATIVE WOODLANDS			
Ensure no net loss of the ecological and cultural values of woodlands in the ACT.	H	H	H
Maintain or improve the proportion of each woodland community located within the ACT's formal reserve system	H	⊘	H
Identify opportunities to improve representation of lowland Snow Gum woodland (u78) and Red Box tall grass-shrub woodland (q6) in the ACT's formal reserve system.	H	⊘	⊘
All species of woodland flora and fauna should be represented by viable, wild populations that will enable the species to be conserved for perpetuity. The ACT Government will continue to support regional and national effort towards the conservation of these species.	H	H	H
Improve understanding of the distribution of Endangered YB-BRG Woodland community in the ACT and aim to protect all remaining areas from unintended impacts	H	H	⊘
Prioritise the protection and ongoing management of woodland that contributes to threatened species conservation (as outlined in respective action plans and conservation advice, Part B).	M	M	L
Identify opportunities to protect and enhance the values of woodlands outside the reserve system, guided by relevant policy and legislation and in collaboration with non-government agencies, the Commonwealth Government and community members	H	M	⊘
After feasible and appropriate avoidance and mitigation measures have been undertaken, manage the impact of residential and commercial development on woodlands according to the Environmental Offsets Policy and those strategies outlined in Section 1.2.	H	H	⊘
MITIGATE THE IMPACT OF URBANISATION			
Mitigate impacts of existing urban development on adjacent woodland habitat (cont. pg. 21).	H	H	⊘
Mitigate impacts of future urban development on woodland areas by (cont. pg. 21).	H	H	⊘

CONSERVATION OBJECTIVE	CONSERVATION IMPERATIVE		
	LOWLAND	SECONDARY GRASSLANDS	SUBALPINE
MITIGATE THE IMPACT OF OVERGRAZING			
Manage macropod densities according to the Controlled Native Species Management Plan for Eastern Grey Kangaroos (ACT Government, 2017b), the Kangaroo Management Plan (ACT Government, 2010a), and other subsidiary documents.	H	H	L
Continue the trial of dart-delivered GonaCon on kangaroos in Canberra Nature Park (CNP) and continue to assess the long-term effectiveness of dart-delivered GonaCon on fecundity. Ensure future culling programs are informed by the outcomes of this program.	H	H	⊘
Undertake activities, including restoration and herbage mass management techniques, to maintain, wherever possible a heterogeneous mosaic of grazing intensity by native herbivores, and at least some pasture that is at a level palatable to macropod and other native herbivores.	H	H	⊘
Continue long-term monitoring of the interaction between vegetation and principal herbivores in grasslands and grassy woodlands to inform ongoing management.	H	H	⊘
Consider actions to enhance woody debris (including fine woody components) to reduce browsing pressure in woodland areas where naturally occurring debris is deficient (see: Stapleton et al. (2017)).	M	M	⊘
Work with rural landholders to support the maintenance and enhancement of woodland values, including protection from overgrazing (as outlined in Section 2.1).	H	H	⊘
Reduce the impact of overgrazing from non-native herbivores according to ACT Government (2012a).	H	H	M
FIRE MANAGEMENT			
Undertake strategic prescribed burning and other fuel reduction activities within woodlands to protect human life and property, maintain species diversity and minimise species' losses according to the ACT Strategic Bushfire Management Plan	H	M	H
Use the best available ecological knowledge to evaluate and make decisions regarding balancing asset protection and woodland biodiversity conservation.	H	H	H
As part of planning for prescribed burning, take appropriate measures to mitigate potential negative ecological impacts.	H	M	H
Lead and support research to improve our understanding of the responses of fauna and flora to different fire regimes in the ACT.	H	M	H

CONSERVATION OBJECTIVE	CONSERVATION IMPERATIVE		
	LOWLAND	SECONDARY GRASSLANDS	SUBALPINE
Facilitate and support cross-tenure fire management planning and activities (including with rural landholders and NSW land managers).	M	M	H
Where it is consistent with objectives to reduce the risk to human life and property, increase the diversity of subalpine woodland post fire age classes. Priority activities include: protecting areas of long unburned subalpine woodlands from fire for the foreseeable future and identifying areas of subalpine woodland to transition to older post-fire age classes (cont. pg. 26).	⊘	⊘	H
Develop weed management strategies for fire management when there is a likelihood of invasive species responding positively to burning (e.g. English Broom [*Cytisus scoparius*], African Lovegrass [*Eragrostis curvula*], Cootamundra Wattle, and Oxeye Daisy [*Leucanthemum vulgare*]) and Nodding Thistle [*Carduus nutans*]).	M	M	L
Facilitate community education initiatives to improve understanding of the complexities of fire management in the ACT and the use of fire to manage woodland biodiversity.	M	M	M
Undertake robust monitoring and evaluation to assess the ecological (and human life and property protection) outcomes of planned fire management activities and unplanned fire events.	H	H	H
In accordance with ACT Government (2015a), protect cultural sites during fire management activities and work in collaboration with Traditional Custodians and the broader Aboriginal community to plan, implement and monitor cultural burns in woodlands.	H	H	H
MITIGATE THE IMPACT OF INVASIVE PLANTS			
Manage established invasive species according to the ACT Weeds Strategy 2009 -2019 (ACT Government, 2009) (note, a revised ACT Weeds Strategy is currently in development) and annual Invasive Plants Operations Plans.	H	H	M
Prevent costly, erratic invasive plant control by ensuring long term, regular funding for targeted management.	M	M	M
Reduce the likelihood of new plant invasions by prioritising management activities that detect and efficiently eradicate emerging species (cont. pg. 30).	H	H	H
Where eradication of a species is not feasible, prioritise management actions to protect significant cultural and ecological assets from further invasion.	H	H	L
When required, undertake staged removal of woody weeds and plan and implement revegetation (e.g. with fast growing native shrubs) to maintain critical habitat for fauna in the absence of complex habitat structure.	H	L	L

