ACT Government

CONSERVATION RESEARCH PROGRAM REPORT 2015–17

Technical Report
September 2017

ISBN 978-1-921117-55-8
Published by the Environment, Planning and Sustainable Development Directorate, ACT Government
Website: www.environment.act.gov.au

Acknowledgements
All of the work undertaken by the Conservation Research unit is supported by funding, executive and management support, collaboration, volunteers, other State and Territory Governments or on-ground help from parties within and external to Government. We would like to thank them all and look forward to working collaboratively in the future.

This publication should be cited as:
ACT Government 2017. Conservation Research programs report 2015–2017. Environment, Planning and Sustainable Development Directorate, ACT Government, Canberra.

Accessibility
The ACT Government is committed to making its information, services, events and venues as accessible as possible. If you have difficulty reading a standard printed document and would like to receive this publication in an alternative format, such as large print, please phone Access Canberra on 13 22 81 or email the Environment, Planning and Sustainable Development Directorate at epd_communications@act.gov.au. If English is not your first language and you require a translating and interpreting service, please phone 13 14 50.

If you are deaf, or have a speech or hearing impairment, and need the teletypewriter service, please phone 13 36 77 and ask for Access Canberra on 13 22 81. For speak and listen users, please phone 1300 555 727 and ask for Access Canberra on 13 22 81. For more information on these services visit the National Relay Service website.

Front cover: Superb Parrot (J. Bundock), Corroboree frog eggs with tadpoles inside (M. Evans), Eastern Quoll (D. Fletcher), Bush Pea *Pultanea procumbens* (J. Smits).

Technical Report

Conservation Research Programs Report 2015-17

Conservation Research
Environment Division
Environment Planning and Sustainable Development Directorate
ACT Government

September 2017

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

This report provides an overview of the nature conservation programs of the Conservation Research unit in the Environment Division of the Environment, Planning and Sustainable Development Directorate (EPSDD) of the ACT Government. The report is for the period of July 2015 to June 2017.

The Conservation Research unit provides science and research evidence to inform ACT Government's environmental conservation, policy, planning and land management decisions. This includes legislative requirements under the *Nature Conservation Act 2014*. This report provides a summary of projects undertaken by the unit and in collaboration with project partners. It informs a number of the research and monitoring projects that are included in the Conservator of Flora and Fauna's Biodiversity Research and Monitoring Program.

The Conservation Research unit spans the elements of: flora, fauna, aquatic ecology and conservation planning. The units program delivers on:

- **Threatened species and communities** – research, survey, monitoring and management of rare and threatened terrestrial and aquatic species and communities to effectively manage current populations, threats, implement action plans and assist recovery.
- **Threatening processes** – improving knowledge, research, survey, monitoring and management of potential or current threatening processes. Assist with ensuring management programs are evidence-based and reduce threats to biodiversity and nature conservation.
- **Survey and baseline information** – maintain up-to-date information on the ACT's biological resources and habitat and make data accessible to stakeholders through ACTMAPi and other on-line platforms.
- **Ecological restoration** – implement and provide research support for on-ground recovery and rehabilitation actions; develop information on connectivity and environmental corridors and support on-going restoration projects.
- **Recreational angling** – provision of recreational angling opportunities and monitoring in the urban lakes of Canberra.
- **Conservation advice for policy, land management and planning** – provide information for planning, policy and management programs for the protection of the ACT's terrestrial and aquatic ecosystems and ensuring it is based on sound scientific information, research, regulation and licensing advice.
- **Conservation planning** – provide scientific advice on planning and development proposals to the Conservator of Flora and Fauna and other government agencies.

None of the work of the unit could be achieved without the interest, investment, enthusiasm and support of our stakeholders and collaborators who assist in many ways, from funding to input and volunteering.

This report provides a comprehensive summary of the projects undertaken and demonstrates the application of evidence to support land management, planning and ecosystem restoration. By providing this overview of the focus and results of the work undertaken, we hope to ensure this knowledge continues to grow and information about our work is shared. Enjoy!

2. THREATENED SPECIES AND COMMUNITIES

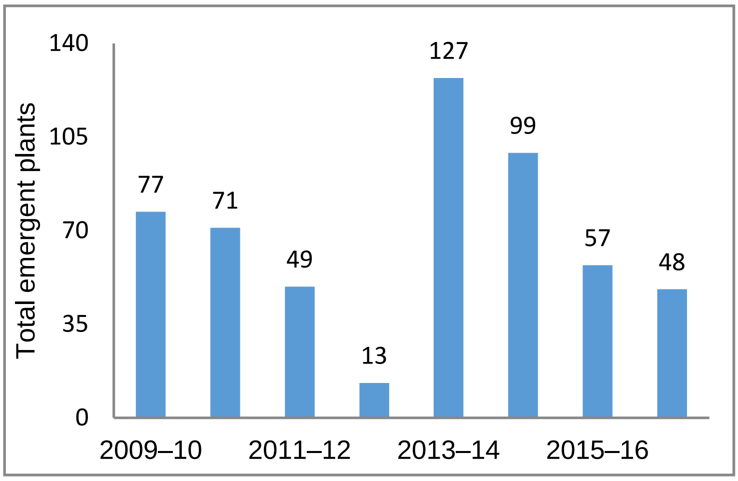
2.1 Brindabella Midge Orchid - monitoring

The Brindabella Midge Orchid (*Corunastylis ectopa*) was first discovered in 1992 and occurs at only one location in Australia. The species is listed as endangered under the *ACT Nature Conservation Act 2014* and critically endangered under the *Commonwealth Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). Continuous monitoring of population dynamics of the Brindabella Midge Orchid (Figure 2.1) has been undertaken by Conservation Research since 2009, in which time the number of emergent plants per year has fluctuated significantly. Following a peak of 127 individual plants recorded in 2013—14, lower numbers have been recorded in subsequent years (Figure 2.2), with the minimum number of Brindabella Midge Orchids known to have emerged in 2016 and 2017 was 57 and 48, respectively (Figure 2.2). Staff from the Australian National Botanic Gardens have continued to collect seed for *ex-situ* conservation purposes, collecting a total of seven stems in 2017, each with a large number of viable seeds. Greater numbers of emergent shoots were observed on each survey visit, indicating that the data collected may not capture the total annual number of emergent individuals or the full phenological cycle.

The resolution of data capture provides some insight into microhabitat preference within the species' localised distribution on a highly disturbed site (an access road cutting). The majority of individuals (between 70% and 84%) were recorded on the upper lip of the cutting face. This environment is free from woodland leaf litter and is more stable than the bare, eroding soils on the steep face of the cutting. No individuals have been observed in the table drain below, despite the previous year's experimental physical vegetation and litter removal.

Figure 2.1 Brindabella Midge Orchid.

Figure 2.2 The minimum number of Brindabella Midge Orchid plants known to have emerged, 2009-2017.



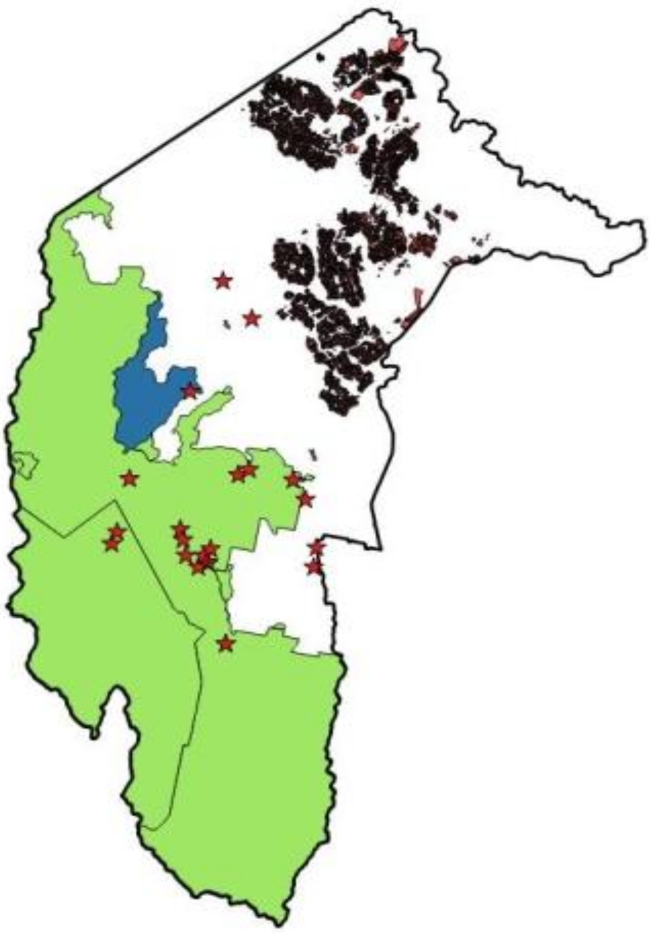
2.2 Brush-tailed Rock-wallaby - management

The Brush-tailed Rock-wallaby (*Petrogale penicillata*) is listed as endangered in the ACT however, to date, conservation efforts relating to this species have focused on *ex situ* reintroduction projects in Victoria. The mainstay of this work has been a highly successful breeding program conducted at Tidbinbilla Nature Reserve in the ACT.

The ACT Government has participated in the recovery of the Brush-tailed Rock-wallaby since the 1980s. Notably, the late Peter Ormay (former Conservation Research ecologist) led survey and research studies into the former range of the species in the ACT and collected evidence of its decline. The ACT has also played leading roles in both National and State recovery teams from the mid-1990s, with Tidbinbilla Nature Reserve closely involved in the development of reproductive techniques and the production of more than 100 animals for the Victorian and NSW recovery programs. Over the past four years, the Southern Brush-tailed Rock-wallaby Recovery Team has been developing a revised Action Statement (as found in the *Victorian Flora and Fauna Guarantee Act 1988*) that focuses on establishing a captive insurance population of around 200 individuals at two large and geographically distinct holding enclosures. The first of these facilities has been established on private land near Werribee, west of Melbourne, at Mount Rothwell.

The Victorian Government has offered funds to construct a similar facility at the Tidbinbilla Nature Reserve to facilitate the establishment of a second 'insurance' population. The proposed enclosure would also be available for housing other compatible species. Rock wallabies bred in the proposed facility could also be available for local conservation efforts. The establishment of this enclosure has the potential to contribute to a possible future reintroduction of the species into the ACT. The agreement with the Southern Brush-tailed Rock-wallaby Recovery Team will allow for animals bred in this proposed program to be utilised for future reintroduction into the ACT. The ongoing involvement with the Recovery Team will enable expertise from that group to contribute to the development of such a reintroduction project. The ACT agencies have considerable experience with the species through prior involvement with the Southern Brush-tailed Rock-wallaby Recovery Team.

Figure 2.3 Previous recorded occurrences of Brush-tailed Rock wallabies in the ACT.



Note: Occurrences of Brush-tailed Rock Wallabies shown by red stars. Namadgi National Park shaded green and Tidbinbilla Nature Reserve shaded blue.

2.3 Button Wrinklewort - monitoring

Button Wrinklewort (*Rutidosis leptorrhynchoides*) is a slender perennial that primarily occurs between grasslands and open grassy woodlands. Monitoring is focused on identifying the condition and threats to 13 populations in the ACT. Due to the abundance of Button Wrinklewort at some sites it is not possible to measure abundance or trends in populations. A number of other populations in the ACT are not monitored by Conservation Research because they occur on land managed by the Commonwealth Government (Campbell Park offices, Majura Training Area, Harman Naval Station).

Table 2.1 shows the Button Wrinklewort populations monitored and estimated by Conservation Research in 2016 and 2017.

Table 2.1 Button Wrinklewort locations and populations, 2016 and 2017.

Population	2016 estimate	2017 estimate
Tennant Street Fyshwick	200–1000	200–1000
Woods Lane (North)	25–50	25–50
Woods Lane (Middle)	25–50	25–50
Woods Lane (South)	50–100	100–200
Baptist Church	25–50	10–25
St Marks	25–50	25–50
Kintore Street	0	0
Blue Gum Point	200–1000	200–1000
Attunga Point	25–50	5–10
Capital Hill	50–100	100–200
Crace	200–1000	200–1000
Stirling Ridge	>5000	>5000
Jerrabomberra East	50–100	Not surveyed

Populations of Button Wrinklewort appear to be stable in the ACT, though this cannot be tested statistically. The Kintore Street population has not been seen for many years and is assumed to be extinct. The Baptist Church site may have declined. The site is regularly mown by the lessee and this management may be reducing the flowering success and long-term viability of this population. The St Marks population is stable and the landowner has indicated that they will remove Blue Gums encroaching on the site. The Crace population is slowly spreading and increasing in number. Friends of Grasslands and the National Capital Authority have cooperated to reduce weeds at Stirling Ridge, Blue Gum Point and Capital Hill. Translocations of Button Wrinklewort have occurred at the Jerrabomberra East Grassland Reserve (by the ACT Parks and Conservation Service) and Barrer Hill (by ACT Offsets).

2.4 Canberra Spider Orchid - monitoring

Monitoring of the Canberra Spider Orchid (*Arachnorchis actensis*) does not include abundance data as the populations are too dispersed and have too many individuals to make counting accurate and efficient. Monitoring is focused on identifying any threats to populations rather than identifying population trends.

In September 2016 Conservation Research staff inspected the lease north of Majura Nature Reserve, the Sheoak exclosure, black stump exclosure and scattered population to the south above the catch drain (all on Majura Nature Reserve), the exclosure on Mount Ainslie Nature Reserve and plants in

cages scattered above the exclosure. Numerous plants were seen at all sites, though the leaves of many plants had been grazed down. Grazing did not appear to be inhibiting flower set.

The populations of Canberra Spider Orchid looked healthy, and the fenced exclosures are in dramatically better condition than the surrounding reserves. At Mount Ainslie the *Acacia paradoxa* that had died out in 2008 has regrown and is in good condition. The bare ground that dominated the Sheoak exclosure is now covered in litter. There is a possibility that increased litter may be detrimental to the orchids but there is no evidence of that in this season's flowering. Two plants at Mount Ainslie were in flower at the time of inspection and pollen was collected from one of them for use in the National Herbarium's *ex situ* breeding program.

Australian National University researcher Tobias Hayashi completed his Honours thesis in May of 2016 exploring the ecological and evolutionary implications of pollination by sexual deception in *Caladenia* spp. in eastern Australia. Tobias found that the Canberra Spider Orchid is pollinated by a single species of Thynnine Wasp, possibly of an undescribed genus. He also speculated that the pollinators are important for the ongoing persistence of Canberra Spider Orchid populations, and so any future conservation work should consider the presence of pollinators as part of the ecological requirements of the species.

In the spring of 2016 Conservation Research staff used herbarium-raised Canberra Spider Orchids to try and locate pollinators within potential translocation sites. This was unsuccessful, resulting in the postponement of the planned translocation of plants held at the National Herbarium. More searches for pollinators are planned for the spring of 2017.

PHOTO: Canberra Spider Orchid 2014 (Taken by: Emma Cook)

2.5 Eastern Quoll - reintroduction

After becoming extinct on mainland Australia over 50 years ago, the Eastern Quoll (*Dasyurus viverrinus*) has been reintroduced to the Mulligans Flat Woodland Sanctuary as part of a joint project between the Australian National University and ACT Government, along with the Tasmanian Government, the Woodlands and Wetlands Trust, the Mount Rothwell Biodiversity Interpretation Centre and James Cook University. This project aims to explore how to rebuild woodland faunal communities and to see what effects these reintroductions have on recipient ecosystems.

The Eastern Quoll persists in the wild only in Tasmania, but the population is in severe decline being experienced and it has recently been listed as an endangered species nationally. Being a native predator, the reintroduction of the Eastern Quoll is likely to have significant ecological benefits, such as helping to regulate prey species.

In March 2016, 16 Eastern Quolls were released into the Mulligans Flat Woodland Sanctuary. Eight of these were obtained from the wild in Tasmania and eight from captivity at Mount Rothwell Biodiversity Interpretation Centre in Victoria. Following the reintroduction all females successfully bred, producing up to six young each.

Additional Eastern Quolls have been released into the Mulligans Flat Woodland Sanctuary in 2017. Further releases are proposed for 2018 and 2019 to establish a genetically and behaviourally diverse population and to continue the research on reintroduction methods that will maximise success.

Figure 2.4 An Eastern Quoll housed at the Australian National University prior to release into Mulligans Flat Woodland Sanctuary.

2.6 Ginninderra Peppercress - monitoring

Ginninderra Peppercress (*Lepidium ginninderense*) is known in only two locations, Belconnen Naval Station and urban open space in North Mitchell. The Belconnen population is on land owned by the Defence department which coordinates monitoring at this site. Conservation Research does not have access to recent counts at the Naval Station. The North Mitchell population was discovered in 2012.

Three counts have occurred at North Mitchell: 2012 (30 plants), 2014 (103 plants) and 2015 (330 plants). New sub-populations have been found each year so it is not possible to determine if the population is increasing. No counts were made in 2016 due to resource limitations. Inspections in summer and autumn of 2017 indicate that the population may be in decline. No plants remain at the initial discovery site of (originally 50 plants) and in some of the scalds where large sub-populations were found in 2015 only scattered individuals remain.

The North Mitchell site has changed very little in the five years since the species was first identified in that location. Limited cattle grazing was permitted in winter of 2016 and inspections of the site during grazing did not raise any concerns about grazing impacts on Ginninderra Peppercress. The sub-populations were not grazed and suffered very little physical disturbance. There is almost no knowledge of the ecology of Ginninderra Peppercress and it may be that population fluctuations occur naturally as mature plants die-off (they are short lived perennials) and most of the population persists as seed in the soil until favourable germination conditions return. The Australian National Botanic Gardens retain a large store of Ginninderra Peppercress seed suitable for future translocation experiments.

2.7 Golden Sun Moth - translocation

A survey in 2013 found Golden Sun Moth (*Synemon plana*) to be widespread across the future suburb of Taylor with a concentration of between 50–100 moths observed along a creek line in the east of Taylor. In 2016, endangered Golden Sun Moth larvae were transferred from the future suburb to an area in the new Kinleyside reserve located 2 km to the west of Taylor. The translocation was undertaken as part of the biodiversity offset requirements of the Gungahlin Strategic Assessment. The release site in Kinleyside reserve had been surveyed previously during three different years with repeated surveys each year, with no Golden Sun Moths detected. However, the site appeared to have suitable habitat characteristics for the species.

In winter 2016, two different translocation methods were trialed.

- Five excavated sods (4 m x 2 m x 30 cm deep) containing Golden Sun Moth caterpillars were moved by backhoe and flat-back truck from Taylor and placed in dugout receiving plots at Kinleyside (soil translocation).
- A total of 40 caterpillars harvested from ripped soil within Taylor were placed into each of three plots (120 caterpillars in total). The larvae were placed in 3–5 cm deep x 1 cm wide holes spiked into the base of food grasses.

Four control plots, subject to no disturbance, were also surveyed within the release site.

In spring 2016 all plots were searched for Golden Sun Moth pupae (which are visible on the soil surface) and a general survey for flying moths was conducted. A similar level of moth emergence was detected from both soil translocation and direct translocation plots.

- Twelve pupae cases were detected in the soil translocation plots.
- Eleven pupae cases were detected in the direct larvae translocation plots, representing 9.2% of larvae transferred.
- No pupae cases were detected in the control plots, supporting the assumption that moths were originally absent from the release site.
- Six male moths were observed flying over the release area, and an additional three males and three females were incidentally recorded in the plots during the pupae searches.

The direct transfer of caterpillars and larvae was logistically easier and cheaper than the soil translocation. For the first time recorded, moths at Taylor were found within the root systems of small to medium sized plants of the South African serrated tussock. Twenty larvae have been deep frozen for potential DNA analysis, but there is little doubt that serrated tussock is a food plant. The release site will continue to be monitored for at least another two years.

2.8 Grassland Earless Dragon - monitoring

Grassland Earless Dragons (*Tympanocryptis pinguicolla*) are small cryptic lizards that occur in the few remaining remnant patches of native grasslands in Canberra–Queanbeyan–Monaro region. This endangered lizard was once broadly distributed across south-eastern Australia but populations have declined following loss or modification of Natural Temperate Grassland habitat. In the ACT the species occurs as two separate populations – one in the Majura Valley and one in the Jerrabomberra Valley.

In the ACT Grassland Earless Dragons are monitored at selected sites to determine trends in abundance. This information is used to guide conservation programs and inform urban development planning. Grassland Earless Dragons have been monitored annually at two long-term sites; the Majura Training Area and the Jerrabomberra West Grasslands Reserve. Since 2009 the species has been monitored in the Jerrabomberra East Grasslands conservation area, and more recently (i.e. since 2013) monitoring has been undertaken on the property 'Cookanalla' in the Jerrabomberra Valley. The species has also been intermittently surveyed at a number of other sites in the ACT where it is known to occur.

