



## 7.3.2 Pressures

### Pest species

#### Why is this indicator important?

Australia's Biodiversity Conservation Strategy 2010–2030<sup>91</sup> lists alien species and genetically modified organisms as a threat to biodiversity. Introduced species cause extensive damage to native ecosystems. They contribute to extinctions by predation, habitat alteration and outcompeting native species.

#### Current monitoring status and interpretation issues

In the ACT, non-indigenous terrestrial species (vertebrates, invertebrates, plants and pathogens) are prescribed as pests through the *Plant Diseases Act 2002* and the *Pest, Plants and Animals Act 2005*. These Acts allow the Minister to identify and manage pest plants and animals that threaten the ACT's land and aquatic resources.

It is not possible to monitor the distribution and abundance of all introduced species. Therefore, the monitoring of introduced species concentrates on those organisms known to be causing significant problems or posing significant threats.

Monitoring of pests also focuses on abundance and extent rather than the effects pests are having on biodiversity outcomes. Thus, this indicator primarily provides information about the distribution of pests. The indicator also provides some general information about the impacts or threats these pests cause or may cause to biodiversity. However, there are few reliable, quantitative measurements for the environmental damage inflicted by pests. With the exception of domestic cats, most information on damage is qualitative or anecdotal.

#### What does this indicator tell us?

This indicator examines the distribution (and abundance, where possible) of non-indigenous species identified as pests. These include:

- vertebrate pests
  - cats (*Felis catus*)
  - Fallow Deer (*Dama dama*), Red Deer (*Cervus elaphus*), Sambar Deer (*Rusa unicolor*)
  - dogs (*Canis lupus familiaris*)
  - foxes (*Vulpes vulpes*)
  - goats (*Capra aegagrus hircus*)
  - horses (*Equus ferus caballus*)
  - rabbits (*Oryctolagus cuniculus*)
  - pigs (*Sus scrofa domesticus*)
  - Indian Myna (*Acridotheres tristis*)
- aquatic pests
  - Carp (*Cyprinus carpio*)
  - Redfin Perch (*Perca fluviatilis*)
- plant pests (see Table 7.18 for the species list)
  - grassy weeds
  - herbaceous weeds
  - woody weeds.

#### Vertebrate pests

##### Cats (domestic)

Canberra is the location of one of the few comprehensive Australian (and international) studies of predation by domestic cats.<sup>92</sup> This study found that domestic cats caught more than 67 species of prey. Small, introduced mammals (rats and mice) were caught most often, followed by birds (27%, of which 14% were native), native reptiles (7%), native frogs (1%) and native mammals (1%).

The study also assessed the spatial effect, and interactions of habitat and urban edge for reptiles and birds. Reptiles, although a minor proportion of the cats' prey overall, were the most preyed species within 50 m of grassland habitat and accounted for 23% of prey within 50 m of woodland or open forest. The percentage of native birds as prey increased closer to woodland habitats. Domestic cats are generally more active for longer periods in spring and summer, which corresponds with the breeding cycle



of many prey species. The level of predation on birds and reptiles also confirms that domestic cats were actively hunting during the day, and cats favoured ground-foraging and ground-dwelling species. Birds were caught in the early morning and reptiles in the afternoon.

Significantly, reptiles and frogs were the third- and fourth-most important prey types. However, the catch of these small prey types may be much higher than that reported by cat owners, as smaller animals are more likely to be consumed at the site of capture and not brought home.

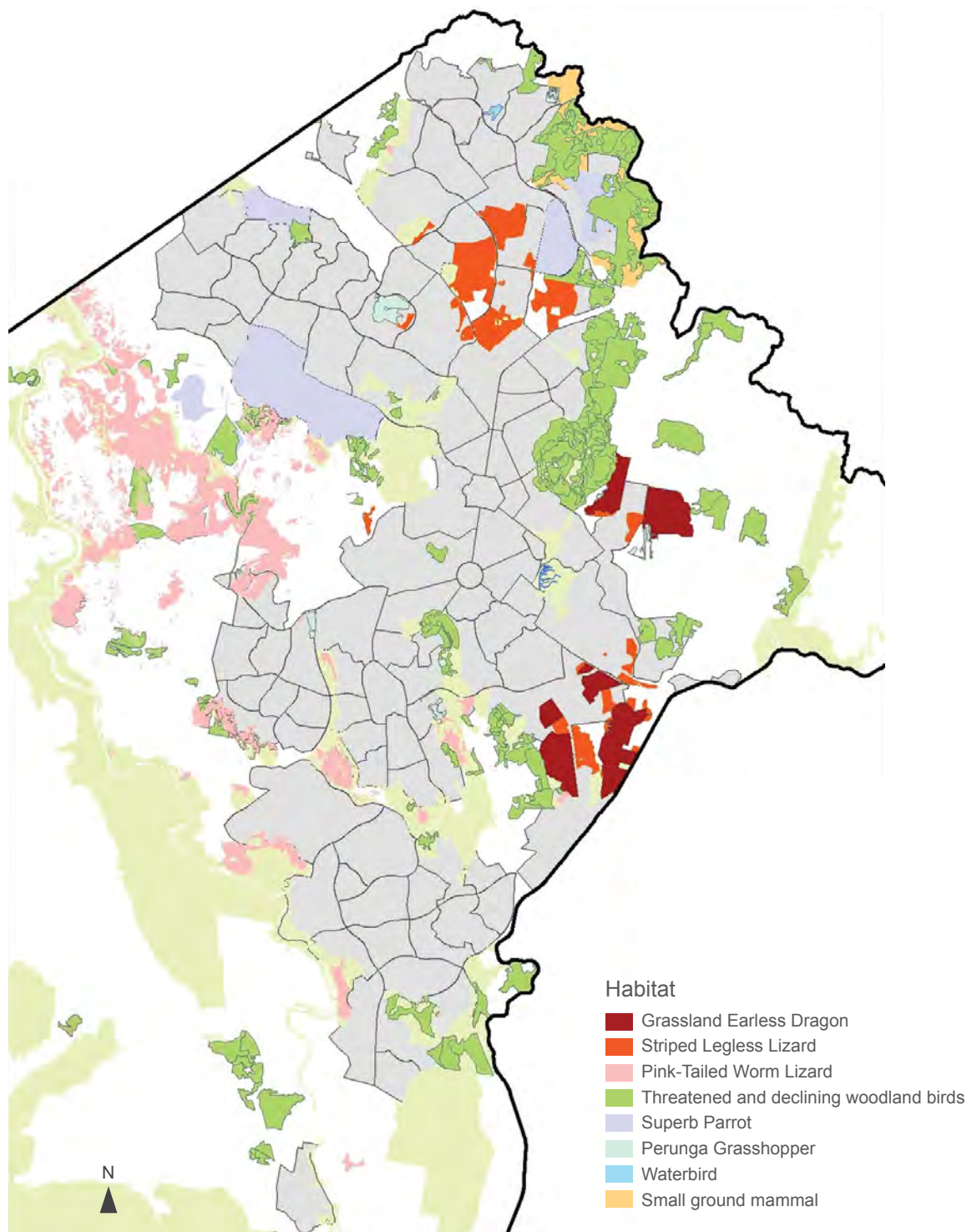
To identify areas where stray and domestic cats may have the greatest impact on wildlife, the known ACT habitat of all threatened species and some declining

woodland bird species that fall within the categories of 'fauna of concern' was mapped (Figure 7.29). The map shows that the existing policy of applying cat containment only to new suburbs adjoining nature reserves has created an isolated mosaic of declarations that does not reflect the potential predation threat that domestic cats pose to vulnerable native wildlife across the ACT. Most cat containment suburbs adjoin older suburbs that have no containment rules, even though they may border the same nature reserves.