CONSERVATION OBJECTIVE	CONSERVATION IMPERATIVE		
	LOWLAND	SECONDARY GRASSLANDS	SUBALPINE
Facilitate and support cross-tenure management of invasive plants where relevant.	H	H	L
As part of control programs, monitor the changes in abundance of invasive plants and their impacts on woodlands.	M	M	L
Continue to use and promote digital technologies to assist in the systematic recording of invasive species distribution and control activities and use this information to monitor changes in the area and density of infestations.	M	M	M
Keep up to date with new control methods and emerging technologies to inform best practice invasive plant species management.	M	M	M
CONTROL PEST ANIMALS			
Prevent costly, erratic pest animal control by ensuring long-term, regular funding for targeted pest management, according to the ACT Pest Animal Strategy 2012-2022 (ACT Government, 2012a).	H	M	H
Reduce the impact of pest animals by prioritising management activities that detect and efficiently manage emerging pest species (cont. pg. 32).	M	L	H
Where eradication of a species is not feasible, prioritise management actions to protect significant cultural and ecological assets from further impacts.	M	L	H
Facilitate and support cross-tenure management of pest animals.	M	M	M
Consider the interactions between ecosystem processes, threatening processes and management activities during the development and implementation of control programs.	H	H	H
Lead and support research to improve our understanding of the relationship between pest animal abundance/density and environmental impacts. Based on research findings, develop management actions that target actual, rather than perceived, impacts.	M	M	M
For all control programs, develop and maintain a robust monitoring program to track changes in the abundance of pest animals and the impact they cause to woodland values.	H	H	H
Develop management triggers for the control of pest animals that are informed by both the abundance of an animal and its environmental impact.	M	M	M
Facilitate community education and participation in pest animal management to maintain community support for pest animal control and to improve efficiencies of control work through cross-tenure management.	M	M	L

CONSERVATION OBJECTIVE	CONSERVATION IMPERATIVE		
	LOWLAND	SECONDARY GRASSLANDS	SUBALPINE
Lead and support research to identify and test innovative control methods and emerging technologies in the space of pest animal control to inform best-practice management.	M	M	M
Maintain local, regional and national research collaborations (including the Centre for Invasive Species Solutions).	L	L	L
MITIGATE THE IMPACTS OF DIEBACK			
Continue to lead and support research and modelling to improve our understanding of the relationship between: dieback and fire (including prescribed burning), the abundance and impact of insects and fungal pathogens, soil moisture and condition, vegetation density, and land use.	H	H	M
Building on the work undertaken by Cowood et al. (2018), continue to map tree canopies using remote sensing methods and undertake associated modelling and analysis to track changes in the condition of trees in lowland woodland communities over time (cont. pg. 36).	M	M	M
Lead and support research to improve our understanding of the susceptibility of individual Eucalyptus trees to dieback (including investigations into genetic variability and seed provenance trials [see Section 4]).	L	L	L
Undertake and support restoration activities that enhance a system's resilience to climate change and other disturbances (see Section 1.3), and encourage regeneration and establishment of Eucalyptus trees.	H	H	L
Management actions that aim to mitigate the impacts of dieback are informed by emerging ideas and research undertaken in the ACT and in *Eucalyptus* woodland communities across Australia.	H	H	M
MITIGATE THE IMPACT OF CLIMATE CHANGE			
Improve understanding of: the predicted impacts of climate change on woodland-associated fauna and flora, future climate refugia for woodland communities and potential colonisation sites for associated biodiversity (cont. pg. 38).	H	H	H
Monitor the long-term response of species (that are characteristic of woodland communities) to climate change. Use monitoring data to inform the selection of thresholds above or below which management actions should be triggered.	H	H	M
Identify management priorities and protect sites identified as significant refugia (and potential colonisation sites) for woodland species.	H	H	L
As outlined in Section 1.3, woodland restoration activities will consider future climate impacts and will aim to enhance a system's ability to adapt to changing conditions.	H	H	L

CONSERVATION OBJECTIVE	CONSERVATION IMPERATIVE		
	LOWLAND	SECONDARY GRASSLANDS	SUBALPINE
Collaborate with local, regional, state and federal stakeholders to undertake research, management activities, and facilitate community awareness raising and knowledge sharing between all parties.	M	M	M
MAINTAIN AND IMPROVE HABITAT FEATURES AND HABITAT HETEROGENEITY			
Enforce policy and undertake management action to retain large, mature trees and other critical woodland habitat features (e.g. mistletoe) across all tenures.	H	H	L
Undertake plantings and introduce habitat elements to restore soil health, increase woodland extent, enhance functional woodland connectivity and enhance habitat for target fauna species.	H	H	L
The prioritisation and planning of restoration projects should: define site and landscape-scale goals, evaluate the appropriateness and cost-effectiveness of assisted natural regeneration to meet objectives otherwise addressed through revegetation and other active regeneration activities, be informed by the best available knowledge (cont. pg. 42).	⊘	⊘	⊘
Work closely with rural landholders and other local land managers to plan and undertake restoration activities to maintain and improve habitat features and contribute to landscape-scale restoration, as outlined in Section 2.1.	H	H	L
Ensure long term funding for ongoing management and / or monitoring of restoration sites.	M	M	L
If there is conflict between habitat management for two or more threatened species, consideration must be given to abundance, habitat specialisation, functional traits, mobility, adaptability and the ACT and National conservation status of the species. The nature of ongoing threats, and how important the site is to the conservation of the species must also be considered.	⊘	⊘	⊘
Seek to improve our understanding of aboveground-belowground linkages to inform effective restoration techniques. This includes: knowledge of species-specific symbiotic relationships, management actions that are advantageous to soil communities and soil community structure (cont. pg. 43)	M	M	L
Continue to support the work of community groups to undertake restoration activities (see Section 2)	H	H	L
Continue to undertake and support research that informs restoration activities (see Section 3.1 and 4.8)	M	H	L