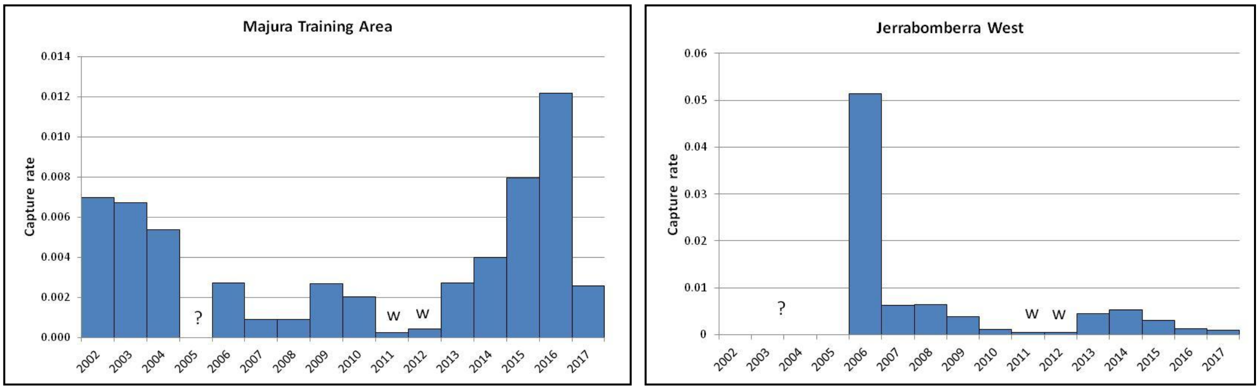
Monitoring involves the use of artificial burrows developed by Conservation Research that mimic the small burrows in soil used by Grassland Earless Dragons. These artificial burrows are now the standard survey technique for the species in the ACT and other jurisdictions. The artificial burrows enable the lizards to be detected in the field and the population size to be estimated. At each site around 200 artificial burrows are checked three times a week for six weeks. The monitoring program for 2015-17 followed a similar program as for previous years, with monitoring usually undertaken by two to six persons during February and March.

Population monitoring of Grassland Earless Dragons at the Majura Training Area (Commonwealth Defence lands) began in 2002 and at Jerrabomberra West in 2006. This monitoring showed a decline in the numbers of Grassland Earless Dragons during the 2002–09 drought, raising concerns about the survival of the species in the wild (Figure 2.5). During this period a captive colony of Grassland Earless Dragons was established at the University of Canberra from eggs collected in the field to investigate aspects of the ecology of the species, develop husbandry techniques in the event that wild populations continue to decline.

Recovery of the species at the monitoring sites following the drought has been slow, and anecdotal evidence suggests a similar pattern of slow recovery at other sites in the Canberra–Queanbeyan region. At the Majura Training Area, the first signs of population recovery following the drought were in about 2009–10, and the population continues to recover. In contrast, populations of Grassland Earless Dragons at Jerrabomberra West Grasslands Reserve do not appear to have recovered from the drought, although this lack of recovery is likely to be due to excessive herbage mass growth and possibly lack of burrows made by arthropods (which may also be a result of excessive vegetation herbage mass). The low capture rates at both sites during 2011 and 2012 have been attributed to exceptionally wet summer/autumn conditions, which resulted in a high proportion of the artificial tubes flooding and therefore not being used by the lizards. Thus, it is likely that numbers of the lizards during 2011 and 2012 were greater at each site than indicated by the capture results. The capture rate at the Majura site is low for 2017, suggesting population size at the site may have declined from the relatively high level of 2016. The monitoring program has highlighted the sensitivity of this species to major environmental disturbances such as drought and loss of grass cover due to overgrazing.

PHOTO: Grassland Earless Dragon (Will Osborne)

Figure 2.5 Capture rates of Grassland Earless dragons at the Majura Training Area and Jerrabomberra West grassland reserve, 2002–2017.



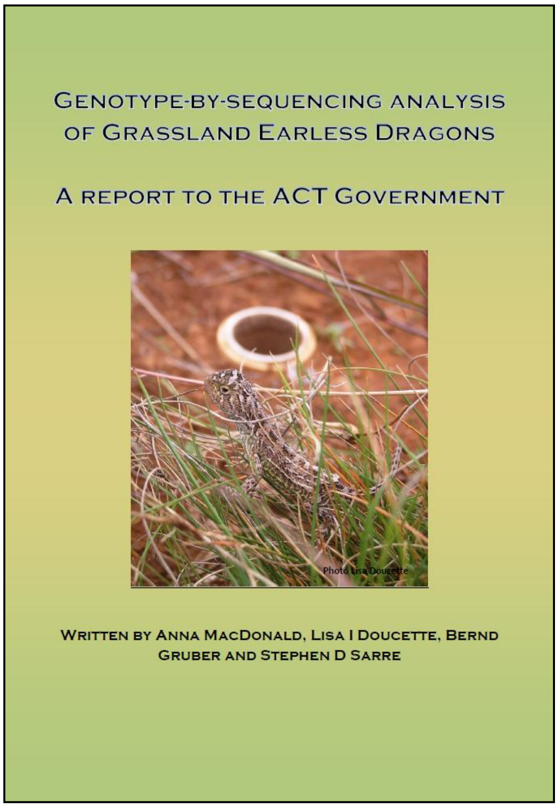
Note: ? = no data available, w = exceptionally wet year.

2.9 Grassland Earless Dragon - habitat management

Conservation Research, in conjunction with the Parks and Conservation Service and the Natural Environment Section (both within the Environment Division) and the University of Canberra, has been investigating methods to improve the condition of native grasslands (including habitat quality for Grassland Earless Dragons) at Jerrabomberra West Reserve and Jerrabomberra East grasslands. This has involved investigating methods to manage grass herbage using grazing (native and introduced herbivores) and fire, which aim to improve the variation (heterogeneity) in the structure (cover and height) of the grass sward. Rather than a uniformly high dense sward, a heterogeneous sward has grass of different heights and contains grass tussocks and inter-tussock spaces which allow a diverse range of other native plants to grow. These heterogeneous conditions suit Grassland Earless Dragons and other animals that live in grasslands. Conservation Research and partners are monitoring the effects of these management practices on the structure and composition of the grassland, and have continued to monitor the abundance of Grassland Earless Dragons. More recently, the abundance of natural arthropod burrows has been monitored at Jerrabomberra West Reserve and at the Majura Training Area. Grassland Earless Dragons are dependent on these burrows for shelter during the cold winter months, and the number and availability of these burrows could affect the abundance of the dragons.

2.10 Grassland Earless Dragon - genetic study

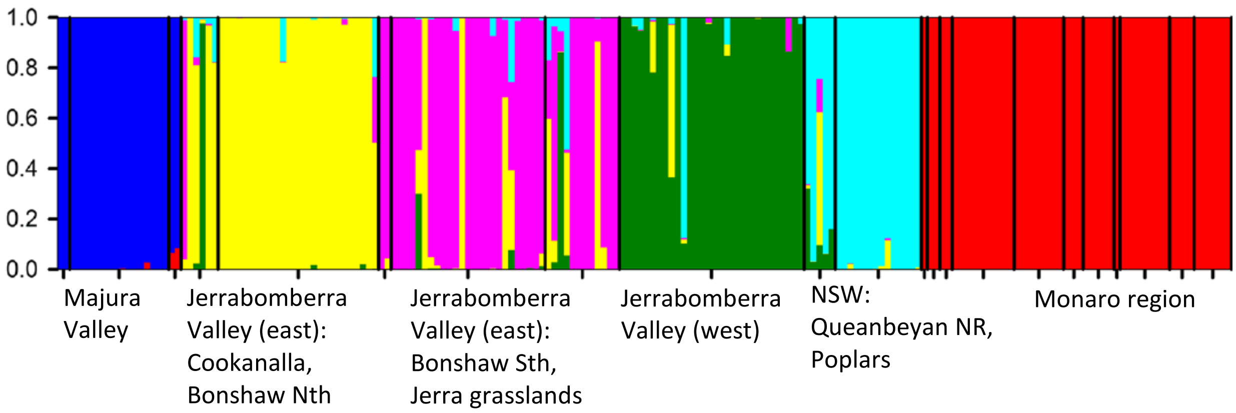
Genetic studies of Grassland Earless Dragons have shown distinct genetic differences between individuals in the Canberra–Queanbeyan area and those of the Cooma area, suggesting these areas comprise different 'evolutionarily significant units' and might even be separate species (Figure 2.6). Fine-scale genetic analyses have also shown differences between the Majura and Jerrabomberra populations, and even between populations in the east and west of the Jerrabomberra Valley that have been separated by the Monaro Highway and Jerrabomberra Creek (Figure 2.6).



Populations of animals and plants that have been reduced to small population size are at risk of losing genetic diversity. Fine-scale genetics analyses undertaken by the University of Canberra, in conjunction with Conservation Research, have confirmed that Grassland Earless Dragon populations (particularly Cookanalla population) have relatively low genetic diversity as a result of the decline in numbers during the 2002–09 drought. In 2017 Conservation Research provided further funding to the University of Canberra, together with genetic samples, to continue research into the population dynamics and genetic diversity of Grasslands Earless Dragons.

Figure 2.6 Genetic analyses of populations of Grassland Earless Dragons.

Note: Each colour represents individuals that are genetically similar (adapted from Carlson *et al*. 2016. How many conservation units are there for the endangered grassland earless dragons? *Conservation Genetics* 17).



2.11 Little Eagle - research and monitoring

In recent decades, the Little Eagle (*Hieraaetus morphnoides*) has undergone a population decline in Australia and has been declared vulnerable in both the ACT and NSW. The main threat to Little Eagles in the ACT is loss of habitat due to the encroachment of urban development on foraging territories. Other threats proposed as contributing factors to this decline include disturbance from nearby human activity, competition from Wedge-tailed Eagles and possible poising by pesticides such as Pindone (used in rabbit control).

To inform planning and conservation and to identify and protect areas deemed critical to Little Eagles, Conservation Research, CSIRO, Ginninderry and university researchers are working together to gain a better understanding of Little Eagle distribution, foraging behaviour, habitat use and territories in the ACT and nearby NSW.

The breeding range of Little Eagles in the ACT is restricted to the lower parts of the northern ACT such as the Murrumbidgee and the Molonglo river corridors. In 2017, four breeding pairs of Little Eagle were found in the ACT and two in nearby NSW. From those pairs, there were two observed successful breeding events in the ACT and one in nearby NSW, where a fledgling left the nest. Little Eagles are secretive and it is possible that additional breeding pairs and successful breeding events were not recorded.

In spring 2015, a light-weight satellite GPS tracking device was fitted to the male of a pair of Little Eagles nesting in West Belconnen. Researchers from the University of Canberra analysed and reported on the movements of the male from October 2015 to January 2016. This analysis revealed that the male hunted over an area of 65 km^2, mainly in open woodland and grassland habitat. On average, the male travelled just under 10 km per day, but often flew high over urban expanses in order to forage in areas separated by up to 20 km.

For unknown reasons, no data were received from the satellite GPS system between January and August 2016. When the data flow resumed on 19 August 2016, it revealed that the male Little Eagle was in Wagga Wagga. Over the next few days the male Little Eagle returned to West Belconnen. In retrospect it seems that the eagle may have been returning from further afield. In March 2017 the eagle departed Canberra and flew directly to Daly Waters in the Northern Territory, travelling some 3,300 km in a little over two weeks (Figure 1). This surprising result highlighted the importance of understanding Little Eagles' movement patterns, as this ranging behaviour has important implications for future planning and conservation decisions. After the 18-month expected life of the tracking device, the flow of data slowed to zero in June 2017, with the eagle still alive at Daly Waters. Researchers hope to recognise this eagle on his expected return to Canberra in spring 2017.

In future this project aims to:

- analyse the remaining GPS data from the male Little Eagle
- place satellite GPS-tracking devices on multiple Little Eagles (including females and juveniles)
- install nest cameras at known and likely nest sites in order to gather information on breeding behaviour, nesting success and diet
- identify and monitor (with the help of the community) all occupied Little Eagle nest localities in the ACT and nearby NSW during the breeding season.

Findings from this project will help to identify core Little Eagle habitat in the ACT and NSW, determine the key features important for Little Eagle nesting, and provide information on the wider movement patterns of Little Eagles. This evidence-based data will be vital to inform planning and conservation of areas deemed critical to maintaining a viable wild population of Little Eagles in the ACT and adjacent NSW.

Figure 2.7 Little Eagle ranging behaviour.

Note: On 9 March 2017, the GPS-tracked male Little Eagle left Canberra for Daly Waters, travelling approximately 3,300 km in just over two weeks. The yellow points show individual GPS fixes.

2.12 Macquarie Perch – snorkelling survey

Macquarie Perch (*Macquaria australasica*) in the Cotter River have only spawned in one of the last five years. In spring 2016, as part of an agreed management response, Icon Water maintained the Enlarged Cotter Dam at full supply level and released extra water from Bendora and Corin Dam to help Macquarie Perch in the Enlarged Cotter Dam to access the Cotter River upstream to spawn. To determine if Macquarie Perch had spawned successfully, Conservation Research ecologists conducted a snorkelling survey to look for larval fish in December 2016 in the Cotter River. Sites surveyed included Pipeline Crossing (9.5km upstream of Cotter Reservoir), Spur Hole (4.5 km upstream), Vanities Crossing (1.8 km upstream) and twice at the confluence of Condor Creek (200 m upstream).

Large numbers of Macquarie Perch larvae were counted at Vanities Crossing and Condor Creek confluence (138 and 172 larvae respectively). Smaller numbers were recorded at Spur Hole and none were recorded at Pipeline Crossing. Numbers at Vanities Crossing and Condor Creek confluence are the largest recorded since sampling began and the first at Condor Creek confluence since the construction of the Enlarged Cotter Dam. Three size classes of Macquarie Perch were observed and collected at these sites – 8 mm, 11–14 mm and 18+ mm – which may indicate that there have been multiple breeding events.

Figure 2.8 Snorkelling in the Cotter River to look for Macquarie Perch larvae.

2.13 Macquarie Perch – genetic rescue

Recent genetic analysis of Macquarie Perch populations has confirmed that the population in the Cotter River in the ACT is genetically impoverished to the point that its long-term survival and evolutionary adaptability to environmental change (such as climate change) would likely be compromised. The ACT Government partnered with University of Canberra and Monash University and a number of other organisations in a four-year Australian Research Council-funded project on genetic rescue of a number of threatened species including Macquarie Perch. The preliminary analysis also identified that a population of Macquarie Perch, which had been translocated to Cataract Dam near Wollongong NSW in the early 1900s, were genetically healthy and of the same

Murrumbidgee genetic strain as the Cotter River population. This population is considered appropriate to potentially improve the genetics of the Cotter River population.

Thirty two Macquarie Perch were collected from Cataract Dam in early May 2017 and held for quarantine disease screening and health checks to minimise the risk to the local population and environment. These fish were released into the Cotter River in mid-June 2017. Monitoring and genetic analysis will be undertaken on juveniles over the next four years to determine the success of the genetic rescue.

Figure 2.9 Macquarie Perch from Cataract Dam being released into the Cotter River.

2.14 Murrumbidgee Bossiaea - monitoring

In 2012 Murrumbidgee Bossiaea (*Bossiaea grayi*) was declared a threatened plant species in the ACT under the *ACT Nature Conservation Act 1980*. A baseline survey by Conservation Research in 2013 established information on population size, critical habitat parameters and perceived threatening processes at 11 sites along the Murrumbidgee, Paddys and Cotter Rivers.

In spring of 2015 and 2016 these sites were revisited to confirm population numbers, population health and any perceived threats. No decline in numbers was observed at any surveyed location, and most large sub-populations remain robust. The smaller outlier sub-populations remain in low

numbers and mixed health. Threatening processes observed include dieback, damage from recreational vehicle use and competition from both native and exotic species.

Conspicuous dieback was previously observed in discrete patches of Murrumbidgee Bossiaea and other tall shrubs on the Paddy's River. In spring 2015 soil samples were collected to test for the presence of *Phytophthora cinnamomi* but the soil pathogen was not detected. A site on the Murrumbidgee River was subsequently found to be displaying similar symptoms but testing has not yet been undertaken. By spring 2016 significant recovery of the affected individuals had occurred, including shedding dead cladodes and new cladode growth, but new dieback was observed in an adjacent gully line. In addition, at these sites the parasitic climber *Cassytha pubescens* was observed attached to several individual plants but no perceivable impact on cladode health was detected. Competition from other exotic and native shrub species continues to increase at some sites.

In early 2016 staff from the ACT Parks and Conservation Service observed recruitment of one new individual at a site in the Bullen Nature Reserve previously known to support only one adult. This individual occurs adjacent to a gravel access road on which recreational vehicle users have formed a makeshift track. In response, an effective rock barrier was put in place to protect the site (Figure 2.10).

Figure 2.10 Example of bank damage remediation adjacent to a small outlier sub-population of Murrumbidgee Bossiaea in spring 2015 (Photo taken by L Johnston).

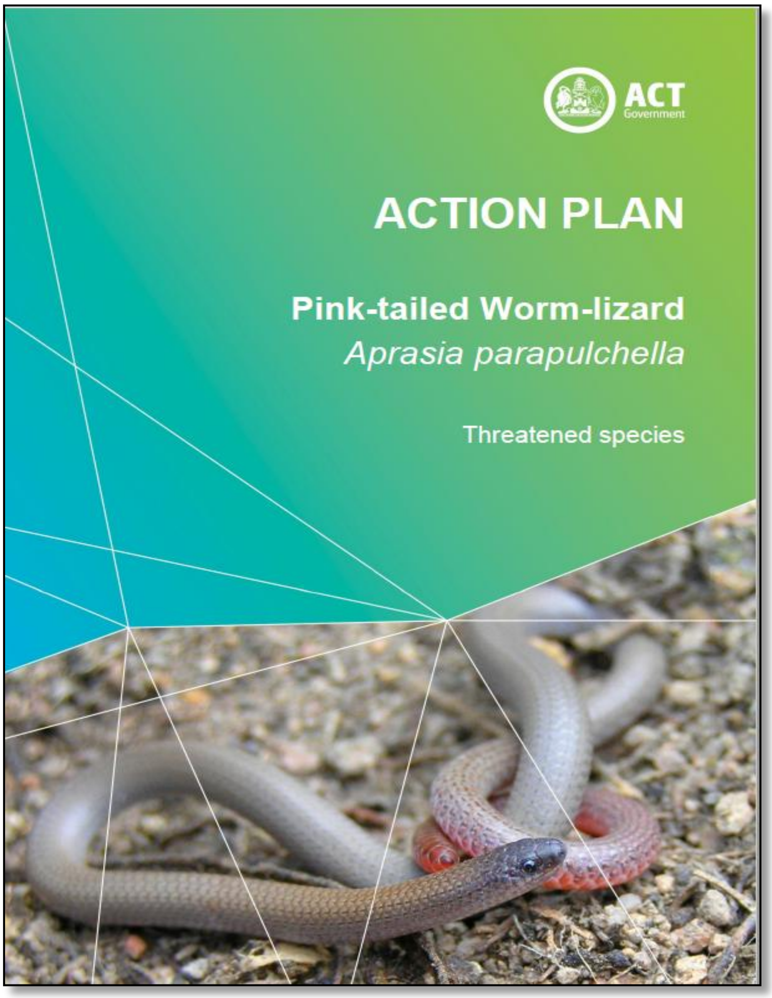
Since surveys began in 2013, Murrumbidgee Bossiaea has not been detected in historically reported locations in the Molonglo River valley. In 2016 Greening Australia (Capital Region) were successful in attracting an ACT Environment Grant to reintroduce the species in the Molonglo. Information collected by Conservation Research played a vital role in assisting the grant application and Conservation Research staff also assisted with selection of suitable sites for reintroduction. Site preparation has been undertaken and planting of tubestock is anticipated to occur later in 2017.

2.16 Pink-tailed Worm-lizard – action plan

Conservation Research prepared and released an Action Plan for the threatened Pink-tailed Worm-lizard (*Aprasia parapulchella*). As the name suggests, the Pink-tailed Worm-lizard is a small, slender legless lizard, which is sometimes mistaken for a worm or a small snake. The lizard is unusual in that it lives under rocks in the burrows of ants, where it feeds on ant larvae and eggs.

The Pink-tailed Worm-lizard occurs in rocky native grassland or rocky grassy woodland, which in the ACT is found mostly along the Molonglo and Murrumbidgee River corridors and on hills such as Mount Taylor, Cooleman Ridge and Urambi Hills. The species was once extensively distributed in south-eastern Australia but due to loss and modification of its habitat the lizard is now found in only a few widely scattered locations, of which the ACT is a stronghold.

The objective of the Action Plan is to 'maintain in the long-term viable, wild populations of the Pink-tailed Worm-lizard as a component of the indigenous biological resources of the ACT and as a contribution to regional and national conservation of the species'. The Action Plan highlights the threats to the species (loss and degradation of its native grassy habitat, which includes weed invasion and rock removal) and the success of restoration works undertaken by the ACT Parks and Conservation Service along the Molonglo River Corridor.



2.15 Northern Corroboree Frog - monitoring, captive breeding and release

The accidental introduction of the Amphibian Chytrid Fungus to Australia (sometime prior to the 1970s) resulted in the decline and, in some cases, extinction of many frog species. Corroboree Frogs are striking black and yellow frogs that are highly susceptible to the fungus. Where they were once abundant in sub-alpine sphagnum bog habitat, these frogs have all but disappeared from the wild. The Brindabella Ranges in Namadgi National Park are home to the Northern Corroboree Frog (*Pseudophryne pengilleyi*), whereas the Southern Corroboree Frog was once widely distributed in the Snowy Mountains of NSW.

PHOTO: Northern Corroboree Frog (M. Evans)

Conservation Research has monitored Northern Corroboree Frog populations in the ACT since the mid-1980s. The frogs are monitored by counting the number of calling males at breeding sites (sphagnum moss bogs and other wet areas) during the annual summer breeding season (January to March) at key breeding sites in the Namadgi National Park, including Ginini Flats, Cheyenne Flats and Snowy Flats. Females do not have a breeding call, though research has shown there are similar numbers of females to males.