The suburb of Crace is a cat containment area

Photo: Office of the Commissioner for Sustainability and the Environment



Source: Eyles & Mulvaney<sup>92</sup>

**Figure 7.29 Cat predation hotspot areas in the ACT**



### *Cats (stray and feral)*

A stray cat is one that has been kept as a pet and has become lost or abandoned; a feral cat is one that has been born in the wild and has had little contact with humans. A proportion of the uncontained cats in the ACT may become unowned or stray cats. These cats may then contribute to the feral cat population if they breed.

The stray cat population in the ACT is difficult to estimate; however, it is likely to exceed 25 000, which is approximately equal to the domestic cat population. In 2012, 2261 cats and kittens were taken to the ACT RSPCA shelter. Of these, 1154 (51%) were strays, 408 (18%) were feral and 610 (27%) were owned cats.

Where stray or feral cats rely solely on hunting, their population density may be quite low (eg in the Brindabella Ranges), with recorded densities as low as 0.2 cats per square kilometre has been recorded. However, where food supply is supplemented by human sources, such as around tip sites, schools or shopping centres, densities can rise dramatically. A density of 19–90 stray or feral cats per square kilometre was recorded around Canberra tips, noting that these data are from the 1990s.<sup>92</sup>

Less is known about the impact of stray and feral cats on biodiversity than of domestic cats.

The ACT has no formal programs to manage stray or feral cats.

### *Deer (feral)*

Deer sightings in the ACT have been steadily increasing during the past 10 years. Three of the six species of feral deer in Australia occur in the ACT. Fallow Deer are the most abundant and widely distributed species, occurring in small groups in river valleys including the Murrumbidgee, Naas, Paddys and Molonglo rivers. Small numbers are also present in woodland reserves in the north-eastern ACT. Red Deer are present in the Naas Valley and adjoining areas of Namadgi National Park. Sambar Deer sightings have shown a marked increase in the past two years, and they are now present in low numbers throughout the northern and western parts of Namadgi National Park and adjoining rural land.

A deer sightings register was established in 2008–09 for reports from staff, landholders and the public. There were 21 sightings reported in 2013–14: 4 Fallow Deer, 11 Red Deer, 4 Sambar Deer and

2 unknown. None of these records were outside the known range for any of the species in the ACT.<sup>93</sup>

Deer management poses a challenge to public and private land managers due to the animals' cryptic and wary behaviour. Ground shooting is a time-consuming and therefore costly exercise, but is currently the most effective technique available for reducing deer populations. There are currently no registered toxins for poisoning deer and, while trapping is possible, there are animal welfare concerns with such flighty animals becoming badly injured in traps.

In 2013–14, the PCS conducted a trial in Namadgi National Park of timed wildlife feeders to attract deer to improve the efficiency and safety of shooting programs. Unfortunately, the trial was unsuccessful in attracting Fallow or Red Deer, despite their presence in the area in which the feeder was located.

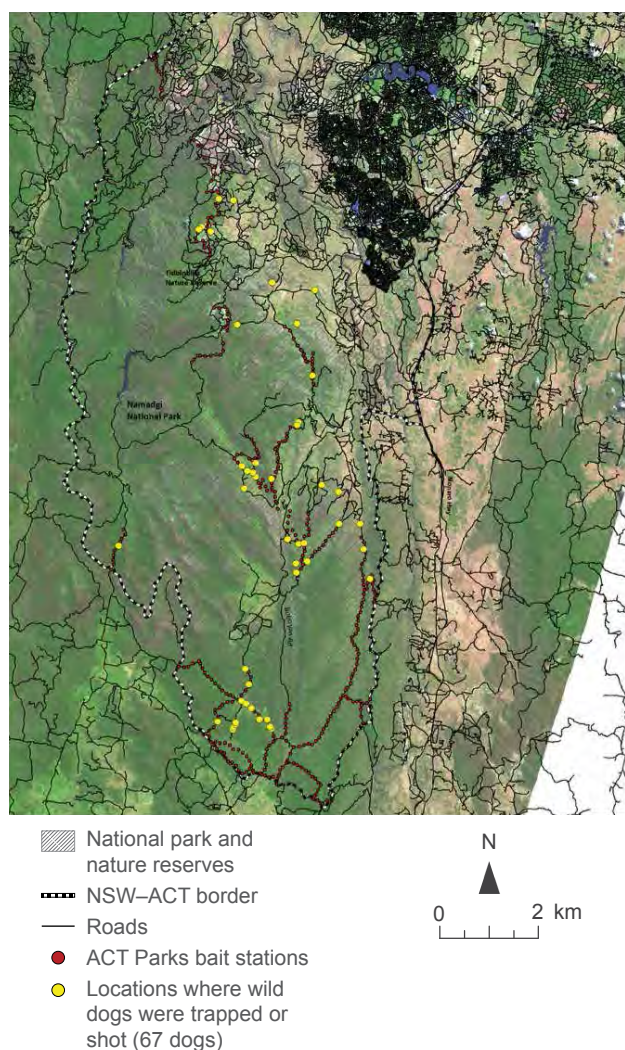
### *Dogs (feral)*

Wild dogs are controlled in designated areas of Namadgi National Park and adjoining nature reserves to minimise attacks on neighbouring sheep. Management involves 1080 poison baiting, 1080 ejectors, trapping and opportunistic shooting. This integrated approach also achieves effective fox management in dog-control areas. However, wild dogs are protected in core reserve areas, including the Gudgenby Valley, Cotter Catchment and Tidbinbilla Nature Reserve, where they are the top-order predator in the ecosystem.

In 2013–14, PCS staff conducted regular 1080 poison baiting, with 23 separate trails baited each month (Figure 7.30). The western side of the Blue Range Recreation Area was baited in spring and autumn in accordance with the Brindabella and Wee Jasper Wild Dog/Fox Control Plan. All baits are buried to reduce nontarget poisoning of native species such as quolls and scavenging birds. Baits are also supplied free of charge to ACT landholders for cooperative baiting; 301 baits were supplied to six landholders adjoining Namadgi National Park in 2013–14.

The PCS's full-time vertebrate pest officer is responsible for wild dog trapping. This trapping is backed up by a contract dog trapper to cover peak dog-activity periods. Traps used are rubber-lined leg-hold traps. Table 7.15 shows the number of wild dogs killed and the number of hours worked by the officer and contractor.