CONSERVATION OBJECTIVE	CONSERVATION IMPERATIVE		
	LOWLAND	SECONDARY GRASSLANDS	SUBALPINE
MANAGE HERBAGE MASS			
In the absence of knowledge regarding species-specific understorey habitat requirements, aim to maintain intermediate levels of herbage mass and a heterogeneous (or 'patchy') grassland structure at the reserve and / or landscape scale.	M	M	⊘
Evaluate the risk and appropriateness of implementing different herbage mass techniques (fire, grazing or slashing / mowing) at a site, and compare with the risk of inaction.	M	M	L
Develop ACT Government guidelines for the management of herbage mass within lowland woodlands (cont. pg. 46)	M	M	⊘
Manage macropod densities (according to the guidelines outlined above) at sites where heavy macropod grazing is resulting in a substantial decline in herbage mass and structural heterogeneity.	H	H	⊘
Undertake and support research and ongoing monitoring to evaluate the ecological, social and economic outcomes of controlled grazing by native herbivores and livestock.	H	H	⊘
If there is conflict between herbage mass management for two or more threatened species, consideration must be given to abundance, habitat specialisation, functional traits, mobility, adaptability and the ACT and National conservation status of the species. The nature of ongoing threats, and how important the site is to the conservation of the species must also be considered.	⊘	⊘	⊘
Livestock grazing for conservation purposes should only be used as a short-term tool to manage herbage mass on ACT Government managed land where the following criteria are met (cont. pg. 46).	⊘	⊘	⊘
ENHANCE HABITAT CONNECTIVITY			
Projects aiming to maintain or enhance connectivity should: prioritise the protection and effective management of woodland patches, identify target species, and consider their requirements for functional connectivity, consider habitat connectivity at both a local and landscape scale (cont. pg. 47)	⊘	⊘	⊘
Maintain isolated trees on and off reserve as 'stepping stone' connectivity, especially when revegetation is not feasible.	M	H	L
Ensure the key east – west and north – south wildlife corridors across the ACT are maintained and where required, restored.	H	M	M
Work with rural landholders and other land managers to improve connectivity of woodland habitat at a landscape scale.	H	M	L

CONSERVATION OBJECTIVE	CONSERVATION IMPERATIVE		
	LOWLAND	SECONDARY GRASSLANDS	SUBALPINE
COLLABORATE WITH RURAL LANDHOLDERS			
Work closely with rural landholders and their representative body, the Rural Landholders Association (RLA), to identify additional strategies to collaborate on projects and support landholders to protect and / or enhance woodland values on rural land (cont. pg 49).	H	H	∅
To effectively work with rural landholders, consideration must be given to: the diversity of priorities rural landholders have regarding the management of their properties, including the need to manage for production and profitability, mechanisms to maintain open communication and effective relationships, including ensuring appropriate levels of on-ground staff to support initiatives (cont. pg. 49)	∅	∅	∅
SUPPORT COMMUNITY PARTICIPATION AND RAISE COMMUNITY AWARENESS			
Collaborate with community groups to deliver woodland conservation activities (e.g. restoration activities) to address the priorities outlined in this Strategy.	H	H	L
Support community groups to undertake on-ground and other projects through the provision of grants, advice and access to research and other knowledge. Agreements between the ACT Government and community groups to undertake shared management of sites will also be considered.	H	H	L
Provide opportunities for community members to engage in volunteer activities, through for example the ParkCare program. Training and access to other ACT Government resources is critical to ensuring the sustainability of the ParkCare program and other volunteer activities as they are identified.	∅	∅	∅
Facilitate, and collaborate with external groups to deliver community education programs that engage the broader community (cont. pg. 51).	M	M	M
Facilitate information and knowledge sharing between ACT Government staff, research organisations and community groups to encourage best practice management of woodlands (cont. pg. 52).	H	H	H
Develop and maintain appropriate interpretative signage and other educational materials in reserves and other open spaces.	M	M	M

CONSERVATION OBJECTIVE	CONSERVATION IMPERATIVE		
	LOWLAND	SECONDARY GRASSLANDS	SUBALPINE
ENHANCE AND PROMOTE CITIZEN SCIENCE			
Explore opportunities for citizen science initiatives to meet conservation objectives outlined in this Strategy. Provide support to relevant community groups to plan projects and implement them.	M	M	M
Encourage the systematic collection and effective use of data collected through citizen science projects by: supporting the management and use of digital information tools, ensuring data collected is subject to appropriate quality control, and supporting community groups to access grants, professional and technical advice, training and equipment.	H	H	H
ENHANCE PARTICIPATION OF ABORIGINAL PEOPLE			
Work in collaboration with Aboriginal community members to manage and monitor woodlands and fill knowledge gaps regarding their long term conservation (cont. pg. 55).	H	H	H
Support Traditional Custodians to access and use the landscape in accordance with Aboriginal Access to Country Cultural Guidelines (in development) (cont. pg. 56)	H	H	H
Implement and / or collaborate with RAOs and other community groups to deliver activities (cont. pg. 56)	H	H	H
SUPPORT SUSTAINABLE RECREATIONAL USE OF WOODLANDS			
Undertake effective monitoring of visitor impacts to inform a proactive and adaptive approach to visitor management.	H	M	L
Undertake effective visitor management, as outlined in individual Reserve Management Plans, to minimise detrimental impacts on the natural and cultural values of woodlands.	M	M	L
Effectively communicate with visitors to promote responsible and respectful use of woodland reserves, promote an understanding of woodland systems and their values, threats and required management, and advise visitors of community safety concerns such as wildfires and native animals (cont. pg. 57)	H	H	H
Promote the sustainable use of woodland reserves and, where practical, reduce physical barriers to community access.	M	M	L