This monitoring revealed a major population crash in the late 1980s and early 1990s, with numbers of calling males at key sites declining from many hundreds in the 1980s to less than 50 in 2007, and declines are continuing. The closely related Southern Corroboree Frog, which occurs in the Snowy Mountains around Mount Kosciusko (monitored by NSW Office of the Environment and Heritage), has suffered a similar catastrophic decline. In 2017 monitoring continued at key historic breeding sites, with additional surveys covering most of the other sites where the species was known to occur in the ACT. The monitoring and additional surveys detected only four males remaining from the once abundant wild populations.

In response to the decline of Corroboree Frog populations, Conservation Research established a captive 'insurance' population of Northern Corroboree Frogs at Tidbinbilla Nature Reserve in 2003

from eggs collected from the wild. The objective is to maintain a captive colony of Northern Corroboree Frogs as insurance against extinction in the ACT. The captive population currently has around 1000 individuals, most of which are from successful captive breeding.

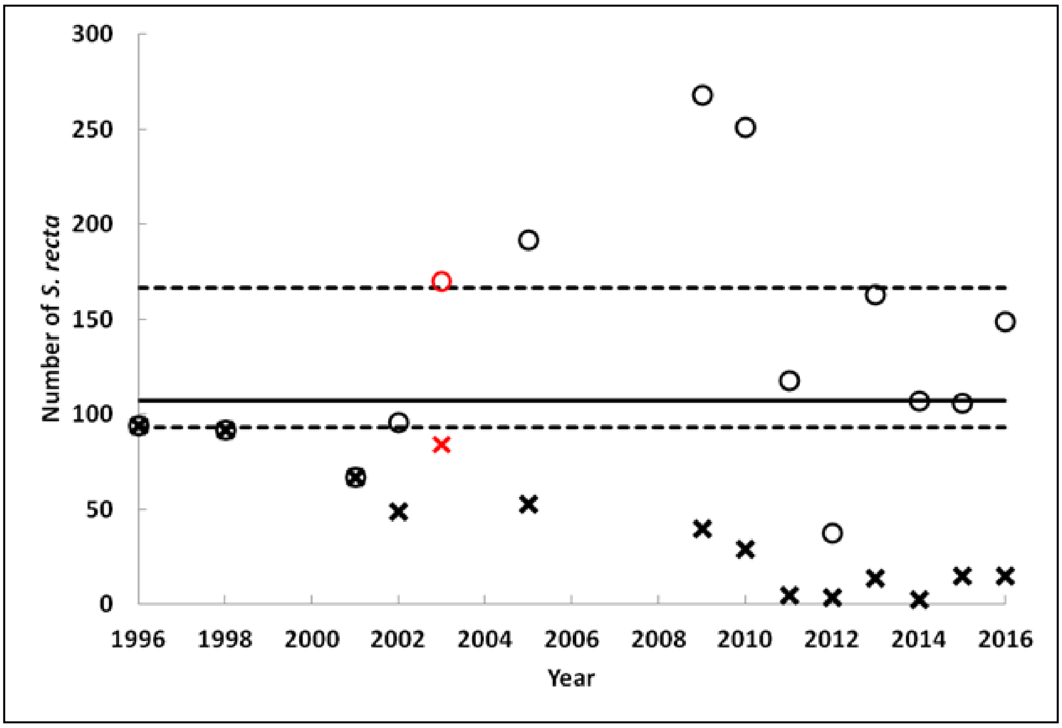
There are now too few Corroboree Frogs remaining in Namadgi National Park to breed and maintain wild populations. Juvenile Corroboree Frogs bred in captivity have been released to sphagnum moss bogs in Namadgi National Park since 2011 to determine whether such releases can bolster wild populations and promote breeding and development of natural resistance to Amphibian Chytrid Fungus. Monitoring in 2015 has shown that some of the juvenile frogs released in 2011 had reached breeding age and begun calling, and monitoring in 2017 showed that at least one pair (and possibly more) of the released frogs had successfully bred. Although the number of released frogs that survive and breed is low, the results are encouraging as they demonstrate that captive-bred frogs can survive in the wild for several years to reach breeding age, and can then breed successfully. Current work is focused on determining whether the number of frogs that survive and breed is sufficient to maintain small wild breeding populations, and exploring methods to breed and raise frogs at Tidbinbilla under more natural conditions. Future work will investigate whether releases in many small breeding sites is a more successful strategy than releases in the few historically large breeding sites.

2.17 Small Purple Pea - monitoring

Five sites within the urban areas of Canberra have been known to support populations of the Small Purple Pea (*Swainsona recta*). Annual counts of individual plants are made at all sites, with individuals in the Mount Taylor and Kambah sites also given tags. This level of monitoring allows population trends to be analysed and relationships with climate and management at the Mount Taylor population to be identified (population sizes are too small at the other locations).

In 2016, 149 individual plants were recorded at Mt Taylor over the three surveys, a 40.6% increase on the 2015 survey. This value is approaching the upper 75th percentile and indicates the population has been stable for a number of years (Figure 1). The number of new individuals (15) recorded in 2016 was the same as in 2015, but represents a proportional decrease. The relatively high number of individuals recorded in 2016 may be attributed to two interrelated events. There was particularly high rainfall in winter and early spring in 2016. Consequently, temperatures – particularly minimum temperatures – were mild, a variable shown to be influential by recent Conservation Research analysis. The proportion of plants that had been affected by grazing or had been broken in 2016 (2.7%) was substantially lower than in 2015 (17%). The site continues to be dominated by a dense shrub layer of *Cassinia* and *Bursaria* that germinated after the 2003 fire. However, it remains to be seen if this is a conservation issue for the Small Purple Pea.

Figure 2.11 Abundance of new and reoccurring Small Purple Pea at Mount Taylor.



Note: Open dots indicate the total number of plants recorded, crosses indicate the number new plants recorded, solid line indicates the median value and the dotted line indicates the 75th (top) and 25th (bottom) percentile. Red points indicate values recorded after a fire event.

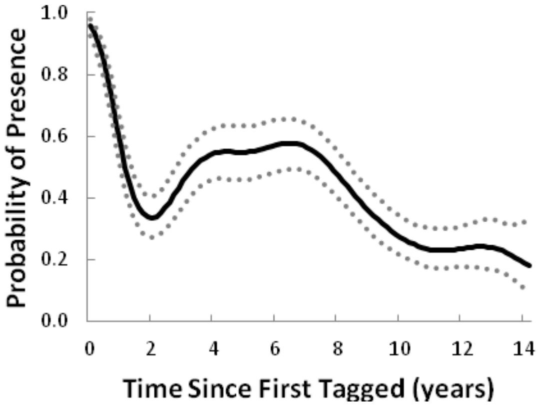
PHOTO: Small Purple Pea (L. Schwiekel)

Fire has been considered as a way of expanding the distribution of the population at Mount Taylor. Given that the site is still recovering from severe fire in 2003, any prescribed burning at this site should be considered carefully. Of particular concern is the potential stimulation of *Bursaria* and *Cassinia* regeneration.

In 2016 only two individuals (both had been recorded in previous years) were recorded at the Kambah site, the second lowest on record. This value fits into a declining trend over the past four years at this site that should be treated with concern if it continues. The Kambah site has been burnt twice since 2011 but biomass remains high, and otherwise the site is in good condition with a high native diversity. Genetic or demographic factors may be limiting recruitment at this site. Translocation of new individuals may ensure the persistence of the Small Purple Pea at the site.

At Caswell Drive three plants tagged in 2015 flowered again in 2016 and one new plant was tagged. Detailed analysis of 15 years of data has revealed some aspects of the ecology of the Small Purple Pea. Analysis of the data shows that plants can live for up to 14 years and that the probability of observing a plant after it has first been tagged declines rapidly but then increases again between four and eight years (Figure 2.12).

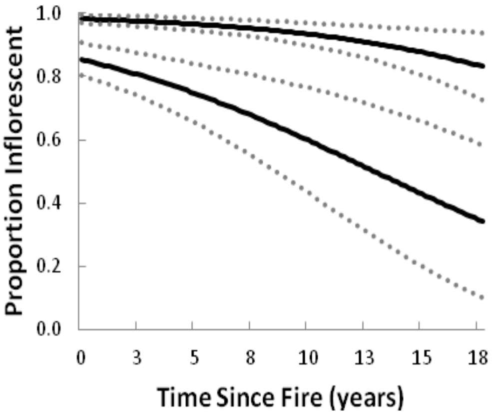
Figure 2.12 Probability of an individual Small Purple Pea's presence in response to the time since first tagged (measured in years).



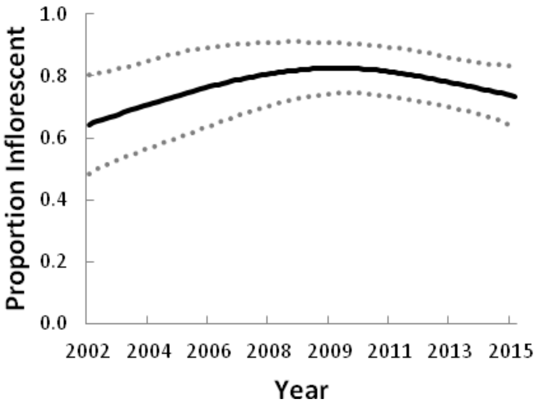
Note: The black line is the predicted mean, and the dotted lines are the 95% confidence intervals.

Analysis also revealed that the production of inflorescence declines with time since fire, but appears to have an optimal number of nights ≤–4°C in the preceding year (Figure 2.13). These findings reaffirm the general management belief that fire – at a moderate frequency – is beneficial for the Small Purple Pea. The proportion of inflorescent plants is likely to be higher with less time since fire. Given that there was no adverse effect of fire on the presence of individuals, fire appears to have a positive influence on the population of Small Purple Pea at Mount Taylor. However, the fire frequency at Mount Taylor over the survey period was relatively low. Given that the Small Purple Pea is vulnerable to persistent grazing (NSW Office of Environment and Heritage 2012), high fire frequency would be expected to have an adverse outcome. A full Technical Report on this analysis can be found here http://www.environment.act.gov.au/cpr/conservation-research/report_series

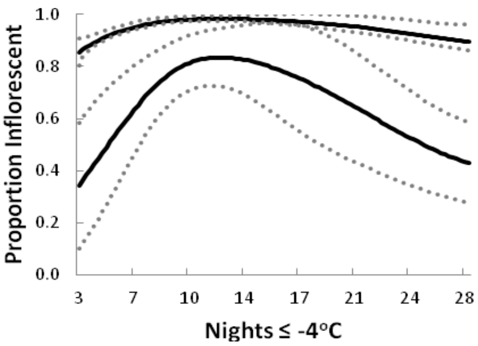
Figure 2.13 The predicted probability of an individual Small Purple Pea flowering in response to (a) time since fire (measured in years), (b) survey year and (c) the number of nights ≤ -4°C in the preceding calendar year.



(a)



(b)



(c)

Note: The black line is the predicted mean, and the dotted lines are the 95% confidence intervals. Predictions for time since fire were estimated with year at its mean (2008) and nights ≤ –4°C at their highest (8 nights, upper line) and lowest (3 nights, lower line) effect. Predictions for year were estimated with time since fire and nights ≤ –4°C held at their mean. Predictions for nights ≤ –4°C were estimated with year at its mean (2008) and time since fire at its highest (0 years, upper line) and lowest (18 years, lower line) effect.

2.18 Striped Legless Lizard - translocation

Striped Legless Lizards (*Delma impar*) were recorded in grassland reserves during spring of 2015 as part of the kangaroo grazing impacts research project undertaken by Conservation Research. The captures of Striped Legless Lizards were from reserves where the species is known to occur. Reptile surveys in reserves are continuing as part of the Grasslands Restoration Project and as a result of Biodiversity Offsets commitments.

The ACT Government partnered with Bush Heritage Australia in a translocation experiment in October 2015, in which 116 lizards were collected from two sites in Gungahlin that were proposed for urban development and translocated to the Bush Heritage property ‘Scottsdale’ (near Bredbo) in

NSW. The lizards were placed into eight plots, four of which were fenced (30 m x 30 m areas) and four were unfenced. To test habitat selection, release sites consisted of 50% Kangaroo Grass (*Themeda triandra)* and 50% African Lovegrass (*Eragrostis curvula*). Roof tiles (used as shelter sites by the lizards) were placed within the fenced grids and over a 45 m x 45 m area in unfenced grids to monitor lizard numbers.

Fifty percent of the lizards in the fenced areas, and 11% of the lizards in unfenced areas, were recaptured 70 days after their release. Twelve animals were recaptured within the fenced grids a year after release, of which two lizards were gravid (i.e. carrying eggs). No Striped Legless Lizards were recaptured in the unfenced area. The results suggest that Striped Legless Lizards move away from the release site after translocation, and further than the 10 m^2 home range recorded for the species in its natural habitat. The results also show that at least some of the translocated lizards can survive for up to a year after release. At Scottsdale Striped Legless Lizards had a preference for areas of higher grass complexity, and preferred native Kangaroo Grass over exotic African Lovegrass, though the African Lovegrass did appear to provide habitat.

In spring 2016 a further 120 Striped Legless Lizards were obtained from the Gunghalin sites and translocated into fenced and unfenced sites within Kama Nature reserve in the central Molonglo Valley. The release sites are dominated by natural grasses and a survey for recaptures will occur in spring 2017. The success or otherwise of the translocation experiments will continue to be monitored through ongoing surveys at both Scottsdale and Kama.

2.19 Superb Parrot - surveys

During the spring and summer of the 2015–16 and 2016–17 breeding seasons, the ACT Government supported research by the Australian National University's Fenner School into the breeding and foraging ecology of the nationally vulnerable Superb Parrot (*Polytelis swainsonii*).

Until 2005 the Superb Parrot was a rare visitor to the Canberra area, but numbers have been growing. From 2009–14, breeding activity was observed in 8–10 pairs in the Throsby area, but the success or otherwise of this breeding activity was unknown.

During 2015–16, 11 pairs of birds were observed nesting at Throsby and another nesting pair was observed at Spring Valley near the Molonglo river. Between them the Throsby pairs laid 57 eggs, hatched 50 and successfully raised 40 fledglings. This was an encouragingly high rate of nest success. In 2016–17, only five pairs of birds nested at Throsby and these arrived two weeks later than when birds arrived the previous season. The five pairs laid up to 21 eggs, hatched 17 and raised 13 fledglings, a 70% reduction in breeding success from the previous season.

This reduced breeding success was due to fewer parrots arriving or staying to breed, rather than nesting attempts that failed. However, in December 2016 a motion-triggered camera observed the predation of a nest of three hatchlings by a Brown Goshawk.

The study has provided previously unknown information on nest-tree selection, characteristics and dimensions of nesting hollows, breeding productivity, social and breeding behaviour, inter and intra-species competition, hollow visitation rates, foraging movements and foraging site selection.

Small transmitters attached to the feathers of adults feeding young found that, amongst other things, they shared foraging areas, spent about 50% of their time foraging in box-gum woodland, used planted and remnant eucalypts to move through the suburban landscape, and searched out planted wattles and elms within the urban environment.

Cameras pointed at the entrance of breeding hollows have captured hundreds of thousands of images of Superb Parrots, hollow competitors and potential predators. Through the Digivol site of the Australian Museum, these images will be categorised by citizen scientists and analysed to provide information on breeding ecology and competition for hollows.

Photo: Superb parrot in elm tree (John Bundock)

Despite fewer nesting birds in 2016–17, nest-site fidelity was high with four nests occurring in trees utilised the previous year and two nests in previously utilised hollows. All nests previously used by Superb Parrots for breeding were either reused by Superb Parrots or occupied by known hollow competitors in 2016–17. The late arrival of the Superb Parrot appeared to intensify hollow competition, as by the time they arrived to Throsby many of the hollows previously used were already occupied, mainly by Crimson and Eastern Rosellas. The predated nest was not used previously and was noticeably open in comparison to other hollows, suggesting that this nest failure may have been an indirect result of intensified nest-site competition.

It is unclear why fewer Superb Parrots were seen in Canberra during the most recent breeding season. High temporal variability in local abundance is characteristic of this parrot's ecology, such that low numbers in Canberra for any given year does not necessarily constitute a worrying trend. However, reports from other breeding locations in NSW in 2016 suggest a more widespread decrease in numbers. It cannot be dismissed that the decline in Superb Parrot numbers at Throsby

was driven by the earth works happening in the nearby developing suburb. Ongoing monitoring and research will continue in order to clarify the cause of the recent decline.

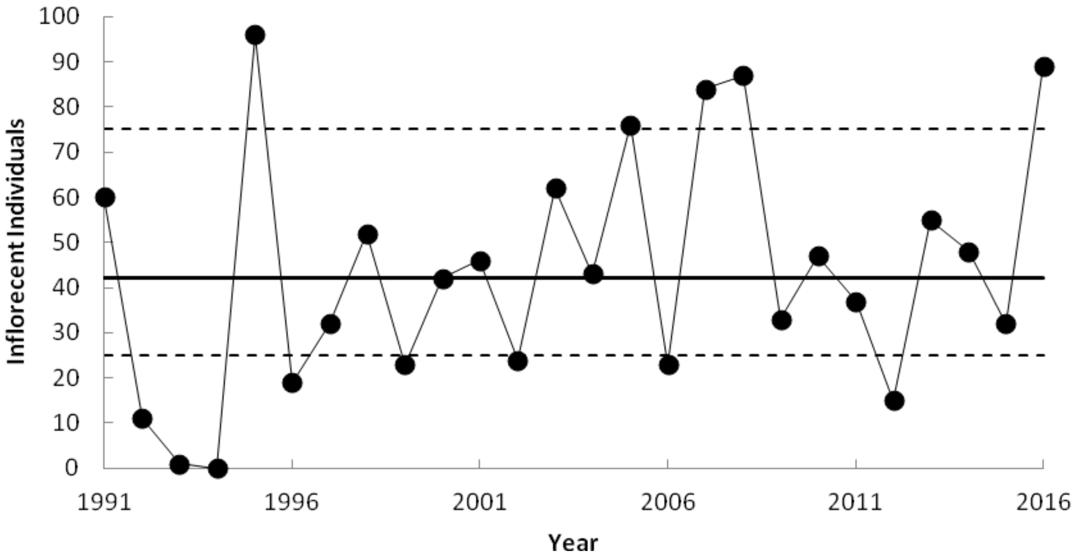
2.20 Tarengo Leek Orchid - monitoring

Hall Cemetery contains the only population of the Tarengo Leek Orchid *(Prasophylum petilum)* in the ACT. The site is a grassy woodland dominated by Blakely's Red Gum (*Eucalyptus blakelyi)* and Yellow Box (*Eucalyptus melliodora*), part of an endangered ecological community under the *ACT Nature Conservation Act 1980* and the EPBC Act. Individual plants at Hall Cemetery are counted and permanently tagged. This level of monitoring allows us to analyse population trends and identify relationships with climate and management.

Eighty-nine individuals were recorded in 2016, making it the second largest flowering event in the 26 years that surveys have been conducted, and a 78.1% increase on the number of Tarengo Leek Orchids found in 2015. This value is also considerably higher than the median recorded value of 42, and the upper confidence limit (Figure 2.14). Of the 89 plants recorded this year, 26 were new individuals (29.2%). As an absolute value this represents a moderate level of recruitment and the highest since 2008. However, as a proportion of plants observed this represents the lowest value to date.

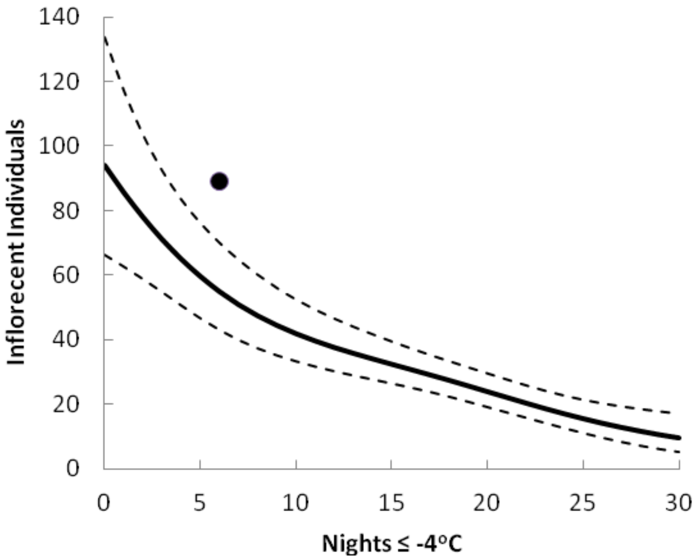
The analysis of the long-term data indicates that Tarengo Leek Orchid flowers in greater abundance during years with fewer nights ≤ –4°C. These findings are supported by the particularly high number of plants recorded after a particularly mild winter in which there were only 6 nights ≤ –4°C (Figure 2.15). That the model under predicted the number of plants might be explained by the occurrence of most nights ≤ –4°C at the start of winter, when the plant is still small and potentially protected from frost.

Figure 2.14 The number of Tarengo Leek Orchid individuals found during the 26 surveys of the Hall Cemetery conducted since 1991.



Note: The solid black line indicates the median number of plants found. The dotted lines indicate the range of typical values as informed by Technical Report 36 (http://www.environment.act.gov.au/__data/assets/pdf_file/0018/1026342/TR36-Factors-influencing-the-flowering-of-the-Tarengo-Leek-Orchid.pdf).