**Figure 7.30** ACT locations where wild dogs were baited, trapped or shot, 2013–14

**Table 7.15** Number of wild dogs killed and trapping effort, 2013–14

2013–14 quarter	Dogs shot	Dogs trapped	Trapper hours
July–September	0	6	489
October–December	2	11	529
January–March	1	20	535
April–June	3	24	763
<b>Total</b>	<b>6</b>	<b>61</b>	<b>2316</b>



#### Foxes

No abundance or population data for foxes were available for the reporting period.

#### Goats (*feral*)

Goats are the other main pest species controlled by the PCS; however, none were recorded as being shot during 2013–14. Between 5 and 10 goats are still present in the Molonglo River Corridor near Coppins Crossing, from where approximately 60 goats were mustered in 2009–10 to protect the nearby National Arboretum.

#### Horses (*feral*)

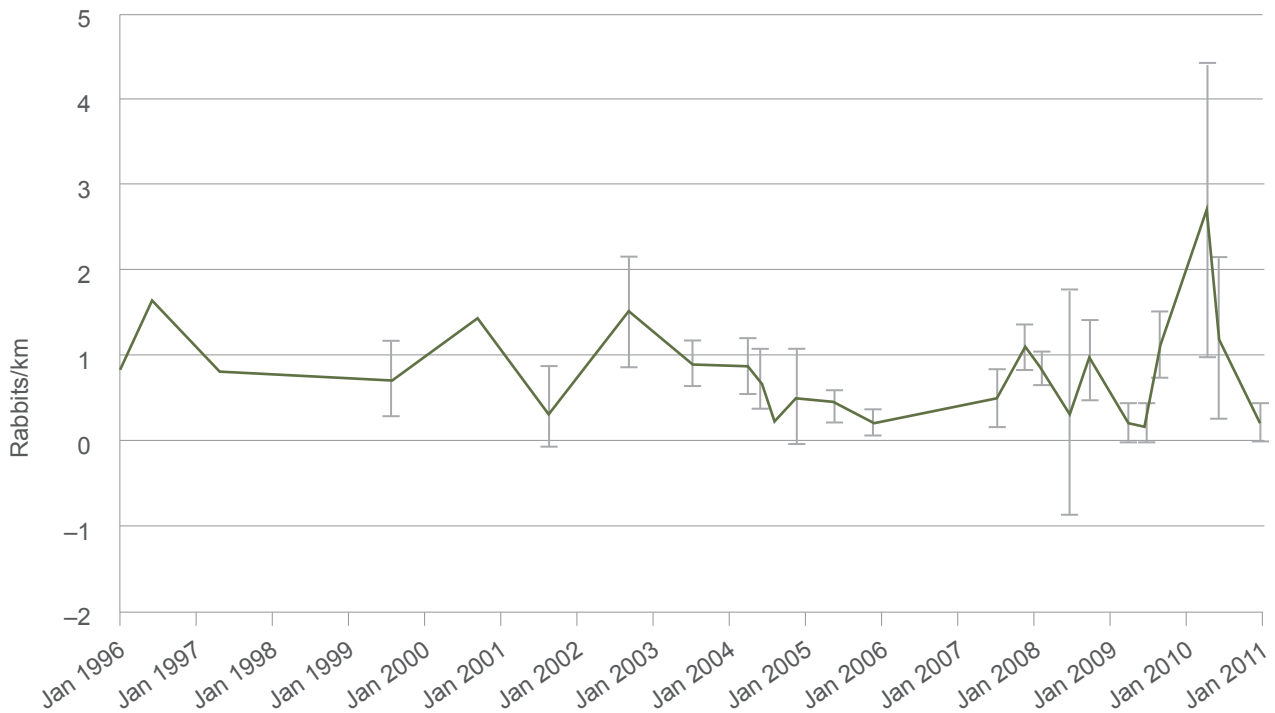
Feral horses within Namadgi National Park damage sensitive subalpine wetlands and bogs, which provide habitat for the rare and endangered Northern Corroboree Frog. Although only a few (15–20) horses are involved, they have already caused damage to subalpine vegetation. If the current small feral horse population in Namadgi is permitted to grow and expand its range, there will be increasing damage to sensitive ecosystems, with deleterious impacts on biodiversity.<sup>94</sup> This issue is acknowledged in the *Namadgi National Park Feral Horse Management Plan 2007*.<sup>95</sup>

#### Rabbits

Rabbit populations are monitored by counting rabbits using the spotlight method while driving transects of known length, to give an index of rabbit abundance expressed as rabbits per kilometre. In 2013–14, it was not possible to conduct the quarterly spotlight counts that form the long-term monitoring within Namadgi National Park, because the wet conditions made driving on the tracks impossible or it was raining during the scheduled count weeks during the new moon. Spotlight counts at Googong Foreshores<sup>q</sup> were conducted in August and October 2010, and May 2011, and show that rabbit numbers remain low (less than two rabbits per kilometre) in the areas monitored (Figure 7.31).

Spotlight counts are also used to assess the effectiveness of each rabbit management program by counting rabbits along the same transects before and after management. Rabbit control programs conducted at Jerrabomberra Wetlands in 2010 and 2011 have reduced numbers (Figure 7.32). At Orroral Valley in 2011, warrens were fumigated and then ripped, with some follow-up shooting. However, rabbits were only reduced by 57% despite combining three management techniques. It appears that significant numbers of rabbits remained in areas characterised by pockets of tea tree or rocky knolls, where it was not possible to rip warrens and rabbits may have been living on the surface. Poisoning may be required in these areas.

q Note that 'Googong Foreshores' and 'Googong Nature Reserve' are used interchangeably to reflect the difference in naming in source documents that are provided to the Office of the Commissioner for Sustainability and the Environment for this report.