CONSERVATION OBJECTIVE	CONSERVATION IMPERATIVE		
	LOWLAND	SECONDARY GRASSLANDS	SUBALPINE
MONITOR WOODLAND CONDITION			
Employ the Woodland CEMP (in development) to guide monitoring priorities. Monitor changes in ecological condition, including the impacts of threats and the effectiveness of management actions in achieving conservation goals across the ACT.	H	H	M
Continue to plan and implement monitoring programs to address ecological and management-related questions within woodlands across the ACT by: establishing monitoring programs with well-defined objectives, sound experimental design and effective data management and assessment standards, and seeking collaboration (cont. pg. 59)	H	H	H
In line with action plans and conservation advice, monitor threatened, declining and rare species and the Endangered YB-BRG Woodland community to: detect short-term changes in distribution or abundance that may require management intervention, and determine long-term trend and status in the ACT and broader region (cont. pg. 59).	H	H	⊘
In planning monitoring programs, ensure long-term investment and sustained funding and resourcing beyond short-term cycles.	H	H	H
Collaborate with community groups to collect and use monitoring data systematically and effectively by providing, for example: professional and technical advice, training, screening and analysis of data, data collection protocols, and support to access grants and equipment.	H	H	H
Priority projects to improve baseline information include: on-ground assessment of the condition of large patches of lowland woodland and those that make a significant contribution to the integrity of the Endangered YB-BRG Woodland across the ACT, improve knowledge of fauna distribution and abundance in subalpine and lowland woodland (cont. pg. 61)	⊘	⊘	⊘
DELIVER RESEARCH OUTCOMES			
Implement and support research projects to address knowledge gaps and answer ecological questions (priorities outlined above) to inform the management of woodlands.	H	H	H
Continue to support the Mulligans Flat – Goorooyarroo Woodland experiment as a key research and learning site for woodland restoration and management throughout the ACT.	M	M	⊘
Identify opportunities to partner with Traditional Custodians to develop research projects that can inform land management, resource use and other activities undertaken by Traditional Custodians in woodlands.	M	M	M

Candlebark (E. rubida), Namadgi National Park

CONSERVATION OBJECTIVE	CONSERVATION IMPERATIVE		
	LOWLAND	SECONDARY GRASSLANDS	SUBALPINE
In line with action plans and conservation advice, undertake and support research into the ecology and conservation requirements of threatened species and communities including: habitat requirements and key resources, including distribution of key habitats, effects of habitat modification, land use practices, and key threats (cont. pg. 63)	H	H	H
In planning and implementing research projects, maintain open dialogue between ACT Government policy, research and land management staff and when appropriate seek collaboration with non-government organisations to: identify and prioritise knowledge gaps for future research, inform research questions and project design (cont. pg. 63).	⊘	⊘	⊘
Communicate research results to land managers, including non-government organisations through: research and technical reports published on ACT Government website and in scientific journals, social media platforms, workshops and seminars, presentations and meetings, and the production of educational resources.	⊘	⊘	⊘

5.3 LIST OF ACRONYMS

ACT	AUSTRALIAN CAPITAL TERRITORY
ANBG	Australian National Botanical Gardens
ANZECC	Australian and New Zealand Environment and Conservation Counci
BOP	Bushfire Operations Plans
CEMP	Conservation Effectiveness Monitoring Program
CIP	Conservation Implementation Plan
COG	Canberra Ornithologists Group
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EPBC	Environment Protection and Biodiversity Conservation
IUCN	International Union for Conservation of Nature
LCC	Lower Cotter Catchment
MARS	Market Attitude and Research Services
MRC	Murrumbidgee River Corridor
NSW	New South Wales
RAO	Representative Aboriginal Organisations
TFI	Tolerable Fire Interval
TRC	Tourism Recreation Conservation Consultants
WONS	Weeds of National Significance
YB-BRG	Yellow Box – Blakely's Red Gum

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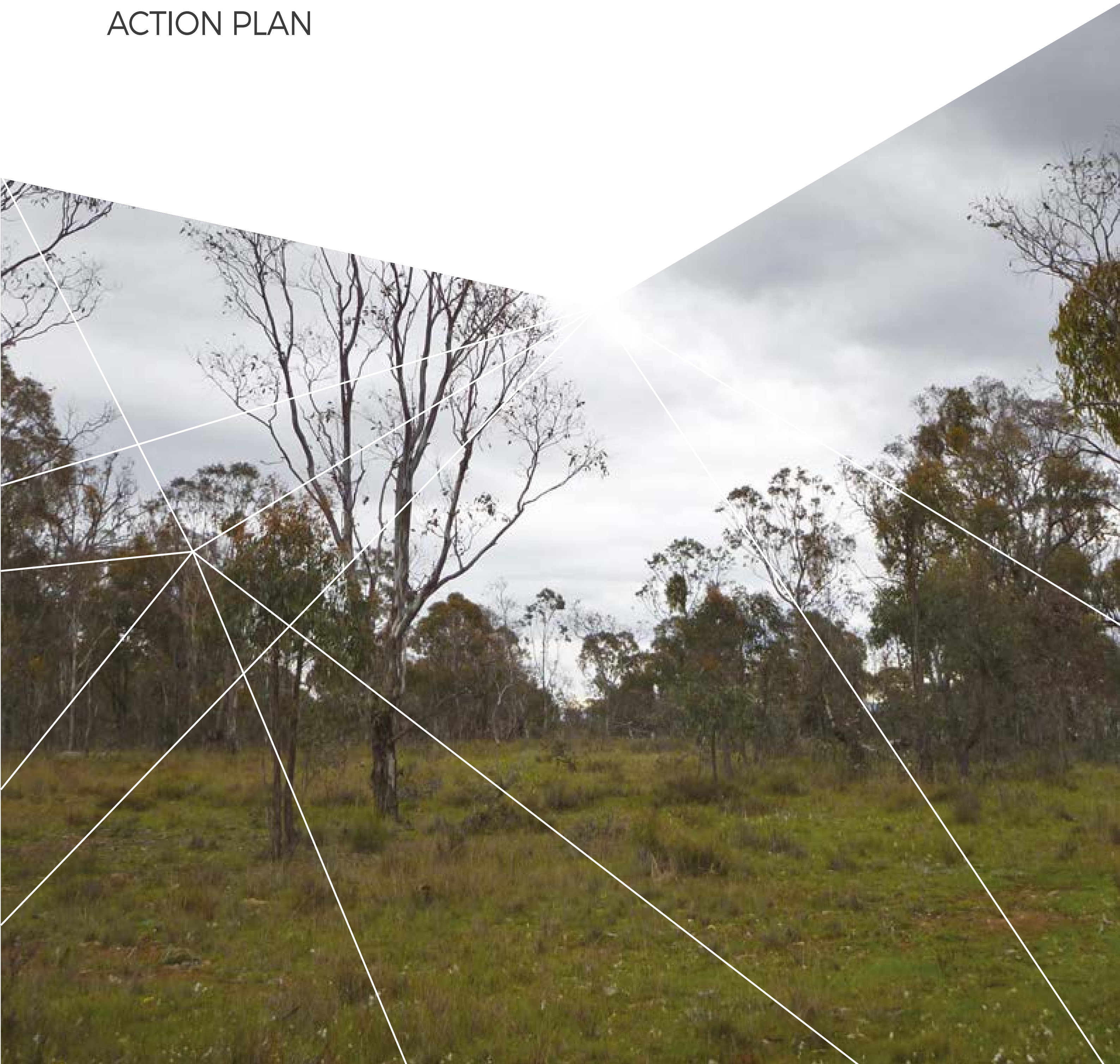
PART B