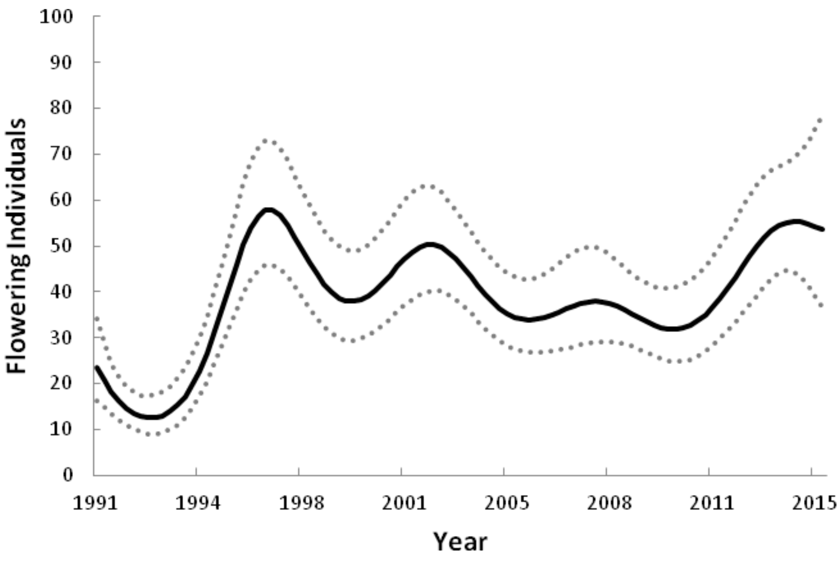
Figure 2.15 The modelled relationship between Tarengo Leek Orchid flowering and nights ≤ –4oC.



Note: The black line indicates the predicted mean, the dashed lines are the 95% confidence limits and the black dot is this year's observation.

Over the 25 years of monitoring, the total number of flowering individuals tended to increase before stabilising in the late 1990s with minor fluctuations (Figure 2.16). At the sub-population level there were marked differences with the largest sub-populations remaining stable while others declined or increased at statistically significant levels. This indicates that unknown factors are driving abundance at the small spatial scale of the sub-population.

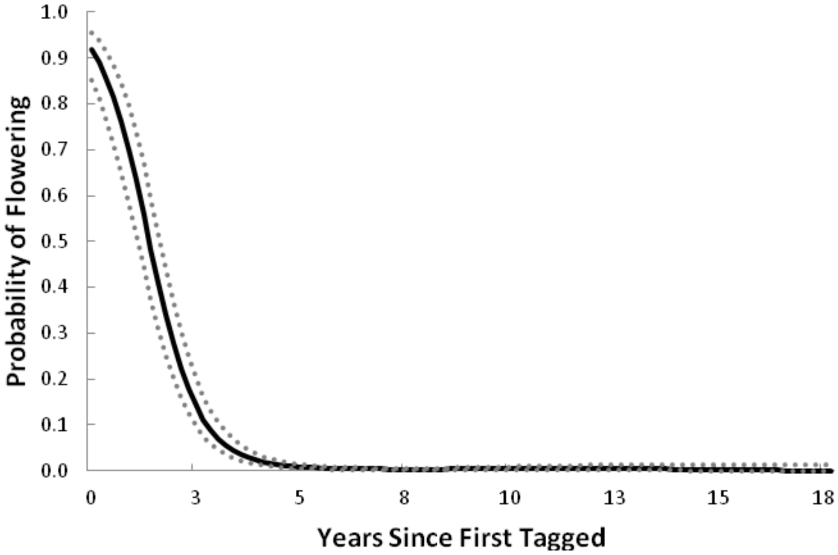
Figure 2.16 The partial plots for the number of flowering Tarengo Leek Orchid individuals, 1991–2016.



Finally, the analysis revealed the probability of a given plant flowering declined rapidly with the number of years since it was first tagged (Figure 2.17). The inference of this trend is limited, as it is not known if a plant has ever flowered prior to being tagged. However, it does indicate that there is not a clear pattern in the frequency of flowering, other than it being more likely within two years of the last flowering event. Thus, flowering appears more likely to be influenced by external factors, such as climate variability.

These findings highlight the need to ensure the persistence of elevated vegetation in and around the Hall Cemetery, so as to avoid frequent and severe frost. A full report on this analysis can be found at http://www.environment.act.gov.au/__data/assets/pdf_file/0018/1026342/TR36-Factors-influencing-the-flowering-of-the-Tarengo-Leek-Orchid.pdf

Figure 2.17 The predicted decline in the probability of an individual Tarengo Leek Orchid flowering with years since it was first tagged.



Note: Dotted lines indicate the standard error and values have been back-transformed to the original scale.

2.21 Two-spined Blackfish - monitoring

Conservation Research has undertaken a Cotter River monitoring program since 2001 and in Bendora Dam since 1995. The program is part of a larger project looking at environmental flows in the Cotter River and threatened species in the ACT. The program fulfils monitoring obligations under the ACT Aquatic Species and Riparian Zone Conservation Strategy Action Plan 29. In 2016, nine sites were surveyed including non-Cotter reference sites. Sites not surveyed in 2016 include above and below Bendora, Bendora Dam and Mountain Creek reference site as it was dry. Fish were surveyed using backpack electrofishing.

In total, 319 Two-spined Blackfish (*Gadopsis bispinosus*) were caught during the monitoring program. From the Cotter River, 307 Two-spined Blackfish (Blackfish) were collected (93 juveniles

and 214 adults). A total of 70% of the juvenile Blackfish were recorded from the regulated Bendora Dam to Cotter Dam reach.

There was an increase in the numbers of Blackfish in the environmental flow (regulated) reaches in 2016 compared to previous years. The unregulated sites above Corin Reservoir also recorded an increase compared to previous years.

Figure 2.18 Two-spined Blackfish in the Cotter River.

Blackfish are doing well in both regulated and unregulated sites (Figure 2.19). The exception is the Below Bendora site, which always contains low numbers of Blackfish because of its proximity to the Bendora Dam wall and associated impacts. Micalong Creek reference site Blackfish numbers were also low, which is suggested to be because Blackfish do not successfully breed in the sampled reach potentially due to differences in habitat and high pest fish numbers.

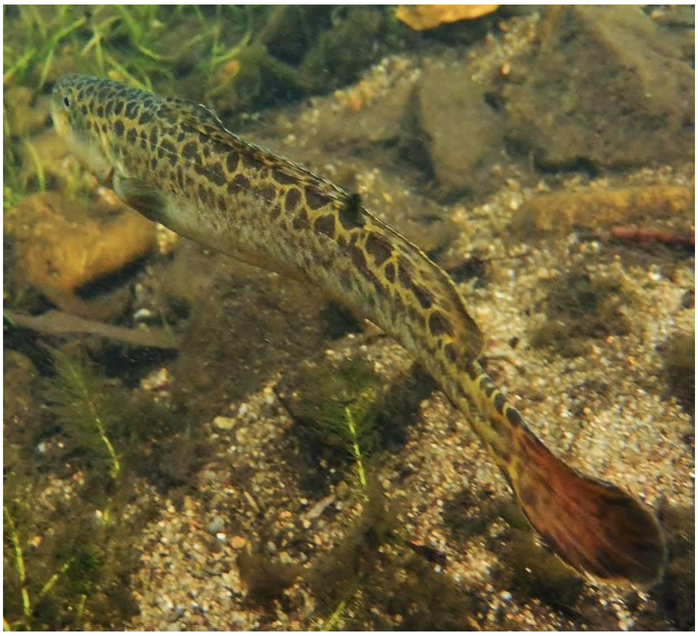
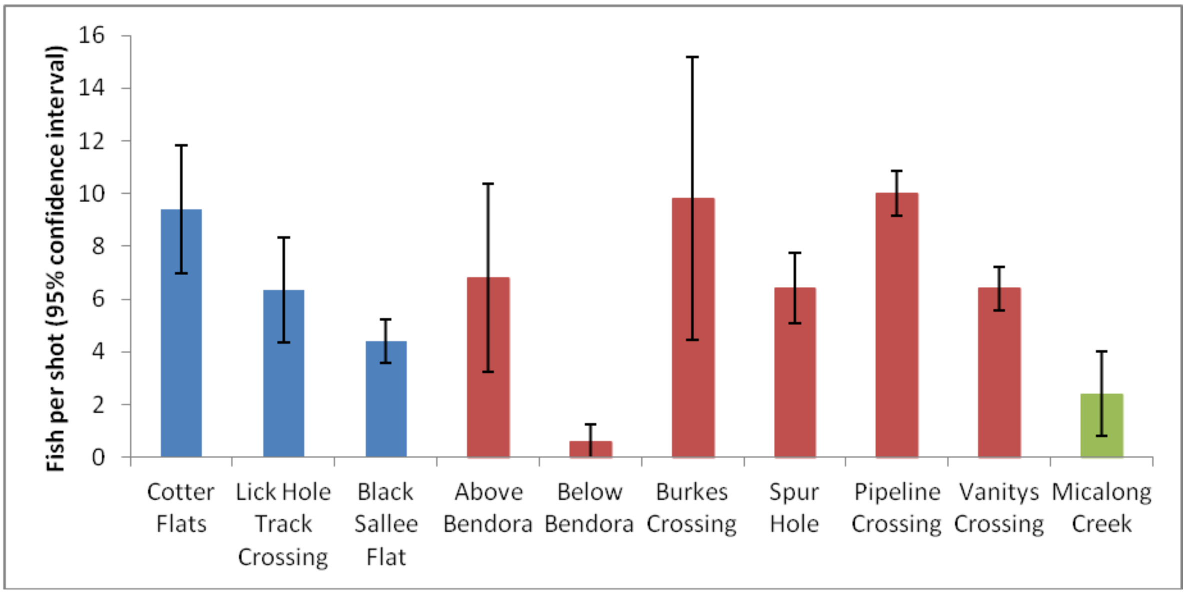


Figure 2.19 Mean Two-spined Blackfish captures per backpack electrofishing shot (30 metres) for each site sampled on the Cotter River for both 2014 and 2015.



Note: Sites are listed upstream to downstream. Sites upstream of Above Bendora (blue bars) are unregulated. Micalong Creek is an unregulated reference site (green bar) outside the Cotter Catchment.

Blackfish are continuing to demonstrate a general increase in abundances since the low numbers captured in 2011–12 (Figure 2.20). Sampling in 2016 suggests that breeding success is improving in both the regulated and unregulated sites as juvenile numbers are increasing (Figure 2.21). Numbers of adult and juvenile Blackfish in recent years are becoming more similar between regulated and unregulated reaches as fish recovery occurs following the millenium dought and the 2010 and 2012 floods. This pattern also indicates that environment flow provisions in the regulated reaches are providing adequate flows to minic natural conditions in the unregulated reaches. The data presented are from sites that were relatively consistently sampled across years.

Figure 2.20 Mean number of Two-spined Blackfish (recruits and adults) recorded per site for each river management type, 2001–2016.

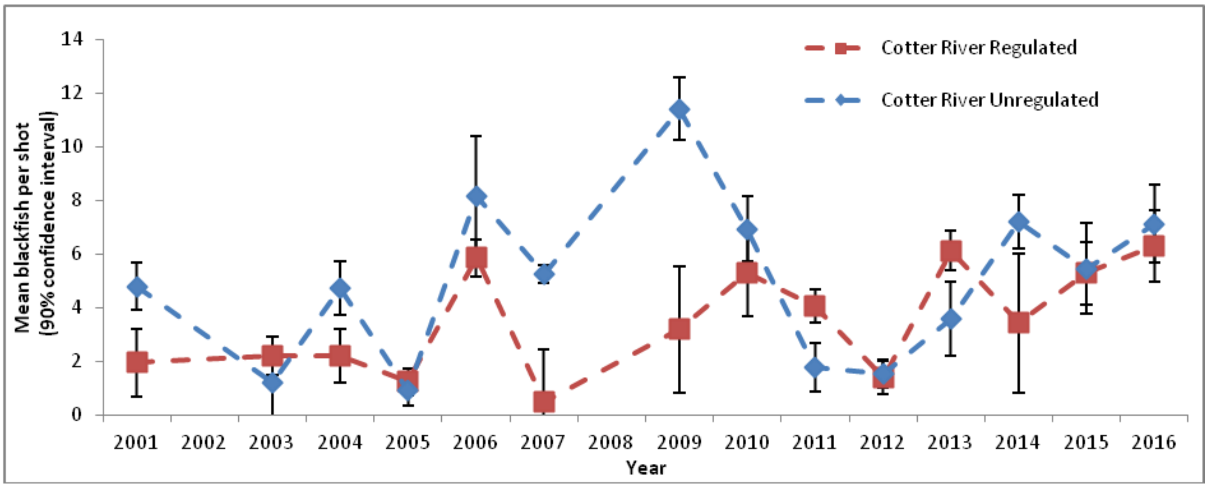
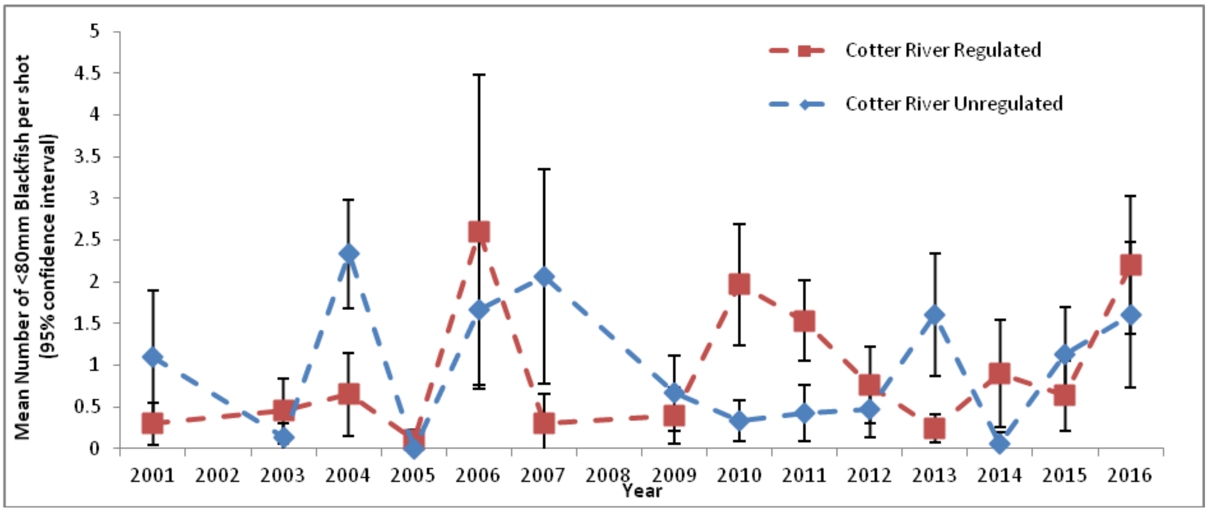


Figure 2.21 Mean number of Two-spined Blackfish recruits (fish < 80mm) captured per site for each river management type, 2001–2016.



2.22 Tuggeranong Lignum - monitoring

Field observations of the wild plants and planted populations of Tuggeranong Lignum (*Muehlenbeckia tuggeranong*) were carried out during summer 2015, mid-summer 2016 and mid-autumn 2016. The condition of each plant found was recorded. Photographs of each wild plant and the locations of surviving planted individuals were taken.

Overall condition of the extant population has remained stable during the reporting period. Of the plantings, only four living plants from the 2010 plantings were located in 2013, while in 2015 and 2016 no living plants were found. There is the potential for other individuals to persist and remain undetected as the river corridor suffers from extensive weed cover, namely African Lovegrass (*Eragrostis curvula*), St John's Wort (*Hypericum perforatum*) and Blackberry (*Rubus discolour*).

The 2013 plantings at Point Hut and Bullen Range are located in areas of low weed cover and utilised tree guards so individual plantings are much easier to locate. The observations of these sites are recorded in Table 2.2.

Table 2.2 Status of Tuggeranong Lignum plantings at Point Hut and Bullen Range from summer 2014 to summer 2016.

Date	Point Hut Crossing*	Bullen Range*
6 January 2014	17 alive	-
10 January 2014	-	1 alive
29 April 2014	11 alive	1 alive
23 July 2014	-	None alive
5 February 2015	10 alive	n/a
25 May 2016	7 alive	n/a

Note: *18 individuals planted in spring 2013 plus extra cuttings

Protection of some wild plants from grazing using mesh guards appear to be having a positive result at this stage. Guarded areas will need careful observation and management to ensure weed cover is kept to an acceptable level.

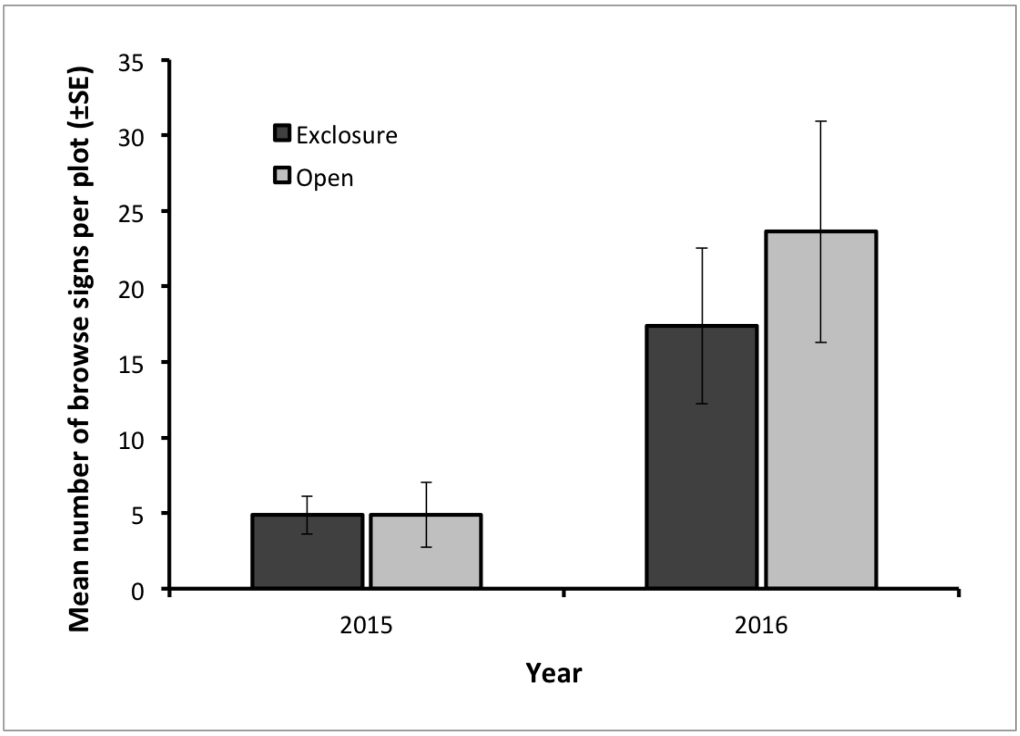
3. THREATS AND THREATENING PROCESSES

3.1 Deer – monitoring impacts of Sambar Deer in Namadgi National Park

Three feral deer species – Fallow Deer, Red Deer and Sambar – have been recorded in the ACT, with the number of sightings of Sambar Deer in particular increasing over the past 10 years. Sambar are known to impact ecological values through browsing of shrubs, damaging trees through antler rubbing and by disrupting hydrology of bogs through wallowing behavior. To assess the ecological risk posed by Sambar Deer, a monitoring study was established in 2014–15 by the ACT Parks and Conservation Service and Conservation Research with the aim of measuring impacts of Sambar Deer on vegetation structure and composition in Namadgi National Park. The resulting data will inform management decisions within the catchment.

Nine partial-exclusion plots and paired open plots were established in tall wet forest in the upper Cotter River catchment. In spring and summer 2014–15 and again in spring and summer 2015–16, each site was surveyed for vegetation structure and composition using quantitative plot and transect-based methods. Evidence of Sambar Deer browsing was recorded and Sambar Deer abundance estimated using faecal pellet transects. Data from the initial two years of surveys were analysed and will be presented in a forthcoming technical report 'Monitoring impacts of Sambar Deer (*Rusa unicolour*) on forests in the Cotter Catchment, ACT. Monitoring design and initial findings'.

Figure 3.1 Mean number of woody plants exhibiting signs of Sambar Deer browsing at partial exclosure plots and open plots in Namadgi National Park, ACT, 2015 and 2016.



Results suggest there has been little impact from Sambar Deer on vegetation structure or composition at this stage. Vegetation structure was similar in open versus partial-exclosure plots and remained relatively constant from 2014–15 to 2015–16. Pellet counts indicated Sambar Deer abundance did not change significantly between the initial sampling periods and there was no significant difference in browsing between open and partial exclusion plots, although evidence of more browsing damage was detected in open plots in 2016 (Figure 3.1).

Ecological impacts of Sambar Deer have also been assessed at a number of alpine bogs throughout Namadgi National Park in autumn 2017. These data will provide a baseline for future monitoring of alpine bogs. Data from both the exclosure study and alpine bog monitoring will provide a baseline from which to assess changes in abundance of Sambar Deer over time and any associated changes in ecological impacts.