km = kilometre

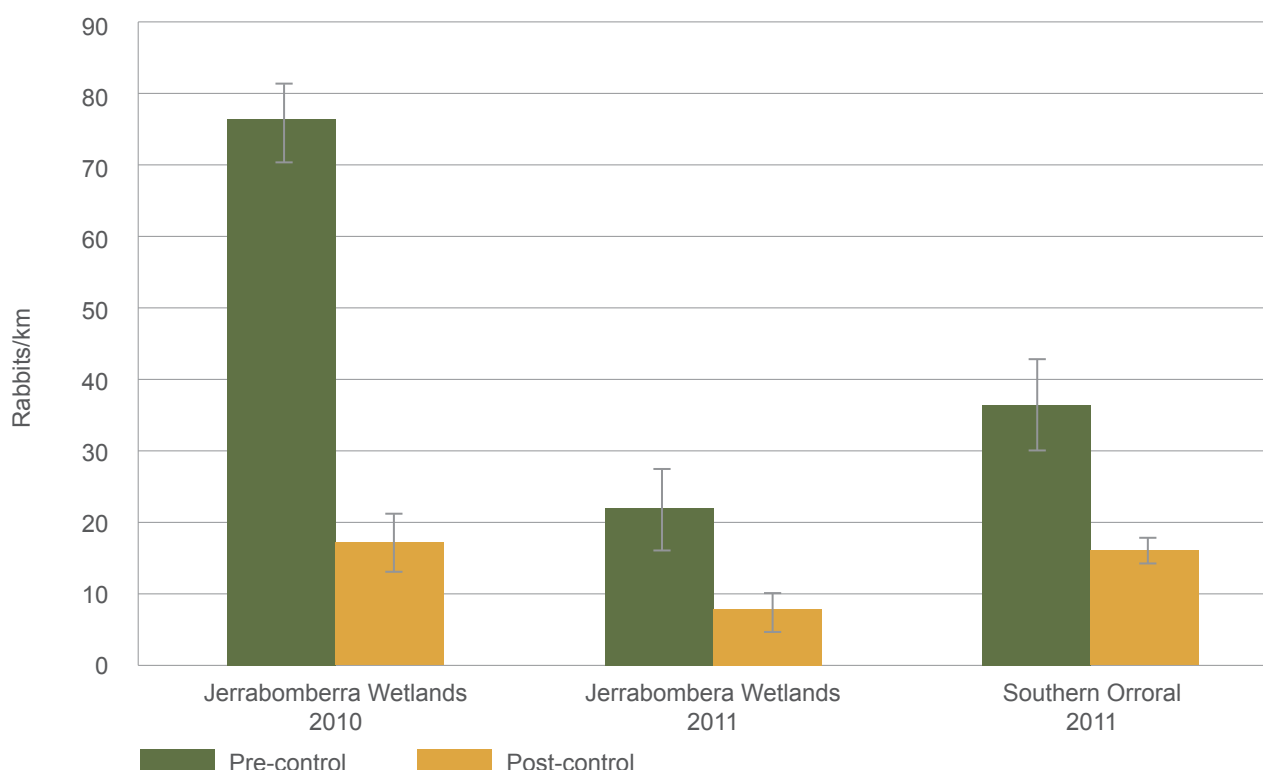
Note: Bars show 95% confidence intervals.

**Figure 7.31 Googong Nature Reserve rabbit counts, 1996–2011**



The urban development of Coombs is very close to the river corridor, requiring land management treatments to mitigate the negative impacts of the urban edge. These include changes to hydrology, waterborne contamination, soil erosion, impact on water quality affecting aquatic habitat, disturbance to wildlife habitats, predation on wildlife from cats and dogs, increased invasive weeds and feral animals, light spill and increased noise disturbing nesting, and increased collision

Photo: TAMS, ACT Government



Note: Bars show standard errors

**Figure 7.32 Abundance of rabbits before and after control**

#### *Pigs (feral)*

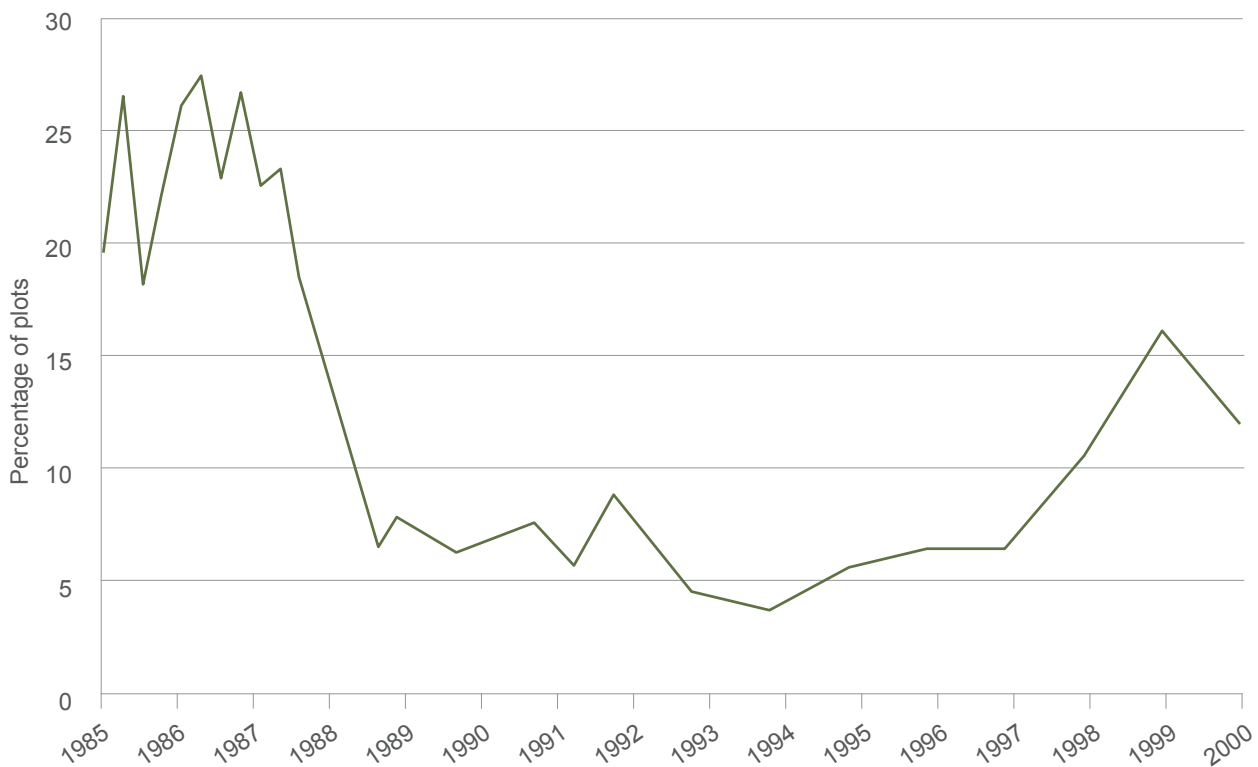
The abundance of pigs in Namadgi National Park was assessed each year from the mid-1980s by Professor Jim Hone of the University of Canberra. The data show the dramatic decline in ground-roosting impact resulting from the instigation of the annual warfarin poison baiting program in the park in the late 1980s (Figure 7.33). This monitoring program concluded in 2009. The PCS instituted a follow-on monitoring program in 2011–12.

In 2011, pigs were baited across 11 broad areas of Namadgi National Park; 9 by vehicle (52 road sections) and 2 (Booth Range and Blue Gum) via helicopter. After pig feeding was initiated and confirmed using unpoisoned (free feed) wheat, 1080-poisoned wheat was laid under rigid plastic tubs secured to the ground by pegs. Pigs were able to flip the tubs, but nontarget species could not access the bait. Remote fauna cameras on bait stations were used to determine the number of pigs feeding, and to confirm that no other species accessed the poisoned bait.

During the 18-day program, 1080-poisoned bait was eaten by pigs at 18 central bait stations; 45 out of 74 pigs that were individually identified from camera footage were observed eating bait and did not return so are presumed to have died. Unfortunately, there was a high degree of disturbance from illegal pig hunters during the program, which disrupted poisoning and ended the program in several areas that usually support high pig numbers. In areas that were not disturbed, there was a 21% increase in wheat bait take compared with PIGOUT® bait take in 2010. A total of 1303 staff hours were involved in undertaking the Namadgi National Park pig program.