ACTION PLANS

YELLOW BOX–BLAKELY'S RED GUM GRASSY WOODLAND

ENDANGERED ECOLOGICAL COMMUNITY 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:
3. understorey structural and floristic diversity in Endangered YB-BRG Woodland
4. optimal habitat for threatened species, including keystone structures
5. improve the condition and ecological function of Endangered YB-BRG Woodland by undertaking restoration
6. improve understanding of Endangered YB-BRG Woodland ecology, restoration principles and best practice threat management
7. strengthen stakeholder and community collaboration in the conservation of Endangered YB-BRG Woodland.

COMMUNITY DESCRIPTION AND ECOLOGY

DEFINITION AND DESCRIPTION

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.

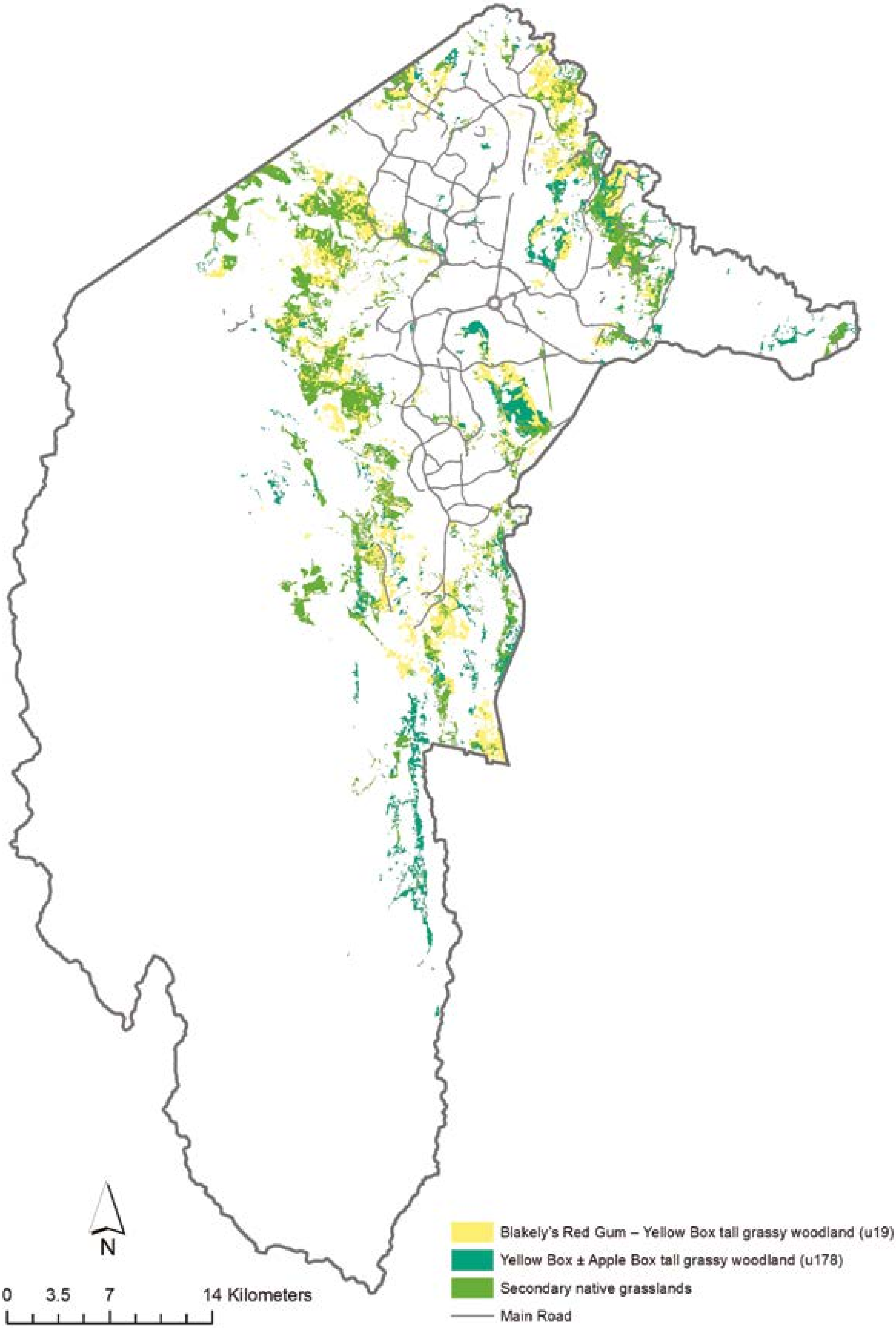


Table 1: Species associated with woodlands in the ACT that are listed as threatened under the *EPBC Act 1999* and/or the *Nature Conservation Act 2014*, and their frequency of occurrence in potential Endangered Yellow Box-Blakely's Red Gum Grassy Woodland (EEC).