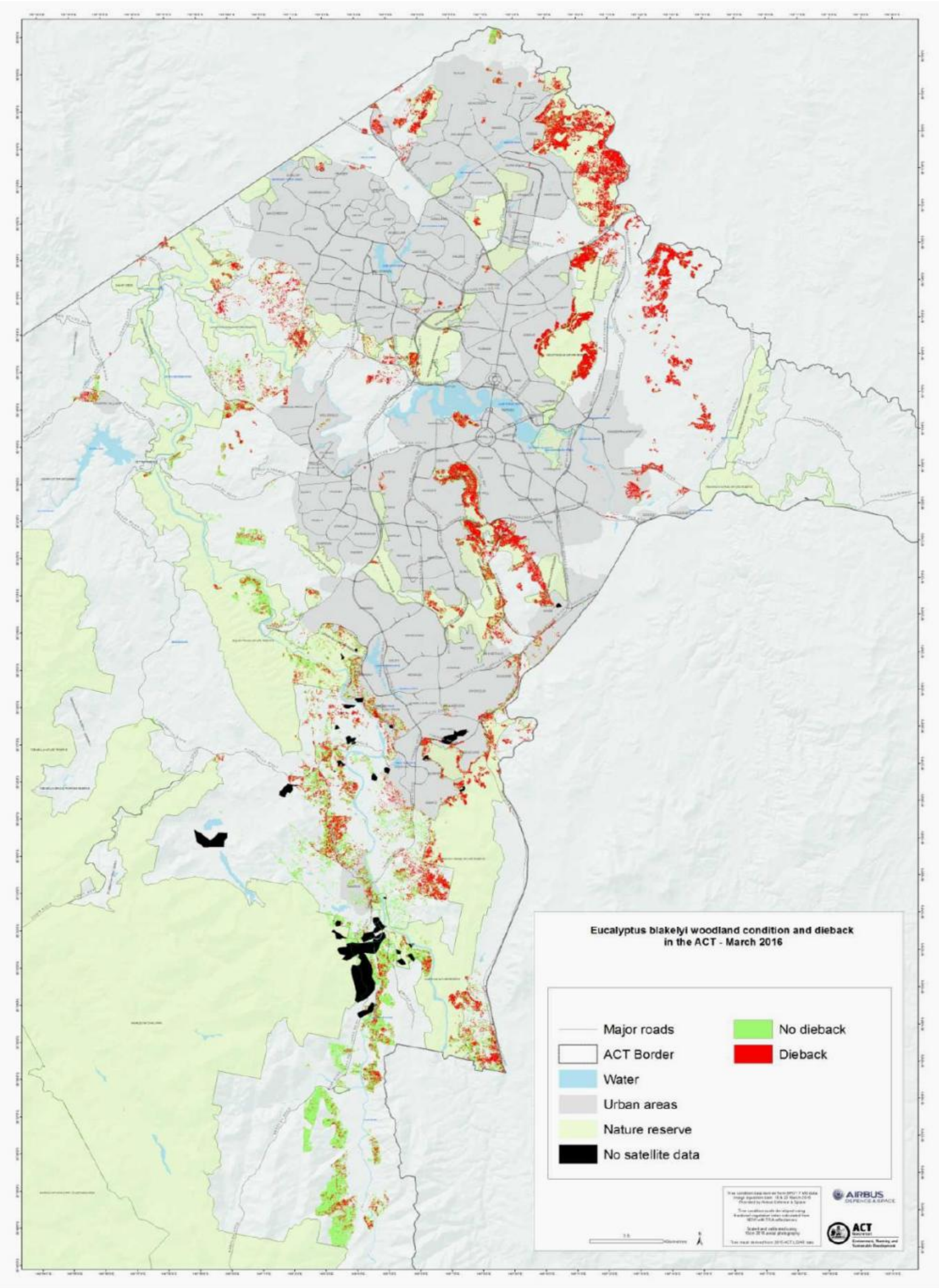
3.2 Dieback in eucalypts – ground truthing mapping

Decline of Blakely's Red Gum (*Eucalyptus blakelyi*) appears to be widespread across the ACT, with dieback affecting all age classes. There is uncertainty about the causes of dieback and its spatial distribution in the ACT. Further research is needed to better understand the range and causes of eucalypt dieback in the ACT.

To address this issue an analysis was undertaken of dieback severity in the ACT using satellite remote sensing and light detection and ranging (LIDAR). Assessment of the condition of tree stands requires regular observations over large areas. Although it is feasibly possible to assess tree health using only an intensive ground survey, it is far quicker and more cost-effective to utilise remote sensing techniques. A Normalised Difference Vegetation Index (NDVI)-based fractional vegetation cover approach provided good theoretical results (see Figure 3.2) when compared with high resolution aerial photography visual analyses. Field testing, verification and calibration of the condition scale map is the next step. Conservation Research has commenced field testing these data.

At each of the 500 stratified tree samples the following characteristics are recorded: an estimate of the proportion of dead branches, epicormic growth and the species of the tree. A mixed modelling analysis is then used to determine if the dieback severity mapping predicts any of these characteristics or a mix of these characteristics. This information can then be used to determine the application of the NVDI-based fractional vegetation cover approach and potentially direct improvements.

Figure 3.2 Blakely's Red Gum woodland condition and dieback in the ACT, March 2016.



3.3 Landscape scale influences on Blakely's Red Gum condition in the Canberra region

Land managers have noticed widespread decline in the condition of Blakely's Red Gum (*Eucalyptus blakelyi*), a dominant woodland species, in the Canberra region over a number of years preceding 2016. The cause of the decline is unknown, and is of concern following a similar event that led to the widespread decline of a different eucalypt species (being Ribbon Gum, *Eucalyptus viminalis*) south of the Canberra region. A review of the literature highlighted landscape position, stand structure and fire history as possible causes of a region-wide decline in condition for Blakely's Red Gum. Conservation Research surveyed 94 Blakely's Red Gum trees across the region to assess if condition varied with landscape position, stand structure or fire history. None of the statistical models identified a link between condition and landscape position. Trees that had experienced more frequent fire tended to have healthier leaves – as indicated by the proportion of the leaf surface that was still green. Trees that had experienced more recent fire also had less epicormic foliage and fewer dead branches.

Fire may reduce the predation burden on trees. It may also reduce nitrogen availability, resulting in less palatable foliage for foliar predators. Trees had healthier leaves if they were larger, had mature foliage and where there was greater spacing between larger trees. Mature trees with less competition from other large trees are likely to be competing less for resources and consequently are under less stress. These findings indicate that Blakely's Red Gum in mature stands that are burnt regularly are likely to be in better condition than regrowth stands that are long unburnt (Figures 3.3 and 3.4). These findings provide a good platform for further understanding the causes of declining condition in this species in the Canberra region.

Figure 3.3 Predicted probabilities of each epicormic foliage score occurring in response to the logarithm of time since fire (a) and the logarithm of average distance to the nearest regeneration (b). Predictions were made with all other explanatory variables held at their mean value.

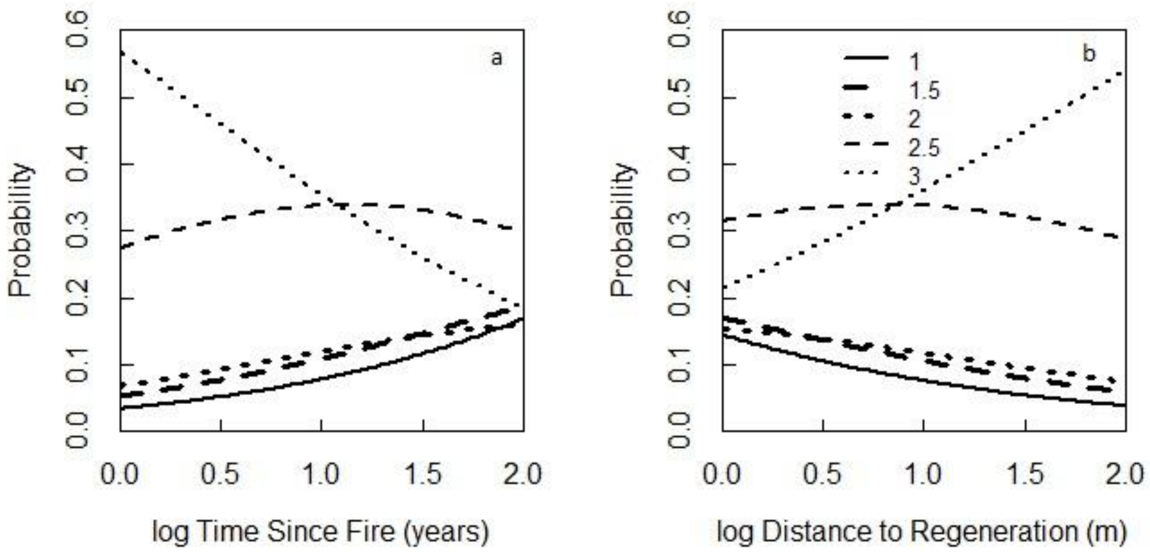
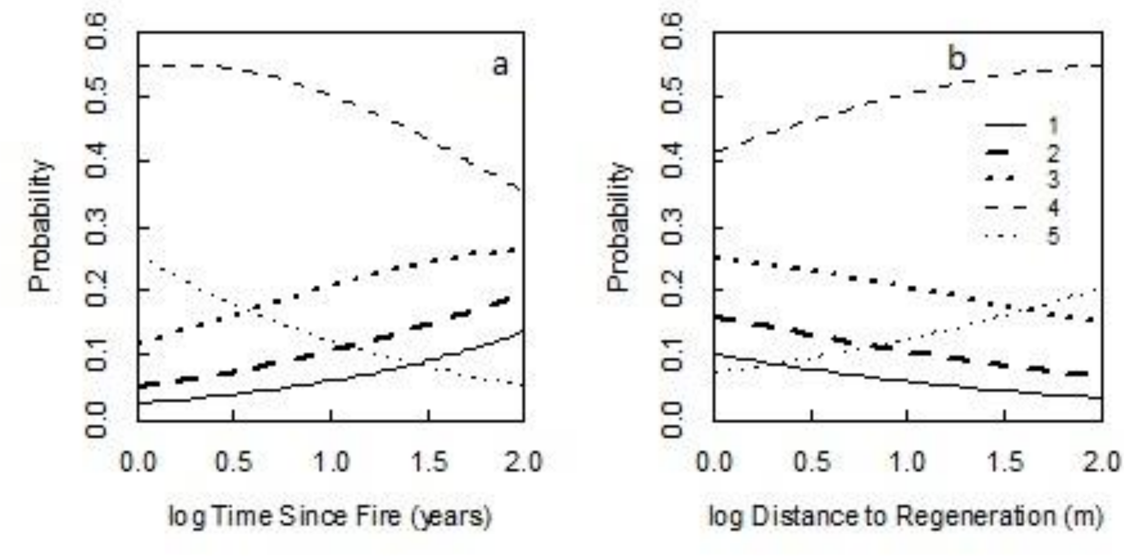


Figure 3.4 Predicted probabilities of each dead branch foliage score occurring in response to the logarithm of time since fire (a) and the logarithm of average distance to the nearest regeneration (b). Predictions were made with all other explanatory variables held at their mean value.



3.4 Managing eucalypt regrowth – thinning trials

Much of the remaining woodland vegetation in the ACT has experienced tree removal to some extent in the past. Many of the reserves were once grazing paddocks that were partially cleared to optimise pasture productivity. Although a lack of tree regeneration is a threat to temperate woodland conservation, it is generally not an issue in woodland reserves within the ACT. Many of these former grazing paddocks are experiencing dense regrowth of eucalypts and other tall woody species, however key structural features remain largely absent. The density of regrowth may inhibit the development of large trees and associated structural attributes. Existing research suggests that the development of these structures will be delayed, or prevented, in the presence of high stem densities due to slow growth rates and the morphology of eucalypts grown in high densities. Given the predicted impact of the absence of large trees, any delay in their replacement should be avoided. Other structures such as groundcover vegetation, open space between foliage and exposed groundcover can occur in regrowth vegetation if it is not too dense.

The aim of this project is to reduce the number of stems of canopy-forming species to benchmark stem densities. The purpose of this activity is to test if stands with benchmark stem densities provide more structurally diverse habitat, and higher growth rates.

Issacs Ridge Offset site was chosen for the location of this trial. Tagged trees in the treatment plots, along with tagged trees in the control plot, will be measured every three to five years to determine if the thinning has accelerated tree growth rates.

3.5 Dieback in eucalypts – *Phytophthora* sampling

Dieback in Blakely's Red Gum (*Eucalyptus blakelyi*) appears to be widespread across the ACT and there is uncertainty about the causes and spatial distribution of dieback. While further research is needed to better understand the range and causes of the problem in the ACT, soil-borne moulds have been implicated in dieback in other areas.

The soil-borne water mould *Phytophthora cinnamomi* has been implicated in eucalypt dieback in other parts of Australia and has been found in a few locations in the ACT. Another exotic species, *Phytophthora cryptogea* was identified in the Issacs Ridge Offset in early 2017. A sampling regime was designed to help determine the distribution of these water moulds in the ACT and explore any relationship to the severity of dieback in nearby trees. Funding for this project was provided by the ACT Parks and Conservation Service and enabled the collection and testing of over 80 soil samples.

Once the laboratory results are received, a mixed-model analysis will be used to determine and relationships between *Phytophthora spp.* presence and species and tree dieback characteristics and affected species.

3.6 Fire ecology – prescribed burn monitoring

Each year the ACT Parks and Conservation Service undertakes prescribed burning activities under the Bushfire Operational Plan to reduce the risk of unplanned fire to life, property and the environment (fuel reduction burning), and to promote ecological outcomes (ecological burning). As part of an ongoing fire ecology program, Conservation Research undertakes monitoring of prescribed burning to provide evidence-based oversight of environmental outcomes and to expand our knowledge of the responses of the ACT's flora and fauna to fire.

Over the period from 2015 to 2017 Conservation Research conducted research and monitoring of:

- the ecological effects of prescribed burning on the structure and composition of dry sclerophyll forest in Canberra Nature Park employing a robust Before-After-Control-Impact (BACI) study design
- the effects of prescribed burning and wildfire on habitat structure and fauna diversity in sub-alpine woodland and wet sclerophyll forest in Namadgi National Park
- the response of orchids to past fire regimes on Black Mountain in Canberra as part of a Canberra Nature Map citizen science project
- the ecological outcomes of 'ridge-top burning' as a strategy for reducing fuels in remote parts of the ACT.

Results from these projects are fed back into the planning and implementation of subsequent prescribed burning activities and form the basis of ongoing discussion between Conservation Research and the ACT Parks and Conservation Service aimed at achieving ecologically sensitive fire management.

Figure 3.5 Low-intensity prescribed fire during the Hall Cemetery ecological burn.

3.7 Kangaroo – fertility control research

The ACT Government has partnered in research on fertility control for Eastern Grey Kangaroos since 1998. The most successful trial to date has been undertaken in collaboration with the former Invasive Animals Cooperative Research Centre and the CSIRO. In 2008, sub-adult female kangaroos resident at Belconnen Naval Transmission Station were capture-darted allowing the fitting of identification collars and ear tags and treatment with either GonaCon Immunocontraceptive Vaccine (16 animals) or a placebo injection (10 animals). Since treatment, animals have been monitored annually to determine their reproductive condition.

Results to date have demonstrated GonaCon to be effective in a high proportion of female Eastern Grey Kangaroos for a minimum of eight years following a single injection (Table 3.1). All the treated kangaroos were infertile for the first three years after vaccination. In the fourth year, one treated animal starting breeding and has produced a young each year since. A second treated kangaroo produced a young in 2016. This result is extremely positive and GonaCon currently represents the most promising contraceptive trialled for use in this species. However, the high costs and resources required to capture and handle each individual to inject the vaccine and monitor their recovery from the anaesthetic limits the viability of this method for treating large free-ranging kangaroo populations. These costs and inefficiencies would be overcome if the vaccine could be delivered to kangaroos remotely.

Table 3.1 Percentages of female kangaroos in each treatment group observed with young each year, 2009–2016.

Treatment	2009	2010	2011	2012	2013	2014	2015	2016
GonaCon	0%	0%	0%	7%	10%	10%	9%	18%
Placebo	100%	89%	100%	38%	50%	83%	80%	50%

With support from CSIRO and the ACT Parks and Conservation Service, Conservation Research is continuing to research the use of GonaCon for Eastern Grey Kangaroos. The aims of this phase of the research are to investigate and trial a remote-dart delivery method for GonaCon, evaluate the effect of GonaCon on individual female kangaroos when it is dart delivered compared to when it is injected by hand, and to assess if GonaCon is an effective tool for limiting the growth of small kangaroo populations. If dart-delivered GonaCon is effective, it could reduce the amount and frequency of culling required in some areas.

Before trialling dart delivery of GonaCon on live kangaroos, initial selection tests of different dart types were undertaken on ballistics gel and carcasses. A suitable dart was identified that successfully expels the viscous vaccine into the target muscle and a temporary marking system was tested to avoid individuals receiving multiple doses.

Since 2015, 145 female kangaroos have been treated with hand-injected GonaCon (n=81), hand-injected placebo (n=10) or dart-delivered GonaCon (n=54). Each kangaroo is monitored regularly for signs of a young in the pouch.

In the year following injection by hand with GonaCon, only 13% of the kangaroos produced a young, while 90% of those injected with a placebo successfully bred. In the second year after treatment, none of the kangaroos hand-injected with GonaCon appear to have a pouch young at this stage. Dart-delivered GonaCon was administered to collared kangaroos in July 2016 (Figure 3.6). Results indicate that dart-delivered GonaCon has been successful in preventing breeding in the year following treatment, with only 20% producing a young.

In addition to the individual breeding information from the treated animals, annual population estimates and fecundity assessments are being undertaken in treated and untreated populations to evaluate GonaCon as a population management tool.

Figure 3.6 Dart vaccination of female Eastern Grey Kangaroos fitted with identification collars and eartags.

Note: The centre kangaroo has just been darted with GonaCon. Once the vaccine has expelled, the pink dart drops from the animal and is collected for disposal. Photo credit: Lyn Hinds.

3.8 Kangaroo – grazing and biodiversity within Canberra Nature Park

Conservation Research collected detailed ecological data between 2012 and 2016 to model relationships between kangaroo density, grazing pressure (off-take), grassy layer structure and biodiversity. This involved counting kangaroos across a range of nature reserves, using off-take cages to assess grazing pressure, taking detailed grass structural measurements such as grass height, herbage mass, species composition and percentage cover, and measuring the abundance and species diversity of a range of plant and reptile species within a range of ACT-managed conservation areas.

Figure 3.7 Total grazing pressure is limited by a lack of available grass when herbage mass is very low, and these conditions will be maintained by a high density of kangaroos.

Statistical analysis of this data has revealed a strong influence of productivity (grass growth) on rates of off-take, as well as reduced rates of off-take when the total amount of grass available was either very low or very high. The relationships between kangaroo density and rates of off-take also varied depending on grass species, with kangaroos showing a preference for native perennial and annual species over introduced grasses.

Grass species also played a significant role in predicting the structural attributes of a grassland, with patches dominated by native perennial grasses having higher structural variability compared to areas dominated by introduced species. Grassland structural variability was also negatively related to average grass height, likely due to an increased likelihood of bare ground and inter-tussock space under low herbage mass conditions.

Figure 3.8 Species composition plays an important role in determining grassy layer structure and thus habitat suitability for a range of species. Here, the left of the image is dominated by *Themeda triandra* and has quite high vegetative cover compared to the more open *Rytidosperma* spp. dominated area on the right.

Grassy ecosystems providing a range of structural 'niches' is considered to be most beneficial for supporting a diverse range of species. This study supported this notion with both reptile and plant species richness responding positively to structural attributes associated with higher levels of grassy layer variability. Non-grass structural elements, such as rocks and logs, were also found to provide important microhabitat niches to improve species diversity in grassy ecosystems.

The next stage of this research will develop a predictive model enabling the most appropriate level of kangaroo grazing to be determined with consideration of current grassland and predicted climatic conditions. This research will also help to identify priority areas for employing alternative grassland management tools (such as fire) to restore grassland habitat for native species.

4. ECOLOGICAL RESTORATION

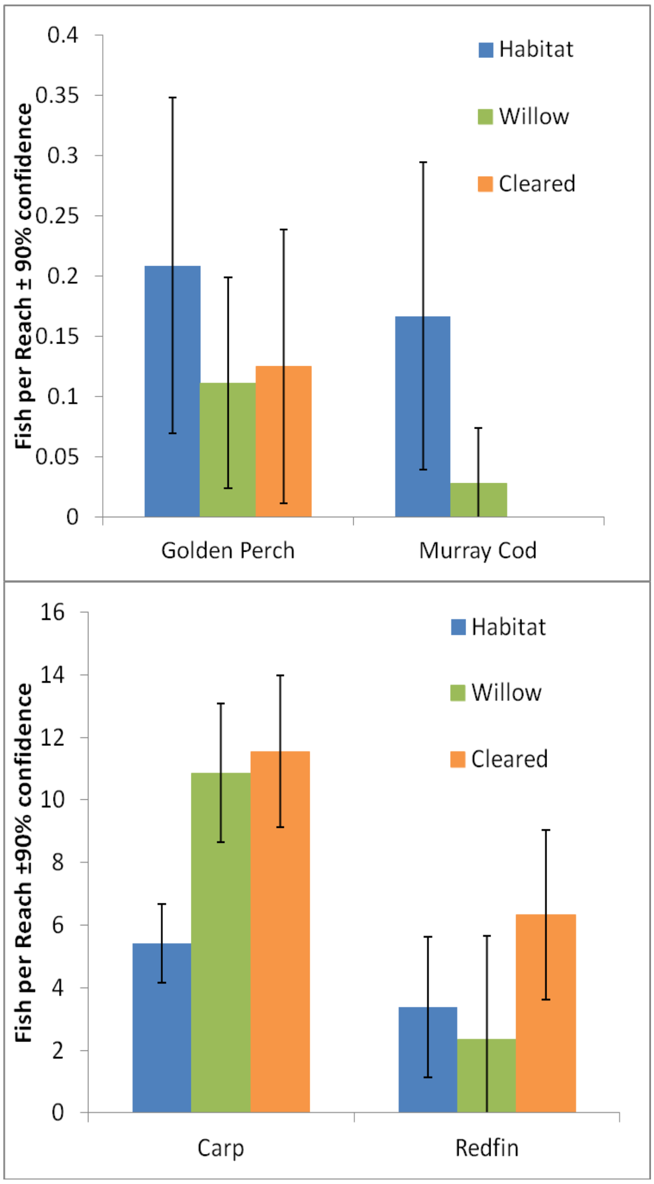
4.1 Cod caves – improving fish habitat

In 2011 a flood resulted in large accumulations of woody debris in the Molonglo River upstream of Lake Burley Griffin. In response, the ACT Government Restoration of Waterways Program cleared 10 km of willow from the banks, removed 400 tonnes of submerged and 10,000 m^3 of floating debris and replanted 6000+ native plants on the cleared banks. However, these plants will take time to grow and provide habitat for fish. To manage the habitat loss, a trial was undertaken to determine if outcomes for native fish could be improved by adding artificial habitat. Eight 100 m reaches that had been cleared of willows were selected for this trial. Concrete reef balls were placed in four of the cleared reaches in three habitat clusters per 100 m (Figure 4.1). An additional six reaches were selected in uncleared willow habitat. These reaches have been surveyed six times between 2012 and 2015 using boat electrofishing. In total, 1143 fish from four large-bodied species were collected, and included two native species (Murray Cod and Golden Perch) and two pest species (Carp and Redfin).