No pigs were reported at Tidbinbilla Nature Reserve in 2013–14. Ten pigs were trapped or shot at Googong Nature Reserve and eight at Freshford near Bullen Range Nature Reserve.





**Figure 7.33** Percentage of monitoring plots with pig rooting, 1985–2000

#### Indian Myna

Indian Mynas were introduced to the Canberra region in 1968, where they have shown a distinct liking for woodland nature reserves and are strong competitors with native wildlife for food and nesting hollows. They are now well established across the ACT. Indian Mynas are very aggressive and intelligent, and are known to evict native birds (including parrots, kookaburras and peewees) from their nests, dumping out their eggs and chasing them from their roosting areas.<sup>96</sup>

In 2006, the Canberra Indian Myna Action Group was formed to reduce the impact of this exotic invader on native birds and other animals. Following the group's concentrated trapping and removal effort using traps made by inmates at the Alexander Maconochie Centre (Table 7.16), the most recent assessment of the threat of this pest is that the aggregate numbers of the Indian Myna across Canberra and surrounding districts is declining. This is also evident from slowed capture rates, although there is a suspicion that this pest has become wary of Indian Myna traps.<sup>97</sup> COG now lists Indian Mynas as the 18th most common bird in Canberra.

**Table 7.16 Indian Mynas trapped and removed, 2010–2014**

	2010–11	2011–12	2012–13	2013–14
Number of mynas trapped and removed	5560	4181	3549	3338

Source: Canberra Indian Myna Action Group<sup>97</sup>

### Aquatic pests

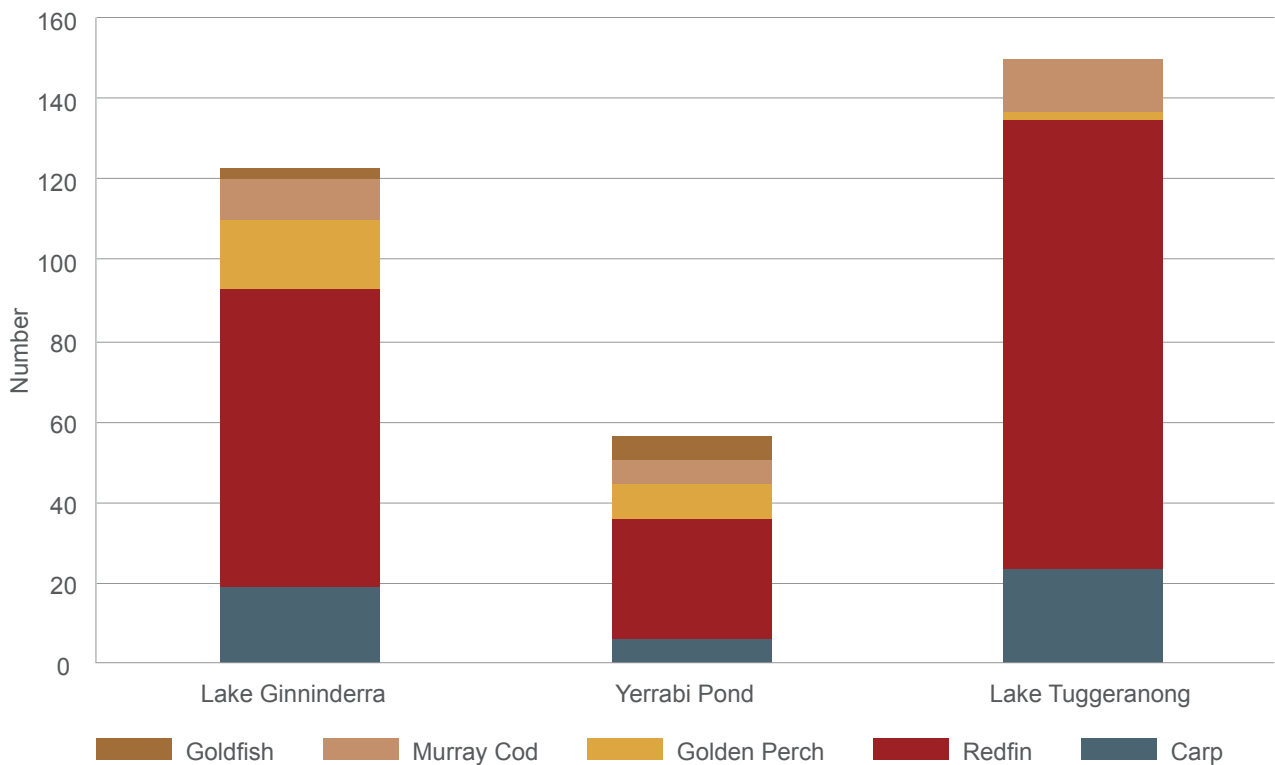
The ACT's stocked recreational fisheries are surveyed every two years using boat electrofishing. This monitoring provides data on the proportion of pest species, identifies growth and success of stocking events, identifies natural breeding events, and allows the detection of disease outbreaks and new pest species. CPR surveyed Yerrabi Pond (two sites) and lakes Tuggeranong (two sites) and Ginninderra (three sites) in 2013–14 and 2014–15.

A total of 327 fish from two native and three introduced species were recorded (Figure 7.34). Redfin Perch was the most abundant species, comprising 65% of the total catch by number. However, due to their small size, Redfin Perch comprised 5% of the biomass (Figure 7.35). In Yerrabi Pond, Carp comprised 68% of the total biomass. This figure is likely to increase in future surveys because the Carp invasion into Yerrabi Pond is recent. (Carp were initially detected in Yerrabi Pond in 2010.) The 2011–12 survey found that the Carp biomass in that water body was 18%; this figure has increased to 44% in the latest survey.