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

OVERGRAZING

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 p**rotect 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 r**estoration 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
	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

OBJECTIVE	ACTION	INDICATOR
	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 partnered with rural landholders to undertake research and/or management projects for the conservation of YB-BRG Woodland (including projects that consider both profitability and conservation outcomes). Community stakeholders are satisfied with their level of participation in conservation of YB-BRG Woodland
	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.

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CANBERRA SPIDER ORCHID

CALADENIA ACTENSIS
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) and *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.
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.

OBJECTIVE	ACTION	INDICATOR
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.
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

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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

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

2.2.1 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

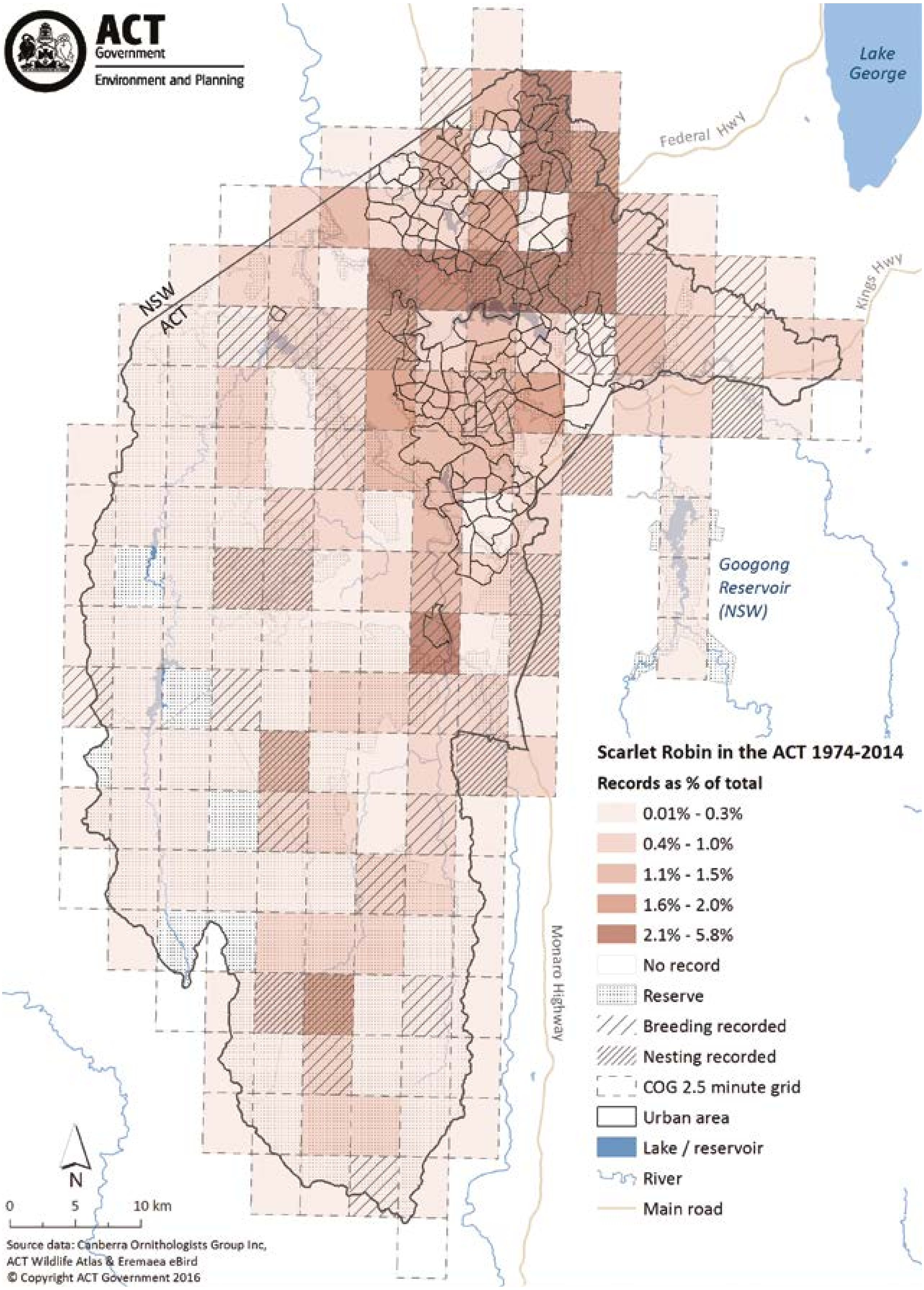
The Scarlet Robin is 12–14 centimetres in length and averages 13 grams in weight. Adult male birds have bold red, black and white plumage and females are brownish with a red/orange wash on the breast (Pizzey and Knight 2012) (**Figures 1a** and **1b**). Young birds resemble the adult female.

Figure 1: Male (top) and female (bottom) Scarlet Robin. G. Dabb.

Scarlet Robins are one of three red breasted robins in Australia, the others being the Flame Robin (*P. phoenicea*) and the Red Capped Robin (*P. goodenovii*). Scarlet Robins are distinguishable from the other red breasted robins by the obvious white forehead and red wash on the breast in females.

Unlike the Flame Robin, the red breast plumage colour of Scarlet Robins does not continue up the throat to the bill. Male Scarlet Robins also lack a scarlet cap and females lack a dull reddish wash on the forehead, which distinguishes them from the Red Capped Robin (Pizzey and Knight 2012).

Figure 2: Distribution of Scarlet Robin in the ACT



DISTRIBUTION

Scarlet Robins are 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 the species 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).