Figure 4.1 An excavator placing an artificial 'cod cave' habitat into the Molonglo River.

The results (Figure 4.2) show that reaches with artificial habitat have a significantly lower number of Carp and significantly higher numbers of Murray Cod than cleared and willow reaches. The results show that adding artificial habitat to cleared areas significantly improves the outcome for large native fish and reduces the dominance of pest species.

Figure 4.2 Number of fish per treatment reach (artificial habitat, willow and cleared) for the four commonly caught species.



4.2 Isabella Pond and Upper Stranger Pond Carp removal

As part of the Healthy Waterways Project and Isabella Weir upgrade, Conservation Research was engaged to provide advice and undertake removal of Carp and rescue of native fauna during the draining of Upper Stranger Pond and Isabella Pond. This project provided the opportunity to fill several knowledge gaps regarding Carp populations in the ACT which are critical to discussions and planning around potential release of a Carp biocontrol under the National Carp Control Plan. Knowledge gaps include determining Carp density, correlating biomass to general electrofishing surveys and size and age structure of the population and assisting the development of other methods such as Environmental DNA to determine Carp biomass.

Prior to the commencement of the pond draining, ecologists undertook preliminary boat electrofishing surveys of Isabella and Upper Stranger Pond and selected ponds upstream to understand the distribution of Carp in the catchment, determine the likelihood for re-invasion and obtain preliminary estimates for Carp density assessments. All ponds upstream of Isabella Pond, other than Upper Stranger Pond, were found to be Carp free.

Fish in the Upper Stranger Pond were manually removed between 5 and 7 April 2017 by up to six ecologists with the assistance of Guideline ACT staff and plant. Processing and counting of Carp was undertaken by the Green Army and Water Watch Volunteers from the Southern ACT Catchment group assisted by ecologists. In total, 1440 Carp, 29 Goldfish, 2 Murray Cod and 234 Redfin were recorded (Table 4.1). In addition four turtles and several hundred yabbies were relocated to other downstream ponds. Dead fish were removed to Lantasia Organic Compost facility for use in organic farm production.

Table 4.1 Fish removal from Upper Stranger Pond, March 2017 to April 2017.

	30 March 2017	31 March 2017	1 April 2017	2 April 2017	3 April 2017	5 April 2017	6–7 April 2017	Total
Carp	1	2	15	50	14	340	1018	1440
Goldfish		1				3	25	29
Murray Cod							2	2
Redfin	1	3	18	24	9	82	97	234

Figure 4.3 Conservation Research staff members, Matt Beitzel and Mark Jekabsons, after removing carp from Upper Stranger Pond.

On 20 and 21 April 2017, five ecologists manually removed and processed fish from the Isabella Pond. In total (including a fish kill during drawdown) 765 Carp, 5 Goldfish and 69 Redfin were removed and sent for disposal (Table 4.2).

Table 4.2 Fish removal from Isabella Pond, April 2017.

	10–19 April 2017	20–21 April 2017	Total
Carp	130	635	765
Goldfish		5	5
Redfin	65	4	69
Grand total	195	644	839

Following drainage of the ponds, additional analysis will be undertaken to determine total fish biomass and density of these two lakes and correlate these numbers to the pre-draining electrofishing to enable extrapolation to other lakes in the ACT. As part of this project, Conservation Research ecologists will monitor both Isabella and Stranger Ponds for six years post-filling and stock each lake annually with native fish.

4.3 Tharwa Fish Habitat Project Stage 2 – engineered log jams at Tharwa

Prior to upstream European occupation, the Murrumbidgee River channel past Tharwa would have predominantly had a base of pebble, cobble and bedrock that would have allowed fish passage and provided habitat for fish. A 'sand slug' derived from upstream clearing and erosion has substantially reduced river channel depth in the Tharwa vicinity and smothered structural fish habitat. In 2009–10 a consultancy report advised ways to manage the sand problem in the Upper Murrumbidgee Demonstration Reach and recommended installation of engineered log jams (ELJs) to improve fish passage and habitat. The initial structures constructed in 2013 have been found to be so successful that further funding has been obtained to construct more engineered log jams downstream of the initial structures (Figure 4.5). The 2013 ELJs were found to provide habitat mainly for Murray Cod, particularly juveniles, and to deepen the river from 40 cm on average during summer to over 2 m in the vicinity of the structures.

Figure 4.4 Murray Cod Juvenile caught at the engineered log jams constructed in 2013.

Stage 2 aims to restore additional areas of deep water in this shallow sand-affected stretch of river and provide more structural fish habitat. The project runs over two financial years from to 2016–17 to 2017–18 and is being managed collaboratively between Conservation Research and the ACT Parks and Conservation Service.

To date, Stage 2 has focused on acquiring materials for construction of the second ELJs. Materials stockpiled include salvaged logs from the Williamsdale solar farm site and salvaged rock from the Throsby development. An adjacent landholder has kindly dedicated a portion of their property for the storage of materials until construction occurs. Designs for the structures have also been developed. Activities in 2017–18 will include further material acquisition, project construction and site cleanup. The project will be followed by further riparian rehabilitation work by the ACT Parks and Conservation Service and fish monitoring to survey project success.

Figure 4.5 Google Earth 2015 image of the Tharwa sand-affected Murrumbidgee River reach.

5. OTHER SURVEY AND BASELINE INFORMATION

5.1 Canberra Nature Map – defining the distribution and abundance of ACTs wildlife

Canberra Nature Map is a community website, partly administered and supported through Conservation Research. The website has become the authoritative source on the distribution and abundance of wildlife in the ACT and surrounding NSW local government areas. It provides easy access to over 1,140,000 records of over 4200 local species or higher-order taxonomic groupings of plants, animals (including invertebrates) and fungi. In an average month 5000 different users download 65,000 pages of information from the Canberra Nature Map website. With an ever-increasing usage it is expected that around a million pages of information will be downloaded in 2017.

The website is a venue to communicate and share knowledge in a friendly setting. Users add to the communal knowledge by loading a wildlife photograph to the site and suggesting an identification (though if the reporter has no idea what is in the photo they can select 'I don't know'). The task of confirming the identity of a new report is then undertaken by a team of over 60 expert volunteer moderators. Moderators may ask reporters for further information to help in the identification or provide tips as to the conservation significance of the reporting.

An indication of how effective this community interaction is to improving overall wildlife knowledge is that 50% of all of the rare plant recordings within the ACT over the last 110 years have come from Canberra Nature Map (now in its third year of operation). This new knowledge has enabled a review of the 317 species that the ACT Scientific Committee for Flora and Fauna previously recommended as being rare or uncommon, with 54 species now found to be common and a further 18 species not previously known in the ACT added to the list. Later this year the Canberra Nature Map community will be asked to look out for and report on a few currently data-deficient plants on the rare and uncommon plant list.

Environmental consultants, land managers and development and planning decision makers all have access to the wildlife information, enabling more informed actions. On dozens of occasions Canberra Nature Map reports have been the first records of significant weeds in the ACT region or the first record of a problem plant in a reserve or private property, enabling land managers to eradicate an infestation before it becomes a problem.

The Canberra Nature Map community has also been called on to help in the understanding of how orchid presence and abundance on Black Mountain sandstone has been influenced by fire history. ACT Government researchers marked 115 points stratified by fire history. Forty-seven users adopted one or more points and, during set survey periods, recorded any orchid within 50 m of the adopted point. In total, 578 records of 35 different orchid species were recorded, with an average of five different orchid species and over 100 orchids per plot. The data are still being analysed, but initial results indicate that certain fire regimes favour certain species. This information will inform the prescribed burn and fire management planning activities.

The website has also led to the recording of many new locations of threatened fauna including the Perunga Grasshopper, Rosenberg's Monitor, woodland birds, Striped Legless Lizard and Little Whip Snake. It is has recorded the first ACT location of many fungi and invertebrates, including a millipede of a usually tropical family, only known from Pine Island and possibly a site near Toowoomba in Queensland.

Canberra Nature Map has significantly increased our understanding of wildlife distribution and abundance and has informed and changed daily land management practice. You are encouraged to join and add to this community effort.

Be sure to go online and enjoy this wealth of flora and fauna information at:
www.canberra.naturemapr.org

5.2 Conservation Effectiveness Monitoring Program – overview

The Conservation Effectiveness Monitoring Program (CEMP) is an overarching ecosystem condition monitoring framework for the ACT conservation estate. Monitoring is an integral part of evaluating the effectiveness of management actions in achieving nature conservation objectives. CEMP aims to create a coordinated, systematic, and robust biodiversity monitoring program that will allow us to detect changes in ecosystem condition within reserves, evaluate the effectiveness of management actions in achieving conservation outcomes, and provide evidence to support land management decisions. A key component of the program is to develop monitoring plans for the eight identified ecosystem units within the ACT reserve system.

The purpose of CEMP and the rationale behind the adaptive management approach central to the CEMP framework are outlined in the technical report published in early 2017 'Conservation Effectiveness Monitoring Program: An overview'.

Central to CEMP are monitoring plans for eight ecosystem units that aim to track changes in condition over time. Each ecosystem monitoring plan includes a set of indicators and metrics representing key ecosystem values and stressors specifically chosen as relevant to that ecosystem. The condition or state of each metric is assessed against explicit reference conditions, baselines and target conditions using available monitoring and research data.

Over time, CEMP will allow measurement of trends in condition and state of metrics and therefore the trajectory of each ecosystem as a whole in response to long-term drivers and to management actions. The CEMP reporting framework enables an assessment of the efficacy of management actions, identification of knowledge gaps and the prioritisation of future research (Figure 5.1). Through consolidating information on ecosystem condition and increasing accessibility of this information across ACT Government, CEMP aims to provide a data-rich decision support tool to inform strategic planning and assist management in conserving ecological values within the ACT reserve system.

Figure 5.1 Levels and corresponding symbology for condition/state, condition trend and data confidence used in the CEMP program.

Condition/State		Condition Trend		Data Confidence	
	Indicator is in good condition	⇧	Condition of the indicator is improving		Confidence in condition assessment is high
	Indicator is in good condition with some concerns	⇔	Condition of the indicator is stable		Confidence in condition assessment is moderate
	Indicator is in moderate condition with a number of concerns	⇩	Condition of the indicator is declining		Confidence in condition assessment is low
	Indicator is in poor condition with many significant concerns		(Blank) Trend in the condition of the indicator is unknown		Confidence in condition assessment is not available

5.3 Conservation Effectiveness Monitoring Program – lowland grasslands

The lowland native grasslands represent the first ecosystem monitoring plan to be developed and implemented under the Conservation Effectiveness Monitoring Program (CEMP) and will be documented in a forthcoming technical report titled 'Conservation Effectiveness Monitoring Program: ACT Lowland Native Grasslands Ecosystem monitoring plan'.

Within the lowland native grasslands ecosystem identified ecological values that are priorities for conservation include native flora and fauna (including threatened species) and the threatened ecological community of Natural Temperate Grassland. Stressors identified as operating within the ecosystem include invasive weeds, inappropriate grazing regimes, introduced herbivores and predators, adjacent land use and inappropriate fire regimes. Management programs designed to reduce stressors and enhancement programs designed to increase ecological values are conducted throughout native grassland ecosystems in the ACT including within reserves.

Indicators of condition of ecological values and state of stressors were derived and used for assessing ecosystem condition compared to both the reference condition and target condition for each indicator. In some instances monitoring data for this initial assessment form a baseline for future comparison. In other cases, where previous data were available, it was possible to assess trend in condition or in state of a stressor.

Overall, most indicators rated in poor condition against their reference condition. This was primarily a result of either the formal threatened status of the indicator or due to the extent to which the indicator has been significantly reduced in range compared with its former range prior to European settlement. In comparison, assessment for most indicators against their target condition resulted in a condition rating of either 'moderate' or 'good condition with some concerns'. This is a reflection

that overall, management within lowland native grasslands ecosystems is achieving conservation goals in protecting and enhancing ecosystem values.

The effectiveness of management programs at minimising stressors in this ecosystem was mixed, with management of fire regimes within lowland grassland for ecological outcomes requiring more attention. The analysis revealed a need for more information on the impacts of introduced predators in lowland grassland ecosystems. Where analysis of trend was possible, most indicators and stressors were assessed as increasing or stable, indicating that broadly the ecosystem condition is stable overall.

The lowland grasslands ecosystem assessment has highlighted a need to make long-term monitoring programs more robust to statistical analysis and the need for a long-term commitment to effective monitoring that is linked to management decision making.

5.4 Eastern Bettongs – trial release into the Lower Cotter Catchment

In 2011 and 2012, 60 Eastern Bettongs (*Bettongia gaimardi*) were translocated from Tasmania in a research trial to re-establish the species in the ACT. The reintroduction has been highly successful, with two populations established within fenced areas at the Mulligans Flat Woodland Sanctuary and Tidbinbilla Nature Reserve. The populations have increased significantly, and now the total number of Eastern Bettongs is estimated to be between 250 and 300.

Following on from this success, trials are underway to evaluate the viability of reintroducing Eastern Bettongs to an unfenced site at the Lower Cotter Catchment. The project, which is being conducted by the Australian National University, ACT Government, the Woodlands and Wetlands Trust and the National Environmental Science Programme, is taking an adaptive approach with a series of trial releases of small numbers of Eastern Bettongs occurring. These releases are designed to evaluate under what conditions a viable population of wild bettongs can survive, including the minimum amount of predator control required.

In 2015, in preparation for the release of Eastern Bettongs, an intensive fox and dog baiting program commenced and remote cameras were installed for monitoring.

The bait-take and camera monitoring data show that fox numbers have been substantially reduced and maintained at a low level within the control area. In August and September 2016, just over a year after the baiting program began, 13 Eastern Bettongs were released into the control area as part of Phase 1 of the project (Figure 5.2). Fifteen more were released in Phase 2 in October–November 2016. Each bettong was fitted with a tracking collar and monitoring occurs regularly. The bettongs have been subsequently trapped to check their condition and all have been found to be close to, or above, their release weight and females have been observed to be carrying pouch young.

Despite some predation, 14 Eastern Bettongs were alive at the conclusion of Phase 2. Phase 3 has now commenced, with more releases planned and changes to the baiting program being implemented to increase operational efficiency.

Figure 5.2 One of the first Eastern Bettongs being released at the Lower Cotter Catchment.
Photo: Don Fletcher

5.5 Fauna and fire - threshold project

Conservation Research has been conducting research and survey work to build understanding of the response of native fauna to wildfire and planned fire to support strategic fire management planning. One component conducted in 2016 investigated the effect of 2003 fire severity and past fire frequency on the phylogenetic and functional diversity of mammals and birds. The project addressed the following question:

> *How does a gradient across fire severity and fire frequency influence faunal community assemblage metrics describing phylogenetic diversity, and ecosystem function?*

Mammal data was collected using camera trapping and observational techniques and was focused on wet montane forest communities in Namadgi National Park and Tidbinbilla Nature Reserve. In addition to fauna data at each mammal camera trapping site a set of vegetation data were also collected and later analysed for their contribution to fauna habitat components.

A total of 23 sites were surveyed across a range of fire frequency and severity classes. Camera trapping yielded a total of 7,860 images and 358 mammal detections of 18 species.

The results of this study indicate that fire frequency and severity have an impact on fauna habitat and on the phylogenetic and functional structure of faunal communities. A key implication for management includes highlighting the need to achieve heterogeneous fire regimes across the landscape to promote and maintain faunal diversity.

Figure 5.3 Detection of fauna using white-flash and infra-red camera traps.

Note: The image on the left was taken by a white flash camera trap and shows the cork tile on which two separate attractants were placed. The image on the right was taken by an infrared camera trap, designed to detect larger species, in this case a Red Fox.

5.6 Longitudinal study of groundcover flora condition- select grassy ecosystem sites

The conservation of the Australian Capital Territory's lowland grassy ecosystems is partly reliant on monitoring of their condition, and linking this monitoring to adaptive management practices. The Action Plans for ACT lowland grasslands and woodlands both highlight the need for monitoring the condition of these ecosystems to inform management activities. The ACT Commissioner for Sustainability and the Environment has also called for the implementation of monitoring programs in these ecosystems. The ACT Government has adopted the use of the Floristic Value Score (FVS) to quantify native grassland ecological condition. This recently-developed measure by Rainer Rehwinkel is widely used across the region for assessing grassland condition, with sites measuring five or more on the FSV scale being considered to have a floristic value sufficient to be identified as part of the Natural Temperate Grassland Endangered Ecological Community under the EPBC Act.

In total, 21 survey plots were retained for the 2016 survey season, located across 12 different sites. An additional 10 plots were added to the project, across the following locations: Mullanggari Nature Reserve, North Mitchell, Gungaderra Nature Reserve, Crace Nature Reserve, Dunlop Grasslands Nature Reserve, Pinnacle Nature Reserve, Kama Nature Reserve, Jerrabomberra East Nature Reserve and Jerrabomberra West Nature Reserve. These plots were selected to examine trends in floristic and vegetation structure attributes in areas of low condition (i.e. plots dominated by exotic grass, broadleaf or significant weed species).

Floristic and vegetation condition measures

Within each 20 x 20 m plot, the following variables were recorded:

- **Floristics**: All vascular plant species present within the survey plot were recorded to species level if identification was possible, otherwise to genus level. When plants were difficult to identify in the field, samples taken for later identification using herbarium reference material.

- **Cover**: Each taxa recorded in the plot (both native and exotic) was assigned a cover value based on a modified Braun-Blanquet scale.

- **Vegetation structure**: Broad composition and structural data was collected from a 100 m step-point transect, running 50 m away from the survey plot (from the star picket) then returning back for another 50 m (Tables 5.2). Each step along the 100 m transect was assigned one of the following classes: perennial native grass, other native, cryptogam (moss/lichen), bare earth, rocks, litter/dead vegetation, annual exotic grass, perennial exotic grass or exotic broadleaf.

Plot summaries

The year-to-year change in FVS and native species richness has been stable (within 25%) for the majority of plots (Table 5.2a, b). However, the year to year change in exotic species richness was more variable (Table 5.2c), with many plots increasing over the 2009–12, 2012–13 and 2013–14 periods. The 2009–12 period experienced the greatest variability in year-to-year change, possibly because it was the longest period between surveys.

In 2015–16, 85% of plots had stable native species richness, and 60% of plots had stable exotic species richness. This period also had a high rate of plots with a stable FVS (75%).

Table 5.2 Summary of percentage changes in floristic variables for plots: Floristic Value Score; native species richness and exotic species richness.

(a) Floristic Value Score	# plots				
	2009–12	2012–13	2013–14	2014–15	2015–16
> –100% decline					
–100% to –50% decline					
–50% to –25% decline	2	2	3	2	3
–25% decline to 25% increase (relatively stable)	11	13	17	15	14
25% – 50% increase	1	4	4	1	1
50% to 100% increase	3			2	
≥ 100% increase	2				
Total	*19*	*19*	*24*	*20*	*18*

(b) Native Species Richness	2009–12	2012–13	2013–14	2014–15	2015–16

> –100% decline					
–100% to –50% decline					
–50% to –25% decline	1	1	1	1	2
–25% decline to 25% increase (relatively stable)	12	14	19	17	15
25% – 50% increase	4	4	4	2	1
50% to 100% increase	2				
≥ 100% increase					
Total	*19*	*19*	*24*	*20*	*18*
(c) Exotic Species Richness	**2009–12**	**2012–13**	**2013–14**	**2014–15**	**2015–16**
> –100% decline					
–100% to –50% decline		2			
–50% to –25% decline	2	7		3	2
–25% decline to 25% increase (relatively stable)	3	9	5	17	11
25% – 50% increase	6	1	10		4
50% to 100% increase	7		6		1
≥ 100% increase	1		3		
Total	*19*	*19*	*24*	*20*	*18*

Note: Data are the number of plots in each time period that have exhibited the percentage change listed. Note that only 18 of the 31 plots surveyed in 2016 had comparable data available between survey years. Only plots with comparable data were included in this table.