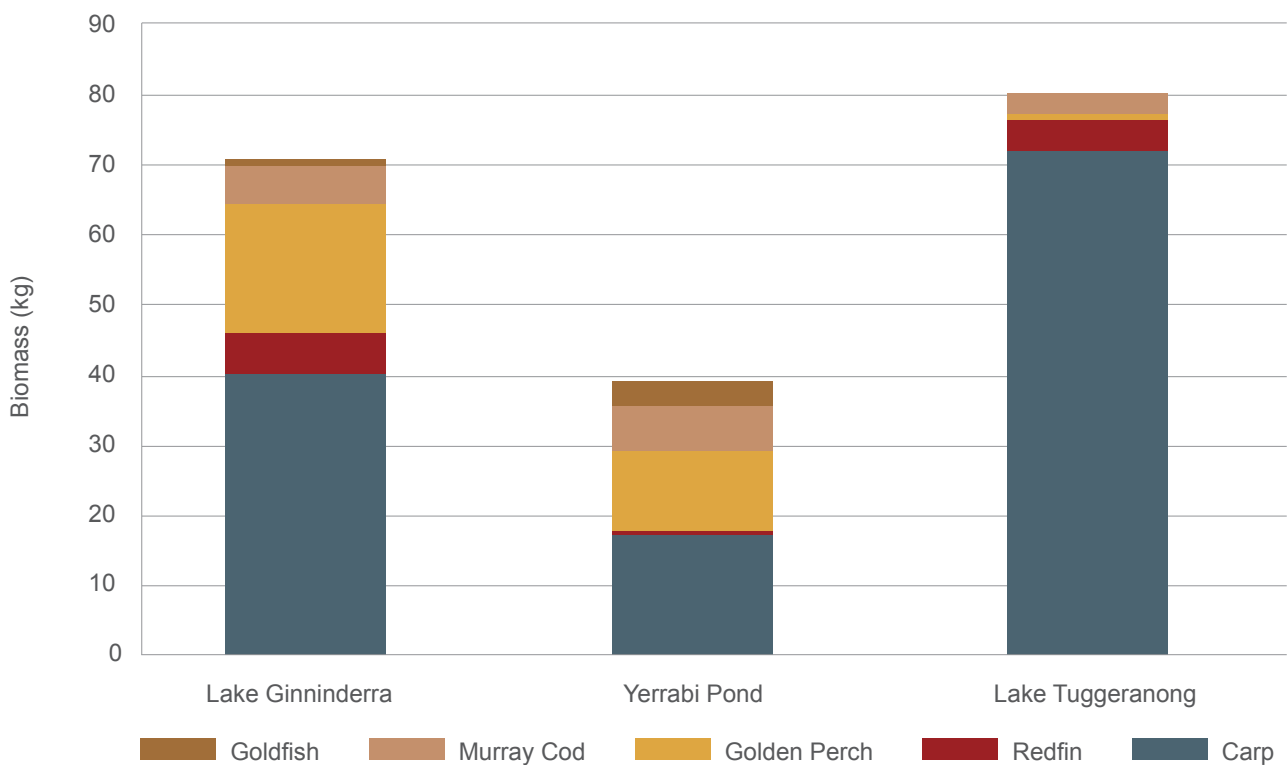


The vulnerable Two-Spined Black Fish is restricted to the Cotter River Catchment in the ACT

Photo: Mark Jekabsons, ACT Government



**Figure 7.34 Fish caught during the urban lakes surveys, 2013–2015**



**Figure 7.35 Biomass of fish caught during the urban lakes surveys, 2013–2015**



### Pest plants

Weeds in the ACT are categorised into:

- weeds of disturbed areas, which invade lawns, footpaths, nature strips and playgrounds, and often affect amenity
- invasive weeds,<sup>98</sup> which are introduced plants that spread aggressively and cause damage to the environment, economy, and human or animal health. Impacts include smothering native vegetation, reducing farm income, preventing use of recreational areas, triggering allergic reactions and poisoning grazing animals. Most invasive weeds are introduced plants from overseas (eg Blackberry from Europe, Serrated Tussock from South America). Some are native plants that have been introduced to an area from outside their natural range (eg Cootamundra Wattle). Invasive weeds that occur in native vegetation are also called environmental weeds.<sup>99</sup>

Data are not available to report on the extent and abundance of weed species. However, we do know that 602 different weed species are known to be in the ACT, of which 312 are introduced weeds and 290 are environmental weeds (Table 7.17).<sup>98</sup> Of the 290 environmental weeds, only 96 species are targeted for control.

Around one-third of environmental weed species are targeted for control because of their invasiveness and impact (Table 7.18). In 2013–14, 16 637 ha was controlled for weeds in the ACT, comprising:

- grassy weeds (4974 ha)
- herbaceous weeds (2516 ha)
- woody weeds (2355 ha)
- St John's Wort (3697 ha)
- Blackberry (3095 ha).

**Table 7.17 Weed species in the ACT, 2014–15**

Total species of vascular plants	Total indigenous native plants	Introduced, but not an environmental weed	Total introduced species	Target for control			Limited action	Total
				Frequently	Occasionally	Total		
1645	1043	312	602	17	79	96	194	290



**Table 7.18 Weed control in the ACT, by species, 2013–14**

Weed species	Isolated (ha)	Lightly scattered (<1% cover) (ha)	Scattered (1–10% cover) (ha)	Scattered/ patchy (10–50% cover) (ha)	Dense (>50% cover) (ha)	Total control area (ha)	Total area weeds destroyed (ha)
African Boxthorn	0.0	7.8	0.0	0.0	0.0	7.8	0.1
African Fountain Grass	0.0	0.0	1.2	0.0	0.0	1.2	0.1
African Lovegrass	1.3	2.7	232.3	1632.2	4.1	1872.6	504.4
Alligator Weed	0.0	0.0	0.0	0.0	2.6	2.6	2.0
Black Alder	0.0	0.0	0.0	1.5	0.0	1.5	0.5
Black Willow	41.2	0.0	6.2	19.0	0.0	66.4	6.4
Blackberry	30.6	26.0	1664.6	1239.7	134.4	3095.3	556.5
Broom	2.7	1.4	1.0	0.1	0.0	5.2	0.1
Butterfly Bush	0.3	124.0	0.0	0.0	0.0	0.3	0.0
Caltrop	0.0	0.0	4.5	10.9	0.0	15.4	3.5
Caper Spurge	0.0	0.0	0.3	0.0	0.0	0.3	0.0
Chilean Needlegrass	0.0	0.0	234.1	156.7	17.7	420.9	72.1
Chinese Pistachio	0.7	0.0	0.0	0.0	0.0	0.7	0.0
Cootamundra Wattle	0.0	0.0	0.0	0.0	2.8	208	2.1
Crack Willow	3.7	0.0	9.6	38.2	0.0	51.5	12.0
Crown Vetch	0.0	0.0	0.0	0.0	0.1	0.1	0.1
European Nettle Tree	0.0	6.2	0.0	0.1	0.0	6.3	0.1
Firethorn	0.0	7.8	4.4	0.0	0.0	12.1	0.3
Garden Asparagus	0.0	0.6	0.0	0.0	0.0	0.6	0.0
Gazania	0.0	0.0	0.0	0.0	0.4	0.4	0.3
Giant Knotwood	0.0	0.0	0.0	3.4	0.0	3.4	1.0