Scarlet Robins are distributed widely across the ACT in eucalypt woodlands and dry, open forest, particularly where shrubs, logs, coarse woody debris and native grasses are present (they are generally absent from open areas where no trees remain) (Taylor and COG 1992). **Figure 2** shows a distribution map of Scarlet Robins 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, Scarlet Robins are 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 the Scarlet Robin as an 'Uncommon breeding resident/ altitudinal migrant' in the ACT (COG 2015b).

The records of Scarlet Robin (**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). The distribution of Scarlet Robins 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 Scarlet Robin abundance in the ACT. More recent research has confirmed the species 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.

Scarlet Robins have been classified as one of three 'urban avoider' bird species (i.e. native birds that show a long-term declining population in the ACT), in addition to the Striated Thornbill and Rufous Whistler. 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

The listed conservation status of the Scarlet Robins is 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 and *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 Scarlet Robins in detail.

THREATS

Following a detailed literature review of the habitat and ecology of Scarlet Robins 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

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 Scarlet Robin.

OBJECTIVES

1. Identify, protect and restore Scarlet Robin breeding and foraging habitat.
2. Manage habitat to conserve Scarlet Robin.
3. Undertake and support survey, monitoring and research.
4. Co-operate with state and local government agencies.
5. Increase community awareness of, and engagement in, managing Scarlet Robin as a vulnerable species.

ACTIONS

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

Table 1: Key objectives, actions and indicators

OBJECTIVE	ACTION	INDICATOR
PROTECT		
1. Identify, protect and restore Scarlet Robin breeding and foraging habitat.	1a. Map the location and extent of breeding and foraging habitat of Scarlet Robin in the ACT.	Maps of breeding sites and the current extent of foraging habitat occupied by Scarlet Robin are prepared.
	1b. Protect Scarlet Robin populations from unintended impacts (unintended impacts are those not already considered through an environmental assessment or other statutory process).	Scarlet Robin populations are considered in the development approval process.
	1c. Improve degraded breeding and foraging habitat by replacing missing structural layers and increasing the size of habitat patches by planting locally indigenous trees and shrubs.	The area of currently occupied breeding and foraging habitat for Scarlet Robin is stable or increasing. Restoration activities have created more structurally diverse habitat for Scarlet Robin.
	1d. Undertake restoration activities to connect isolated habitat for Scarlet Robin.	Targeted restoration activities have improved habitat connectivity for Scarlet Robin.
MAINTAIN		
2. Manage habitat to conserve Scarlet Robin.	2a. Distribute coarse woody debris (or similar ground layer enhancement treatments) in known (or potential) breeding or foraging habitat for Scarlet Robin.	Area of breeding or foraging habitat enhanced by placement of coarse woody debris (or similar ground layer enhancement treatments) has increased.
	2b. Continue to expand cat containment areas in new suburbs where they coincide with known Scarlet Robin breeding sites or potential breeding habitat	Cat containment policy is implemented in all new suburbs that coincide with Scarlet Robin habitat.
	2c. In areas of known Scarlet Robin habitat, replace woody (berry-bearing) invasive plants with locally indigenous species (e.g. *Acacia dealbata*, *Bursaria* sp., and *Allocasuarina verticillata*)	Area of exotic trees or shrubs cleared and replaced with locally indigenous species has increased.

OBJECTIVE	ACTION	INDICATOR
IMPROVE		
3. Undertake and support survey, monitoring and research.	3a. Undertake and/or support monitoring initiatives that track changes in population abundance and distribution.	Data on population abundance and distribution are collected and mapped
.	3b. Undertake and/or support research initiatives to fill gaps in knowledge of Scarlet Robin, including: → responses to climate change (e.g. timing of breeding and arrival/departure) → vulnerability to predators → critical habitat parameters (i.e. canopy cover, shrub cover, ground cover, logs, fallen branches and litter) → seasonal migration/movements and habitat corridors.	At least one research project is initiated within the first five years of the action plan's commencement.
COLLABORATE		
4. Co-operate with state and local government agencies.	4a. Support cross-jurisdictional conservation research and monitoring activities.	At least one cross-jurisdictional research or monitoring initiative is undertaken.
5. Increase community awareness of, and engagement in, managing Scarlet Robin as a vulnerable species.	5a. Collaborate with community groups and citizen science groups to promote incidental and systematic data collection of Scarlet Robin sightings.	Community group activities are actively supported and records are collected.
	5b. Undertake community engagement and awareness raising activities to disseminate research and monitoring findings to inform the conservation of Scarlet Robin.	Engagement activities are undertaken.
	5c. Encourage landowners to manage areas to improve habitat for Scarlet Robin (e.g. rotational grazing, promote shrub and tree regeneration).	Increased awareness and participation by rural landholders to improve habitat that is suitable for Scarlet Robin.

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 the occurrence of Scarlet Robin 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 the Scarlet Robin. 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.

ACKNOWLEDGMENTS

This action plan was prepared by the Conservator of Flora and Fauna situated in the Environment and Planning Directorate, ACT Government. Use of the bird database held by the Canberra Ornithologists Group is gratefully acknowledged.

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.

APPENDIX 1(A)

HABITAT AND ECOLOGY

Scarlet Robins live 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).

Scarlet Robins 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 they join mixed flocks of other small insectivorous birds that forage through dry forests and woodlands.

Scarlet Robins breed 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.

Scarlet Robins form 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).

Scarlet Robins 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 the species has been estimated at five years based on the congeneric Flame Robin (Garnett and Crowley 2000).

CRITICAL HABITAT

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

APPENDIX 1(B)

THREATS

HABITAT LOSS AND DEGRADATION

The main threat to the Scarlet Robin 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, the species 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, the occurrence (presence/absence) of Scarlet Robins 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).

Habitat for Scarlet Robins 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 Scarlet Robins 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 the breeding productivity of the Scarlet Robin and Yellow Robin (*Eopsaltria australis*) 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 the Scarlet Robin in NSW (NSW Office of Environment and Heritage 2016a).