Conclusions and recommendations

This report examined trends in a range of floristic and vegetation structure attributes across 31 monitoring plots located in grasslands and grassy woodlands of the ACT, between 2009, 2012, 2013, 2014, 2015 and 2016. Twelve plots were located in grasslands, thirteen plots in grassy woodlands, and six plots in secondary grasslands. The report found that:

- FVS, native species richness and exotic species richness were stable (less than 25% change on the previous year) across the majority of plots.
- The FVS of one plot (GO04) declined by more than 25% in the 2015–16 season. Over half of the plots experienced an increase in the FVS, however the majority also experienced an increase in exotic species richness. Consequently, the majority of plots experienced an increase in total species richness.
- Significant weed species richness remained stable in the majority of plots and increased in five plots.

- Only four of the plots surveyed in 2016 had no significant weed species present.
- Changes in FVS and native and exotic species richness differed between grasslands, secondary grasslands and woodlands. Most notably, native species richness declined in a higher proportion of woodland and secondary grassland plots. In addition, the FVS in woodlands tended to be higher, despite having the highest rate of plots with a decreased FVS in 2016.
- Structurally, native grass cover decreased in 11 plots and other native cover declined in nine plots. The majority of plots experienced increases in exotic perennial and broadleaf cover, with only one plot decreasing slightly in exotic broadleaf cover.

5.7 Mountain Spiny Crayfish – bait choice, escapism and wildlife camera detection

The ACT has two species of montane *Euastacus* 'spiny' crayfish. These two species, *Euastacus rieki* and *Euastacus crassus*, inhabit the streams and bogs in the mountain areas of the ACT. Relatively little is known about their biology or distribution in the ACT, however, they are known to require permanent water, be restricted by cool temperature and suspected of being long lived. Based on their habitat requirements, these two species are likely to be highly susceptible to the impacts of climate change, including increases in temperature and reduction in water availability.

Baited trapping was selected by the previous research as the most practical and efficient sampling technique for determining crayfish distribution and abundance in the ACT. However it was noted that this method is not without its own inherent sampling bias and inefficiencies. For example, trap escapism is speculated but the rate at which it occurs is unknown and it requires at least 7 cm of water depth to submerge the trap entry holes which limits its utility in bogs and fens. In an attempt to improve this sampling method, laboratory research was conducted. Issues investigated included simple bait choice experiments and in-tank escapism trial monitoring.

Six different bait types were included:

- three dog foods: beef, mixed chicken/pasta/vegetables, sausage
- cat food (canned)
- carrot
- frozen fish (trout)

Crayfish were given a choice of two baits. A total of 15 combinations of bait were replicated six times to provide a sample size of n=90. Throughout the trial the crayfish showed no preference for a particular bait, although they spent more time on trout, carrot and cat food. Additional trials were undertaken between carrot and trout, and dog food (sausage) and trout with 20 replicates to further examine the relationships between these options and the current trout bait.

To investigate escapism, a simple experiment was conducted on nine nights using separate crayfish. A bait trap baited with trout was introduced to the tank and 1-minute time-lapse cameras used to

determine the entry and time spent in the trap between 4 pm and 9 am. Out of the nine trials, five crayfish did not escape overnight while the other four did. The quickest to escape did so in less than an hour. Some crayfish were also able to enter and exit the trap multiple times in a night.

Due to the limitation on bait traps and video or time lapse analysis a further trial was undertaken to determine if wildlife cameras can detect crayfish terrestrially in motion sensor mode. A Reconyx Hyperfire wildlife camera (Figure 5.5) was set up so that the motion sensor function would detect the movement of crayfish as they explore the habitat above the water between 5 pm and 9 am. The camera successfully detected the terrestrial wandering of the crayfish.

Figure 5.5 A crayfish is detected by motion sensors at night using a Reconyx Hyperfire wildlife camera.

These short-term studies have indicated that there is no compelling reason to change from the current bait choice (trout). It also indicates that there is additional work to be done on escapism and capture efficiency, and that motion-sensing wildlife cameras may be an option in bogs and fens where bait traps are not effective.

5.8 Murrumbidgee River - fish monitoring

The Murrumbidgee River is the largest river in the Canberra region. It is impacted by a large number of current and historic threats in the ACT and surrounding catchment. These threats include water extraction and flow modification, erosion and sedimentation, degraded riparian vegetation, urban and rural pollution and invasive species. The Murrumbidgee River still supports a number of native fish species, including threatened species such Trout Cod, Macquarie Perch and Murray Crayfish, and

recreationally important species such as Golden Perch and Murray Cod (listed as Special Protection Status in the *ACT Nature Conservation Act 2014* and vulnerable nationally in the EPBC Act). The river is also part of the water supply network for Canberra, with both the Cotter Pump Station and the recently completed Murrumbidgee to Googong Pipeline (M2G) able to extract water from the river.

The Murrumbidgee Fish Monitoring program is undertaken biennially to monitor the fish populations in the Murrumbidgee River in the ACT region and inform management of the river and threatened, pest and recreational fish species. Capture methods included boat electrofishing, overnight netting with fyke nets and bait traps. In 2017 ten sites on the Murrumbidgee River were surveyed. The six sites within the ACT form part of the ACT Government's long-term monitoring of the Murrumbidgee River. In 2017 an additional site, above Uriarra was surveyed in the ACT between Casuarina Sands and the junction with the Molonglo River with the view to including it as a long-term site to assist in monitoring water extraction and urban encroachment. The other three sites are upstream of the ACT and, with several of the ACT sites, are surveyed as part of an ongoing baseline for Icon Water's Murrumbidgee to Googong Pipeline Project. Many of the sites are within the Upper Murrumbidgee Demonstration Reach.

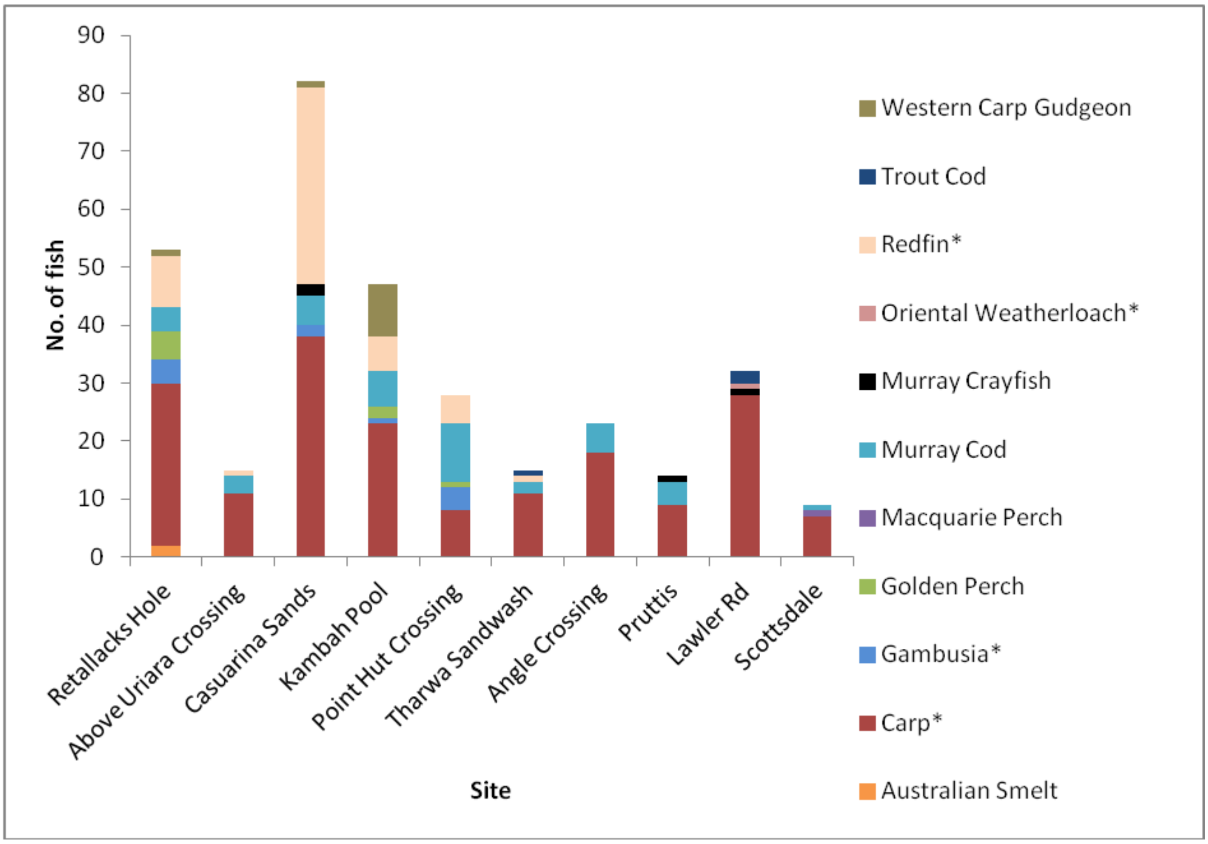
Figure 5.6 Murray Crayfish captured during the 2017 Murrumbidgee monitoring.

(Photo: M Jekabsons)

In 2017, 318 fish were captured from 11 species including three ACT threatened species (Murray Crayfish, Trout Cod and Macquarie Perch) and four pest species. All the Trout Cod recorded in 2017 were considered to have the potential of being hybrids with Murray Cod. Hybridisation has recently been detected and highlighted for Trout Cod in the Upper Murrumbidgee. Additional work is required to understand the level and impact of hybridisation on both species. Figure 5.7 shows the numbers of fish caught for each site. Carp are present at all sites. Nationally or ACT-listed threatened species were recorded at all sites. Murray Cod were recorded at all sites except Lawler Road where a

Trout Cod or Trout Cod hybrid was recorded. Murray Cod juveniles were well-represented upstream of Kambah Pool. In comparison to 2015 the Point Hut site recorded a large number of juvenile Murray Cod where previously it has had the lowest proportion of native fish abundance.

Figure 5.7 Number of fish caught during the 2017 Murrumbidgee River Monitoring.



Note: * indicates alien species. Sites are in order of downstream to upstream.

5.9 Riparian condition - surveys 2016–2017

In 2016 Conservation Research designed and establishment a long-term riparian condition monitoring study in the two most extensive wooded riparian communities in the ACT. The need for consistent baseline data was an identified priority of the 2007 ACT Aquatic and Riparian Zone Conservation Strategy. Building on detailed earlier spatial mapping and survey work by Conservation Research that described the range and extent of riparian communities within the jurisdiction, a new quantitative survey of River Sheoak riparian forest and Ribbon Gum very tall riparian woodland was conducted in spring 2016. Stratification of the two communities was based on previously recorded riparian geomorphic variation and overstory canopy state. Condition data collected was consistent with the site condition component of the NSW Biometric Native Vegetation Assessment Tool (Gibbons et al. 2009).

A review of spatial data indicated that riparian forest historically occupied close to 800 ha of floodplain within the ACT. Only approximately 113 ha (14%) of remnant canopy remains intact, due

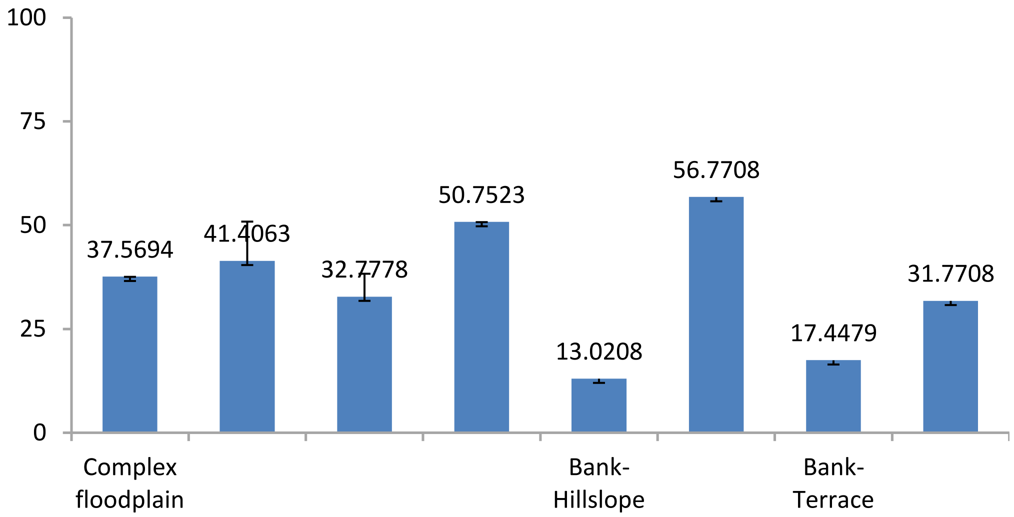
largely to a lack of recovery on floodplains away from the wetted margins following the 2003 fire. The majority of this remnant River Sheoak vegetation was determined to be in moderate condition against reference state. Approximately 536 ha (68%) was classified as having no remnant or regenerating canopy in poor to moderately poor condition against reference state.

A review of spatial data indicated that Ribbon Gum very tall riparian woodland historically occupied close to 400 ha of floodplain within the ACT. Approximately 178 ha (45%) of remnant canopy remains intact. Only 13 ha was recorded on lowland alluvial terraces of the Murrumbidgee River corridor reserves due to past clearing, fire, and weed invasion and was in moderate condition against reference state. Ribbon Gum woodland occurs in highly fragmented, isolated stands over a modified understory. Of the lowland floodplain presumed to historically host the community, 78 ha of Ribbon Gum woodland was recorded to have no remnant or regenerating canopy in poor condition against reference state.

In contrast, previously undocumented Ribbon Gum woodland in southern Namadgi National Park was recently mapped by Conservation Research, including over 100 ha of intact, moderate to high condition vegetation. Unfortunately much of this has been subjected to widespread defoliation/dieback associated with the Eucalyptus Weevil (*Gonipterus* sp.), which is known to be the primary defoliating agent associated with 'Monaro Dieback'.

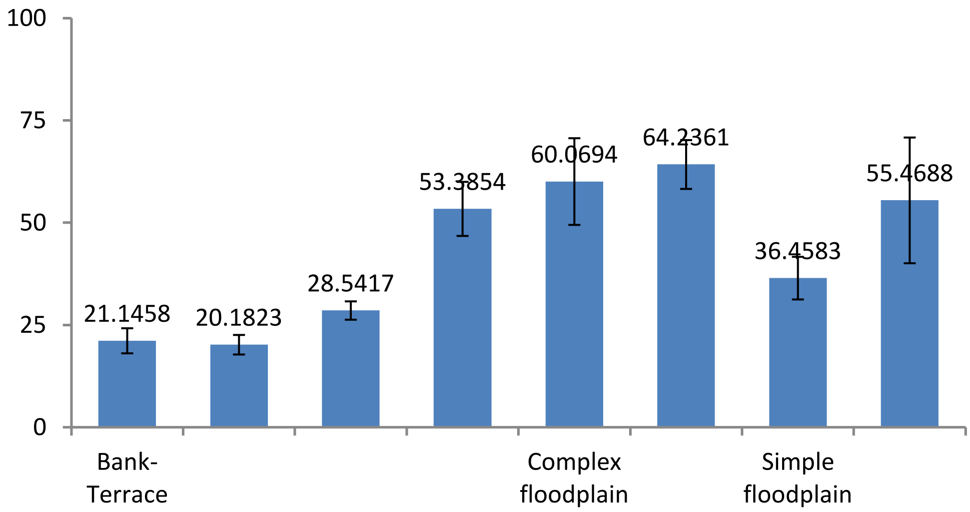
The quantitative monitoring methods and an understanding of the state of ecosystem health and dynamics established in this project will inform ongoing management of these ecosystems and long-term monitoring. The methodology and baseline data from this project will contribute to development of a Conservation Effectiveness Monitoring Program (CEMP) for aquatic and riparian ecosystems within the ACT reserve network.

Figure 5.8 Mean condition scores (+/– SE) within sampled stratification units of River Sheoak riparian forest.



Note: Scores are a percentage value against benchmark condition.

Figure 5.9 Mean condition scores (+/– SE) within sampled stratification units of Ribbon Gum very tall riparian woodland.



Note: Scores are a percentage value against benchmark condition.

Figure 5.10 Reference condition Ribbon Gum very tall riparian woodland in southern Namadgi National Park.

Figure 5.11 Monitoring site within moderate high condition River Sheoak riparian forest at Woodstock Nature Reserve.

5.10 Rosenberg's Monitor – camera survey

Rosenberg's Monitor (*Varanus rosenbergii*) is one of two rare monitors or goannas in the Canberra region. Seen relatively often until the 1960s, the Lace Monitor (*Varanus varius*) is now extremely rare, being reported less than once per decade in the region. Rosenberg's Monitor is rare but widespread, with only occasional sightings in parts of Namadgi National Park, along the river corridors and in the few areas of Canberra Nature Park where it still remains (Mount Ainslie, Mount Majura and Rob Roy Nature Reserves). Rosenberg's Monitor is listed as threatened in NSW, Victoria and South Australia.

Both goanna species seem to have disappeared from parts of their former ACT range such as Black Mountain, Mulligans Flat, Goorooyarroo Nature Reserve and Tidbinbilla Nature Reserve, but it is hard to be sure because there has previously been no effective survey method. When they were abundant, the two goanna species are likely to have exerted beneficial regulatory pressure on

woodland ecosystems, along with other missing predators such as the slightly smaller Eastern Quoll and Masked Owl and the slightly larger Spotted-tail Quoll and Carpet Python. Some of the missing woodland species are potential candidates for reintroduction, for example at Mulligans Flat Woodland Sanctuary and elsewhere.

Since 2015, volunteers Matthew Higgins and Don Fletcher have been gathering information on Rosenberg's Monitors at Mount Ainslie through observation, supported by the use of remote automatic wildlife cameras. In January 2016 Matthew recorded what is believed to be the first footage in the ACT of a breeding pair, including the female laying eggs. A second breeding female was identified in February 2017. This monitoring continued throughout the summer of 2016/17.

In 2017 a larger survey project was established to develop and apply a suitable method for surveying Rosenberg's Monitors using baited wildlife cameras. It is thought that the method could detect either species of goanna. The initial stage of the project was conducted along the Naas Valley Fire Trail in the Namadgi National Park. Nineteen wildlife cameras (a combination of Little Acorns and Reconyx) were positioned along the road and baited with rabbit carcasses (Figure 5.12). The cameras were re-baited after one week and retrieved from the field after three weeks. Analysis revealed 16 of the 19 cameras had recorded images or video of Rosenberg's Monitors, making the Naas Valley a hotspot for the species. Such patches are typical of declining species, locally extinct in some sites (such as Black Mountain), and generally rare but still abundant in other sites (such as Naas).

The second stage of the project was an evaluation of alternative camera types, settings and camera positions in relation to the bait to determine an optimal survey protocol. Five camera stations were positioned along the Naas Valley Fire Trail (Figure 5.12, camera location numbers 5, 6, 7, 8 and 12). Each camera station had four cameras (three Little Acorns and one Reconyx) set to record on either a trigger or time-lapse mode and to record pictures or video. Preliminary results indicate that the Little Acorn cameras detect significantly more Rosenberg's Monitors than the Reconyx cameras and are therefore the most suitable camera to use in future stages of the project. Analysis of photo and video imagery collected from this stage of the project is ongoing.

A third stage of the project, which is yet to commence, is to conduct a Mark-Resight estimation of goanna abundance in sites of interest across the ACT region, including Naas Valley, Black Mountain, Goorooyarroo, Mount Majura and Mount Ainslie. Facial recognition of individual goannas may be possible, thus enabling mark-resight estimates of goanna density. Mark-Resight is equivalent to the 'Capture-Mark-Recapture' method except animals are not marked because they can be individually recognised. Special thanks to volunteers Don Fletcher and Matthew Higgins for their expertise and Ryl Parker for assistance with field work.

Figure 5.12 Camera locations along the Nass Valley Fire Trail.