*continued*

## 7 Biodiversity

Table 7.18 *continued*

Weed species	Isolated (ha)	Lightly scattered (<1% cover) (ha)	Scattered (1–10% cover) (ha)	Scattered/ patchy (10–50% cover) (ha)	Dense (>50% cover) (ha)	Total control area (ha)	Total area weeds destroyed (ha)
Giant Parramatta Grass	0.2	0.0	0.0	0.0	0.0	0.2	0.0
Goat Willow	1.3	0.0	0.0	0.0	0.0	1.3	0.0
Gorse	0.1	0.0	0.0	0.0	0.0	0.1	0.0
Hawthorn	0.0	0.0	14.4	206.3	0.1	220.9	62.7
Honeysuckle	0.0	0.0	0.0	0.5	0.0	0.5	0.2
Horehound	0.0	0.0	0.0	238.5	0.0	238.5	71.6
Khaki Weed	0.0	0.0	2.0	7.9	0.0	9.9	2.5
Madagascan Fireweed	9.2	4.2	268.0	0.0	0.0	281.5	13.5
Moth Vine	0.0	0.1	0.0	0.0	0.0	0.1	0.0
Nodding Thistle	0.0	0.0	0.0	1163.0	3.9	1166.9	351.8
Oregon Grape	0.0	0.0	9.2	0.0	0.0	9.2	0.5
Paterson's Curse	0.0	2.9	141.8	61.2	40.0	246.0	55.5
Periwinkle	0.1	0.0	0.0	0.0	0.0	0.1	0.0
Poplar	0.0	0.0	0.0	0.0	0.6	0.6	0.5
Potentilla	0.0	0.0	0.0	30.7	0.0	30.7	9.2
Prickly Pear	0.1	0.0	0.0	0.0	0.4	0.6	0.3
Radiata Pine	2.3	0.0	33.8	0.0	0.0	36.0	1.7
Saffron Thistle	0.0	0.0	4.3	5.8	4.2	14.3	5.1
Scotch Thistle	0.0	0.0	18.6	253.7	18.8	291.2	91.1
Serrated Tussock	68.7	477.3	1394.8	356.5	272.9	2570.2	336.8
South African Daisy	0.3	0.0	0.0	0.0	0.0	0.3	0.0
St John's Wort	0.0	15.6	694.3	1524.5	1462.4	3696.7	1589.0
Stinkwort	0.0	0.0	0.0	0.2	0.0	0.2	0.1
Sweet Briar	0.0	338.7	728.1	159.0	664.0	1889.9	585.5

*continued*



Table 7.18 continued

Weed species	Isolated (ha)	Lightly scattered (<1% cover) (ha)	Scattered (1–10% cover) (ha)	Scattered/ patchy (10–50% cover) (ha)	Dense (>50% cover) (ha)	Total control area (ha)	Total area weeds destroyed (ha)
Sweet Vernal Grass	0.0	0.0	0.0	1.9	0.0	1.9	0.6
Tall African Lovegrass	0.0	0.0	1.0	35.5	70.8	107.3	63.8
Tree of Heaven	0.0	0.0	0.1	0.0	4.2	4.3	3.2
Verbascum	0.0	1.6	2.7	239.7	0.0	244.0	72.1
Western Australian Bluebell Creeper	1.0	0.0	0.0	0.0	0.0	1.0	0
Willow Hybrid	0.0	0.0	0.0	5.0	0.0	5.0	1.5
<b>Total</b>	164	905	5471	7392	2704	16 637	4530

ha = hectare

Source: Taylor & Thomson<sup>100</sup>

## Altered fire regimes

### Why is this indicator important?

The ACT's biological diversity has evolved in the presence of fire. However, altered fire regimes, resulting from management approaches or climate change, can disturb biodiversity. Plants have varying levels of tolerance to fire frequency, season of occurrence and intensity. Frequent burning can therefore result in the dominance of more fire-tolerant plant species (in the short term, this often includes weed species). Altered composition of vegetation communities may also disturb the composition of fauna due to changes in habitat, resource availability and predation.

### Current monitoring status and interpretation issues

A fire regime for a particular region comprises the typical patterns of:

- fire frequency
- fire intensity
- season of fire occurrence
- fire type.

Interpreting changes in any one of these components or the interaction between them is complex and difficult.

Fire plays a crucial role in many Australian ecosystems, including those within the ACT, yet little is known about pre-European settlement fire regimes. Further research is required to fully understand how to interpret this indicator in terms of measurable impacts on biodiversity.

The data available to assess the alteration of fire regimes are very limited in the ACT. This is because most data are collected for managing emergency responses to bushfires and monitoring planned fire regimes, rather than assessing impacts on biodiversity. In addition, the ecological thresholds used for fire planning in the ACT are currently limited to vegetation recovery rather than fauna and habitat, noting that this is currently a challenge for all Australian jurisdictions.



This indicator is therefore measured with the following available metrics and assessments:

- number of bushfires (unplanned fires) and area burnt by vegetation type
- causes and origins of bushfires
- number of planned fires, completion rate by number, completion rate by area burnt, and number that satisfy the ecological guidelines applied to bushfire fuel-reduction activities to protect fire-sensitive species and ecological communities.

The ACT Strategic Bushfire Management Plan (SBMP) (Schedule 2) requires the Emergency Services Agency (ESA) to maintain records of:

- estimated annual fire damage
- other economic or ecological consequences.

The recording of the ecological consequences of bushfires is not required in the framework specified in the Australian Incident Reporting System reference manual. For this reason, the ESA keeps no record of the ecological consequences of bushfires in the ACT (Manager, Spatial Services ESA, pers comm by email, 26 June 2015).

### What does this indicator tell us?

Fire risk in the ACT is characterised by the following features:

- The topography of the ACT means that there is a heightened risk of bushfire from the north and west. In addition, 60% of the ACT consists of hills or mountains,<sup>101</sup> which is significant because fire burns faster uphill.<sup>102</sup>
- The extensive ACT areas of forests, woodlands and grasslands are dominated by plant species that rapidly regenerate after fire and species that produce high fuel loads, such as planted pines and wildings.

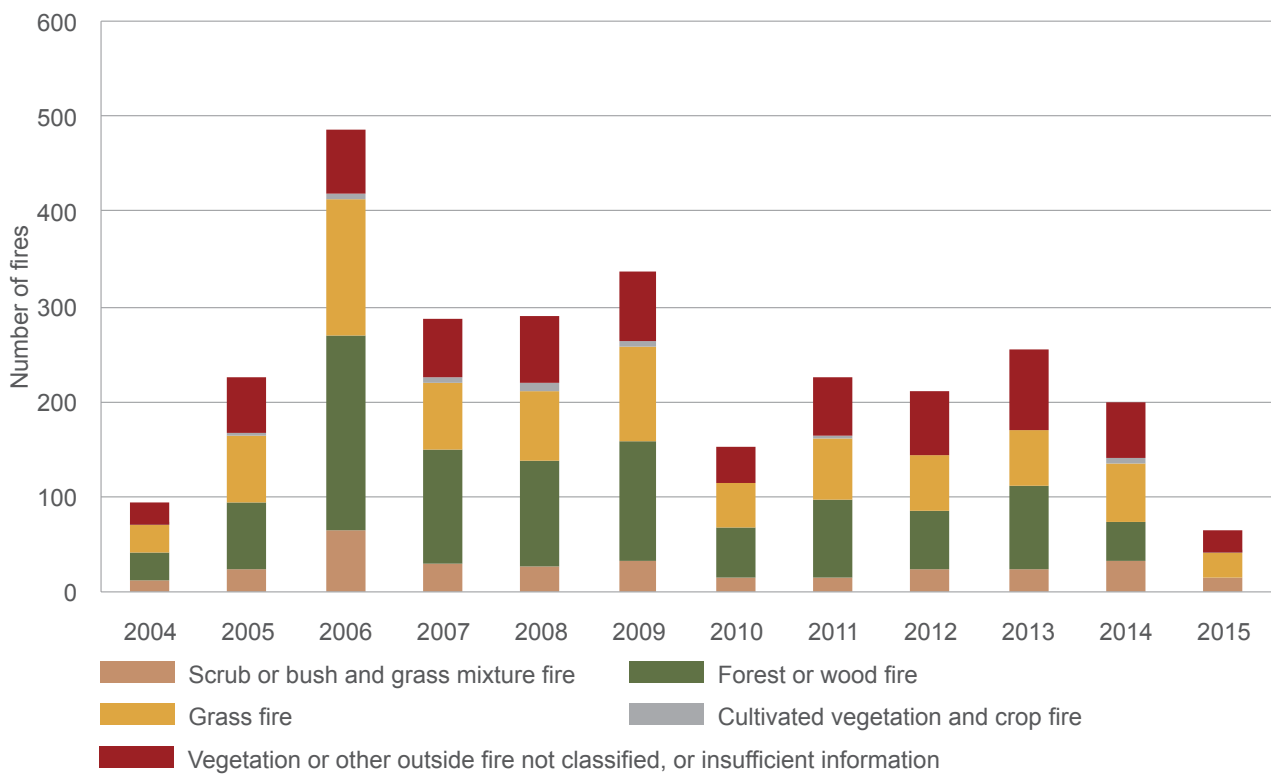
- The combination of topography and vegetation, compounded by the warm, dry climate, exposes Canberra to a high risk of bushfire.
- Variations in weather and rainfall, and emergency response capacity mean that any trend in frequency and size of fires may not be observed during the 2015 reporting period, or even during the past three reporting periods (ie from 2004). Nine large fires have occurred since the beginning of the 20th century, including the worst in January 2003.<sup>103</sup> None have occurred in the past three reporting periods.