CLIMATE CHANGE

An assessment of the likely response of the Scarlet Robin 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 Scarlet Robin 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' (*Manorina melanocephala*) as a Key Threatening Process under legislation (Department of Environment 2014). In making the declaration, the NSW Scientific Committee recognised Scarlet Robins as one species 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 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

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SMALL PURPLE PEA

SWAINSONA RECTA
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) and *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). 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 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.
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).

OBJECTIVE	ACTION	INDICATOR
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).	5a. 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.	6a. 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.	7a. Undertake or facilitate stakeholder and community engagement and awareness activities.	Engagement and awareness activities undertaken and reported.

ACKNOWLEDGMENTS

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SUPERB PARROT

POLYTELIS SWAINSONII
ACTION PLAN

Male Superb Parrot at tree hollow (L Rayner)

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) and 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.).

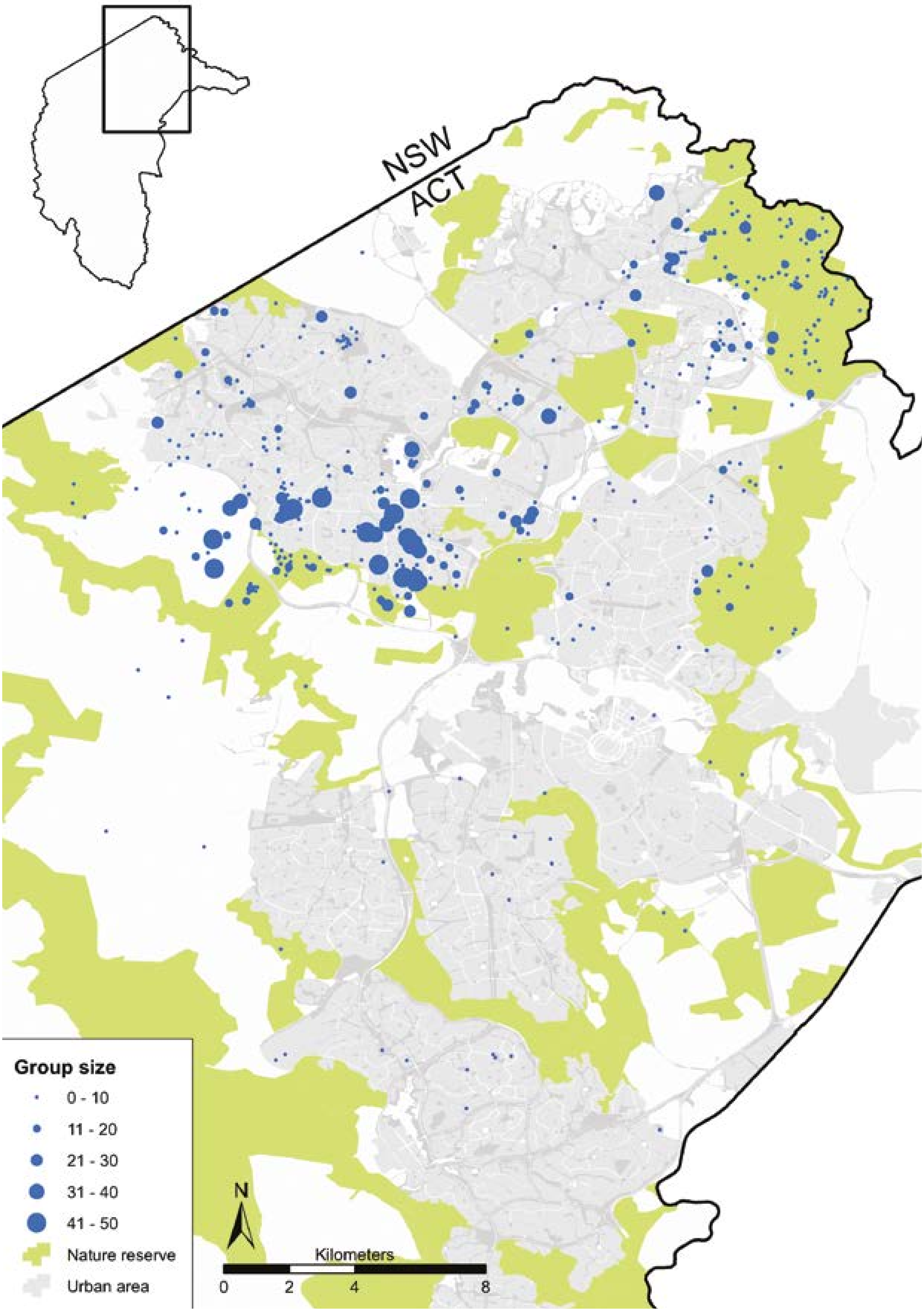
High variability in observed Superb Parrot abundance, due primarily to movement, impedes reliable estimates of population size and growth (Manning et al. 2007). Best available recent estimates of Superb Parrot population change, based on survey data, suggest ongoing decline of the wild population across 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 (TSSC 2006).

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). The prevalence of drone use in urban areas is increasing; the impact of this on Superb Parrot flight space is unknown.

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 a focus on (1) open woodland located in the Molonglo Valley and Stromlo Districts, and (2) the distribution and abundance of mature native trees. Once identified, future habitats may require proactive management to maintain and improve habitat values for the Superb Parrot.
- **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.
	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.

OBJECTIVE	ACTION	INDICATOR
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.
	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.

OBJECTIVE	ACTION	INDICATOR
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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COMMUNICATIONS

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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.

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TARENGO LEEK ORCHID

PRASOPHYLLUM PETILUM
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* and 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 thenumber of nights at or below -4°C, 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, some consideration is given to avoiding known Tarengo Leek Orchid habitat when planning the establishment of new graves.

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.
	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.

OBJECTIVE	ACTION	INDICATOR
	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).	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.
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 and Hall Cemetery Management Plan.
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.

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