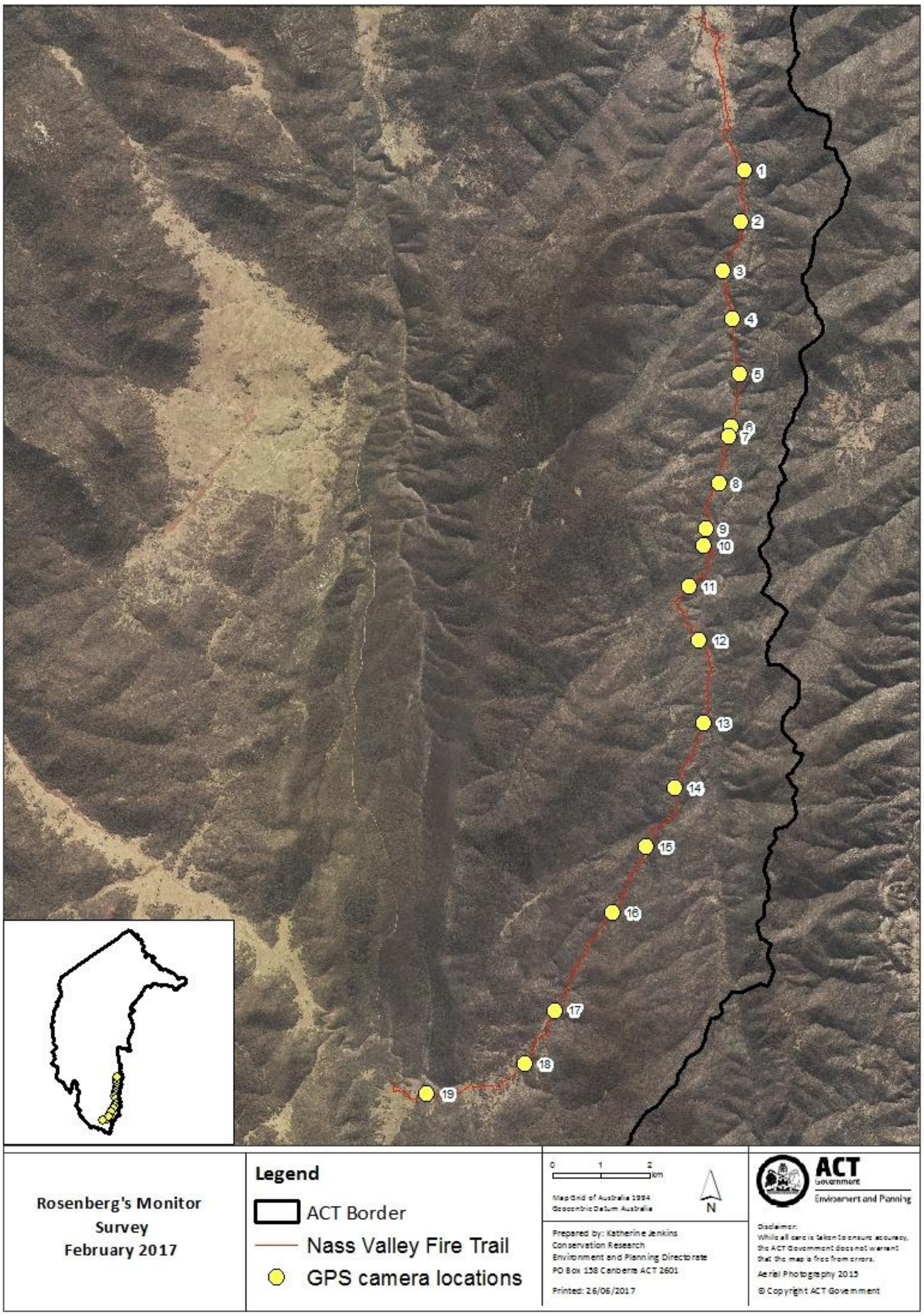


Figure 5.13 Setup of Stage 2 camera stations.

Photo: Katherine Jenkins (above); Matthew Higgins (below)

Figure 5.14 A female Rosenberg's Monitor at Mount Ainslie Nature Reserve.

5.11 Vegetation map of the ACT

Mapping of vegetation communities has continued through 2015 and 2016. To date 184,964 hectares of vegetation has been mapped with the final 20,000 hectares to be completed by the end of June 2017. The mapping defines 62 different mapping units (see Table 5.3), 44 of which are naturally occurring vegetation communities dominated by native species. A total of 14 mapping units represent vegetation altered by human activities such as clearing for the development of agriculture of forestry or planted vegetation. The final four mapping units represent land not predominantly covered by vegetation. Urban areas of the ACT are not covered by this mapping, although it will include Canberra Nature Park reserves. The accuracy assessment of the mapping is ongoing and will not be finalised until the project is complete, however overall accuracy is currently 76%.

The mapping has documented the distribution of 13 natural vegetation communities that are either endemic to the ACT or have the majority of their distribution in the ACT. The project has also mapped the distribution of six natural communities that have been heavily cleared or fragmented and may warrant nomination as endangered.

The mapping will ultimately be augmented using Light Imaging Ranging and Detection data to attribution structural information such as percentage canopy and shrub cover, mean tree height, maximum tree height and the standard deviation of tree height.

The mapping is currently being used in planning for prescribed fire, dieback severity modelling, habitat modelling and supporting information for the new woodland conservation strategy. The mapping is publicly available on ACTMapi.

Table 5.3 The area covered by natural vegetation communities and other mapping units in the ACT.

Vegetation Mapping Units	Hectares	Vegetation Mapping Units	Hectares
Alpine Ash - Mountain Gum +/– Snow Gum wet sclerophyll open forest_u239	7518.9	Mountain Gum - Snow Gum +/– Robertson's Peppermint grass-forb very tall woodland to open forest_u22	8054.0
Alpine Baeckea - Swamp Heath - Candleheath - Sphagnum moss wet heathland_a2	186.6	Mountain Plum Pine - Kosciuszko Rose heathland_a54	129.4
Alpine Sallee shrub-grass sub-alpine mid-high woodland_u158	378.4	Native Grassland_NG	15022.1
Amenity Planting Exotic_APE	267.0	Native Shrubland_NS	187.9
Amenity Planting Native_APN	327.0	Natural Temperate Grassland_NTG	423.6
Apple Box - Broad-leaved Peppermint tall shrub-grass open forest primarily on granitoids_u29	11066.0	Plantation Exotic_PLE	8950.5
Aquatic Fringing Vegetation_AFV	33.7	Prickly Snow Grass - Carex gaudichaudiana sub-alpine valley grassland_a14	78.7
Arboriculture_ARB	58.4	Red Box tall grass-shrub woodlands primarily on hillslopes and footslopes_q6	1429.9
Black Cypress Pine - Brittle Gum tall dry open forest on hills_u191	131.9	Red Stringybark - Broad-leaved Peppermint dry sclerophyll grassy open forest_p23	35.8
Black Sallee grass_herb woodland in drainage depressions and moist valley flats_u118	2615.9	Red Stringybark - Scribbly Gum - Red-anthered Wallaby Grass tall grass-shrub dry sclerophyll open forest_p14	7140.8
Black Sheoak - Silvertop Ash shrubby dry scleophyll forest_p10	20.8	Ribbon Gum - Robsertson's Peppermint very tall wet sclerophyll open forest_u52	16876.6
Blakely's Red Gum - Yellow Box +/– White Box tall grassy woodland_u19	3643.7	Ribbon Gum very tall woodland on alluvial soils along drainage lines_p520	173.8
Broad-leaved Peppermint - Candlebark tall dry sclerophyll open forest of quartz rich ranges_u21	14417.9	River Bottlebrush - Burgan rocky riparian tall shrubland_u181	320.8
Broad-leaved Peppermint - Mountain Gum shrubby tall open forest_u150	6181.4	River Red Gum ± Apple Box very tall grass-forb riparian woodland on alluvial flats_u173	0.1
Broad-leaved Peppermint - Mountain Gum tall shrub-grass open forest_u105	2956.7	River Sheoak riparian forest along major watercourses_p32d	235.8
Button Tea-tree - Yellow Kunzea - Burgan dry heathland_g36	405.2	River Tussock - Kangaroo Grass - Rush wet tussock grassland_r2	1375.0
Derived Native Forest_DNF	789.7	Robertson's Peppermint - Red Stringybark very tall grass-forb sheltered open forest_u152	2218.9
Derived Native Shrubland_DNS	3156.7	Robertson's Peppermint very tall shrubby open forest_u165	1140.6
Derived Native Woodland_DNW	3470.3	Rock	56.6
Drooping Sheoak low woodland to open forest on shallow infertile hillslopes_q1	607.9	Sand	68.7

Environmental Planting Native_EPN	719.4	Small-fruited Hakea - Drumstick Heath - Swamp Heath sub-alpine wet heathland_u193	142.2
Exotic Forest_EXF	721.8	Small-fruited Hakea - Mountain Baeckea - Myrtle Tea-tree sub-alpine wet heathland_e59	63.2
Exotic Grassland_EXG	8647.8	Snow Gum - Candlebark tall grassy woodland in frost hollows and gullies_u27	14449.8
Exotic Shrubland_EXS	679.0	Snow Gum - Drumstick Heath - Myrtle Tea-tree tall woodland to open forest of drainage depressions_u23	332.8
Exotic Woodland_EXW	340.3	Snow Gum - Mountain Gum - Mountain Bitterpea tall dry grass-shrub sub-alpine open forest_u28	18224.3
Jounama Snow Gum - Snow Gum shrubby mid-high woodland_u207	4679.1	Snow Gum grassy mid-high woodland_u78	86.4
Kurrajong - Australian Blackthorn - Kangaroo grass shrub-grass mid-high open woodland on limestone karsts_u178	3.5	Sub-montane moist tussock grassland_r1	1465.2
Leafy Bossiaea - Mountain Cassinia - Mueller's Kunzea - Mountain purplepea heathland_a33	195.4	Tufted Sedge - Small River-buttercup - Common Reed aquatic herbfield of waterways_a9	239.4
Mealy Bundy - Broad-leaved Peppermint shrubby mid-high open forest on granite substrates_u18	3580.4	Urban_URB	1585.7
Mealy Bundy - Red Stringybark grass-forb mid-high open forest_u66	1952.1	Water	894.1
Mountain Gum - Blackwood tall wet sclerophyll open forest primarily on granitoids_u53	94.4	Yellow Box +/- Apple Box tall grassy woodland_u178	3714.5
		Total Area	**184964.5**

6. RECREATIONAL ANGLING

6.1 Recreational fisheries - stocking and monitoring

The ACT Government conducts an annual fish stocking program in accordance with the ACT Fish Stocking Plan 2015–20. The Plan outlines the numbers and species of fish to be stocked across the ACT for 2015 to 2020 and provides guidance for other stocking activities that may take place, such as research or conservation stockings. The Stocking Plan can be found at http://www.environment.act.gov.au/cpr/fish/fisheries_management/fish-stock-plan-for-the-australian-capital-territory-2015-2020

The ACT Government funded the stocking of 13,000 Murray Cod and 37,000 Golden Perch in the 2015–16 season and 16,000 Murray Cod and 16,000 Golden Perch in the 2016–17 season. Additional fish stocking was funded by the National Capital Authority and the Canberra Fisherman's Club.

Each of the four stocked lakes is surveyed every three years using boat electrofishing. Monitoring of the fish communities provides data on the proportion of pest species, identifies growth and success of stocking events, identifies natural breeding events and allows for the detection of disease outbreaks and new pest species.

Gungahlin Pond and Yerrabi Pond were monitored during the 2015–16 season. A total of 141 fish across five species were caught during the 2015–16 urban lakes monitoring program (Table 6.1). Overall, the most common species caught was Golden Perch with 42 caught, however Carp (*Cyprinus carpio*) were the dominant species in terms of biomass at 47%. This figure is the mean between the two water bodies and varied from 10% in Yerrabi Pond to 71% in Gungahlin Pond where Carp was the most abundant species (Figure 6.1). Carp were first detected in Yerrabi Pond in 2011. Golden Perch were the dominant species in Yerrabi Pond in terms of both abundance and biomass. The largest Golden Perch has the potential to be up to 18 years old which equates with the first stocking into Yerrabi Pond in 1997–98.

The largest Murray Cod caught in Gungahlin Pond is likely to be a nine year old fish from the 2006–07 stocking. A Murray Cod fish kill in Yerrabi Pond in October 2014 may have affected the number and biomass of this species caught during sampling.

Table 6.1 Numbers of fish caught in urban lakes monitoring, 2015–2016.

<table>
<tr><th></th><th></th><th colspan="2">Murray Cod</th><th colspan="2">Golden Perch</th><th colspan="2">Carp</th><th colspan="2">Redfin</th><th colspan="2">Goldfish</th><th colspan="2">Total</th></tr>
<tr><td rowspan="2">Gungahlin Pond</td><td>Dam wall</td><td>7</td><td rowspan="2">18</td><td>4</td><td rowspan="2">8</td><td>22</td><td rowspan="2">36</td><td>0</td><td rowspan="2">8</td><td>0</td><td rowspan="2">1</td><td>33</td><td rowspan="2">71</td></tr>
<tr><td>Mid lake</td><td>11</td><td>4</td><td>14</td><td>8</td><td>1</td><td>38</td></tr>
<tr><td rowspan="2">Yerrabi Pond</td><td>Dam wall</td><td>4</td><td rowspan="2">5</td><td>23</td><td rowspan="2">34</td><td>3</td><td rowspan="2">3</td><td>18</td><td rowspan="2">23</td><td>3</td><td rowspan="2">5</td><td>51</td><td rowspan="2">70</td></tr>
<tr><td>Mid lake</td><td>1</td><td>11</td><td>0</td><td>5</td><td>2</td><td>19</td></tr>
<tr><td>Total</td><td></td><td></td><td>23</td><td></td><td>42</td><td></td><td>39</td><td></td><td>31</td><td></td><td>6</td><td></td><td>141</td></tr>
</table>

Figure 6.1 Percentage biomass of species in urban lakes monitoring, 2015–2016.

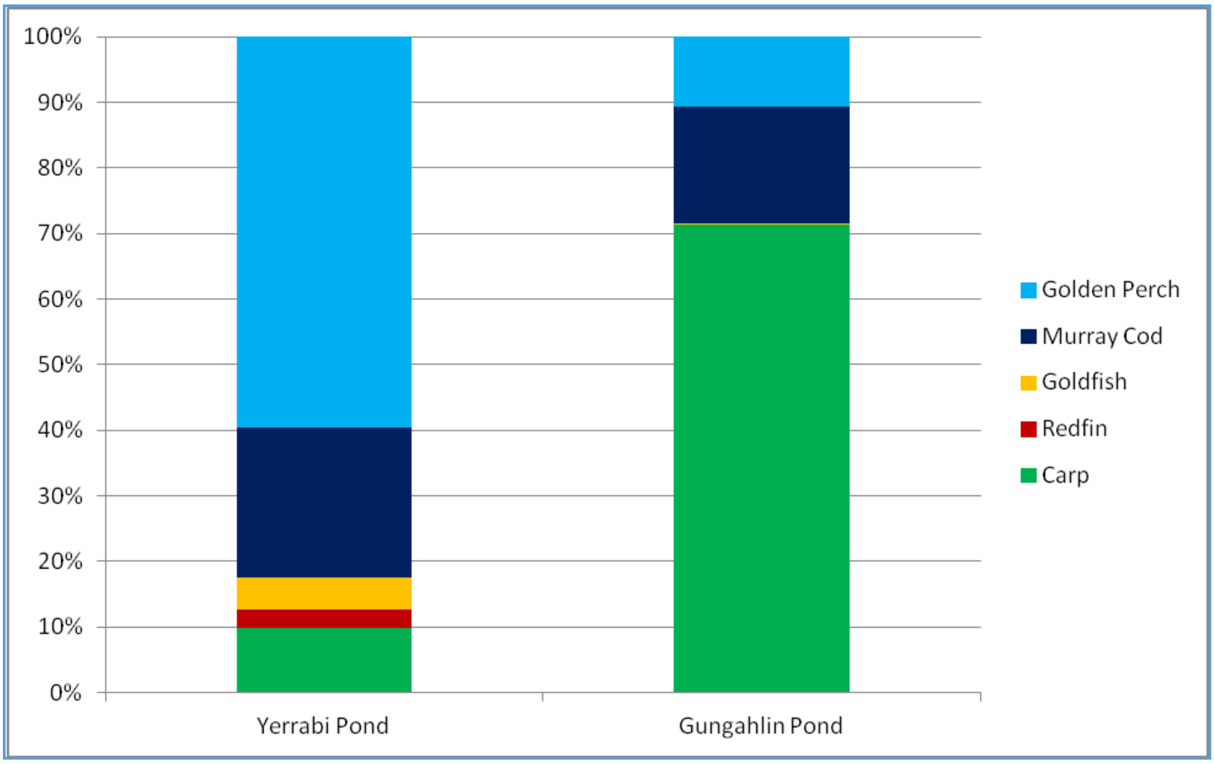


Figure 6.2 Murray Cod being measured during urban lake monitoring.

Figure 6.3 Boat electrofishing at Yerrabi Pond.

7. CONSERVATION STRATEGIES AND ADVICE

7.1 Aquatic and Riparian Conservation Strategy

An updated Aquatic and Riparian Conservation Strategy, with accompanying threatened-species action plans, has been drafted and reviewed by the ACT Scientific Committee. The vision in the Strategy is 'Healthy waterways supporting diverse aquatic and riparian flora and fauna, and providing high quality ecosystem services'. The Strategy has been supported by the ACT Government Scientific Committee and will be available for community consultation soon.

7.2 Native Grassland Conservation Strategy

The Native Grassland Conservation Strategy and Action Plans document is the result of a review of the original Action Plan 28: Lowland Grassland Conservation Strategy (2005). Conservation Research has prepared a revised Draft Strategy and reviewed the related species and community action plans.

In late 2015, staff from Conservation Research provided an overview of an early draft of the Native Grassland Conservation Strategy to representatives of the Conservation Council (a key stakeholder). In 2016 the Draft Strategy and the eight associated Action Plans, were circulated to relevant staff within the Environment, Planning and Sustainable Development Directorate, the ACT Parks and Conservation Service (land managers and key stakeholders) and the Land Development Agency within the Chief Minister, Treasury and Economic Development Directorate.

In March 2017 the ACT Government released the Draft Strategy and Action Plans for a six-week public consultation period. During consultation the Conservator received 12 submissions. These submissions were from individuals (3), community organisations (4), government agencies (3) and environmental consultants (2). Overall, the submissions were generally supportive of the Draft Strategy and Action Plans. The Draft Strategy and Action Plans are being revised after taking these submissions into consideration. The Native Grassland Conservation Strategy and Action Plans is due to be released before the end of November 2017.

8. TECHNICAL REPORTS AND AUTHORED PAPERS

Technical reports

Technical Report 31 - Risk Assessment for the Importation of Native Reptiles into the ACT. Will Osborne and Murray Evans (May 2015).

Technical Report 32 - Conservation Research and Conservation Planning Program report 2013–15 (November 2015).

Technical Report 33 - A Simple but Useful Map of Vegetation Structure In and Near Canberra. Claire Wimpenny, Brett Howland and Don Fletcher (November 2015).

Technical Report 35 - Distribution and ecology of the Broad-toothed Rat in the ACT. Richard Milner, Danswell Starrs, Greg Hayes and Murray Evans (October 2016).

Technical Report 36 - Factors influencing the flowering of the Tarengo Leek Orchid *(Prasophyllum Petilum).* Nicholas Wilson, Julian Seddon and Greg Baines (November 2016).

Technical Report - Conservation Effectiveness Monitoring Program: an overview. Renee Brawata, Ben Stevenson and Julian Seddon (April 2017).

Authored papers

Batson, W. G., Gordon, I. J., **Fletcher, D. B**., and Manning, A. D. (2015) The effect of pre-release captivity on post-release performance in reintroduced eastern bettongs (*Bettongia gaimardi*). *Oryx*, First View, 1-10.

Batson, W. G., Gordon, I. J., **Fletcher, D. B**., and Manning, A. D. (2015) Translocation tactics: A framework to support the IUCN Guidelines for wildlife translocations and improve the quality of applied methods. *Journal of Applied Ecology*, 52, 1598–1607.

Batson, W. G., **Fletcher, D. B**., Portas, T., Crisp, H., Ryan, S., **Wimpenny, C**., Gordon, I. J., and Manning, A. D. (2016). Re-introduction of eastern bettong to a critically endangered woodland habitat in the Australian Capital Territory, Australia. In: IUCN Global Reintroduction Perspectives Series: 2016. Ed Sooare, PS. IUCN, Species Survival Commission, Reintroduction Specialist Group.

Batson, W. G., Gordon, I. J., **Fletcher, D. B**., Portas T. J. and Manning, A. D. (2017) The effect of pre-release captivity on the stress physiology of a reintroduced population of wild eastern bettongs *Journal of Zoology* doi:10.1111/jzo.12494

Fancourt, B., Sweaney, B. and **Fletcher, D.** (2017) More haste, less speed: pilot study suggests camera trap detection zone could be more important than trigger speed to maximise species detections. *Australian Mammalogy* Online Early, https://doi.org/10.1071/AM17004.

Howland, B., Stojanovic, D., Gordon, I.J., **Fletcher, D., Snape**, M, Stirnemann I., and Lindenmayer, D.B., (2016) Habitat preferences of the threatened striped legless lizard: implications of grazing

by native herbivores and livestock for conservation of grassland biota. *Austral Ecology* 41, 455 – 464

Lowe, Andrew, Anita K. Smyth, Ken Atkins, Ron Avery, Lee Belbin, Noleen Brown, Amber E. Budden, Paul Gioia, Siddeswara Guru, Mel Hardie, Tim Hirsch, Donald Hobern, John La Salle, Scott R. Loarie, Matt Miles, Damian Milne, Miles Nicholls, Maurizio Rossetto, **Jennifer Smits**, Ben Sparrow, Gregston Terrill, David Turner, Glenda M. Wardle (2017) Publish openly but responsibly. Science 357(6347):141 July 2017.

Martin J. Westgate MJ, Scheele BC, Ikin K, Hoefer, AM, Beaty, RM, **Evans M**, Osborne O, Hunter D, Rayner L, Driscoll D. 2015. Citizen science program shows urban areas have lower occurrence of frog species, but not accelerated declines. *PLOS online* http://dx.doi.org/10.1371/journal.pone.0140973.

McFadden, M., Hunter, D., **Evans, M.**, Scheele, B., Pietsch, R. And Harlow, P. 2016. Reintroduction of the northern corroboree frog in the northern Brindabella mountains, New South Wales, Australia. In Global Reintroduction Perspectives: 2016. *Case-studies from around the globe*. (Ed P. S. Soorae) pp. 35-39. IUCN Reintroduction Specialist Group, Gland Switzerland.

Milner, R.N.C., Starrs, D., Hayes, G. and **Evans, M**. 2015. Distribution and habitat preference of the broad-toothed rat (*Mastacomys fuscus*) in the Australian Capital Territory, Australia. *Australian Mammalogy* 37: 125