### Number of bushfires and area burnt

Each year, the ACT records the number of unplanned fires more than 1 hectare in size by vegetation type (Figure 7.36). Unplanned fires have declined since reporting began in 2004; however, the change in the proportion of unplanned fires occurring within each vegetation type has remained relatively stable.

In the ACT, unplanned fires are also categorised into areas below or above 1 hectare (Table 7.19). Fires in grassland and mixed vegetation (scrub–bush–grass) are typically 1 hectare or more in size, while forest or woodland fires are typically less than 1 hectare in size. The 2014 and 2015 records diverge from this pattern; however, it is too early to tell whether this is an isolated anomaly or will become an established pattern.





Source: Data provided by ACT Emergency Services Agency

**Figure 7.36 Unplanned fires by vegetation type, 2004–2015**



Large unplanned fires such as the 2003 Canberra bushfires can harm biodiversity when they occur frequently. This Eastern Grey kangaroo was a fortunate survivor

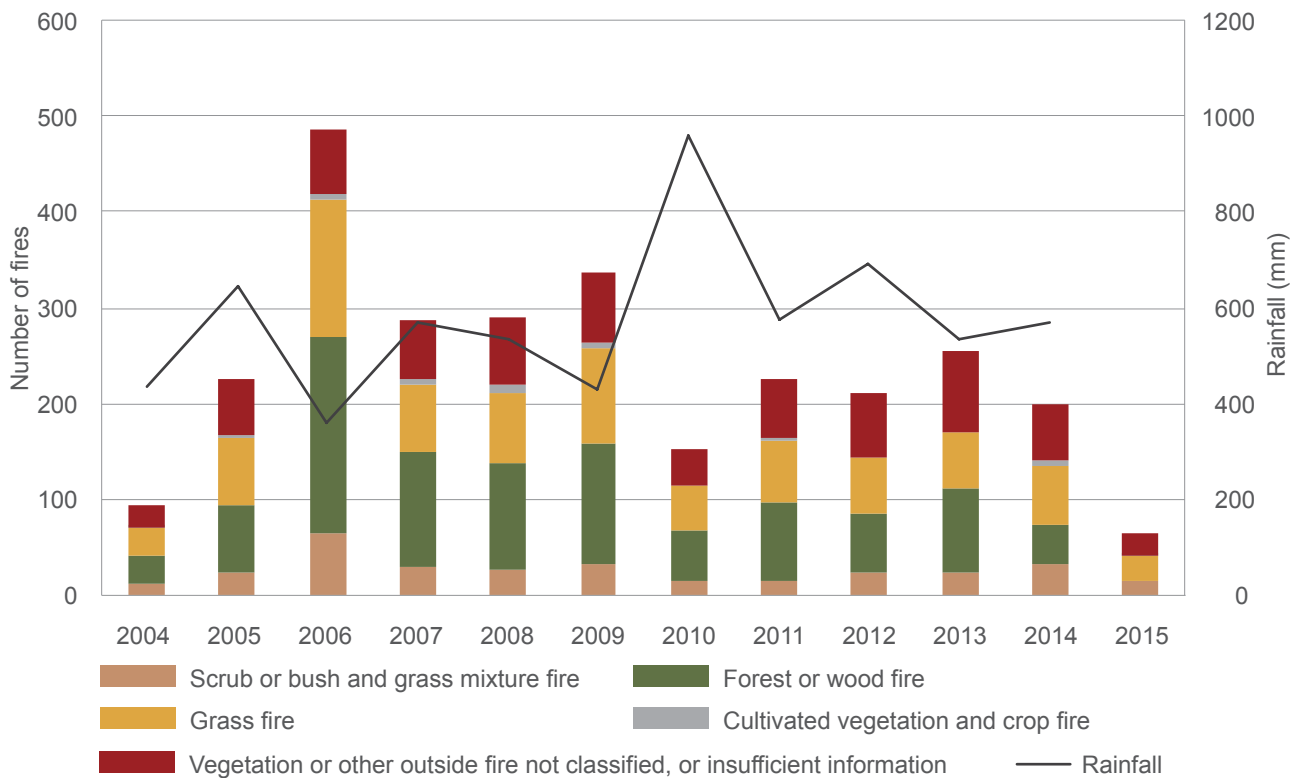
Photo: Andrew Meares, Fairfax Syndication

**Table 7.19** Number of unplanned fires in native vegetation types, by size, 2004–2015

Vegetation description	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	First half of 2015 (to 30 June)
Scrub or bush and grass mixture fire <1 ha	0	0	0	0	0	0	0	0	0	0	14	14
Scrub or bush and grass mixture fire >1 ha	13	24	66	29	28	33	16	16	23	23	20	0
Forest or wood fire <1 ha	28	71	201	119	107	122	51	78	63	88	37	0
Forest or wood fire >1 ha	1	0	3	2	2	3	1	3	0	2	2	0
Grass fire <1 ha	0	0	0	0	0	0	0	0	0	0	27	24
Grass fire >1 ha	28	68	143	69	74	101	46	64	59	57	36	2

ha = hectare

There is a correlation between unplanned fires and yearly rainfall (Figure 7.37). This correlation suggests a long-term outlook for an increase in unplanned fires as the effects of climate change and decreased rainfall in the ACT region increase. Climate models predict that the ACT will experience an increase in average and severe Forest Fire Danger Index in the near future (2020–2039) and the far future (2060–2079).<sup>104</sup>



Source: Data provided by the Bureau of Meteorology, [www.bom.gov.au/climate/data/stations](http://www.bom.gov.au/climate/data/stations)

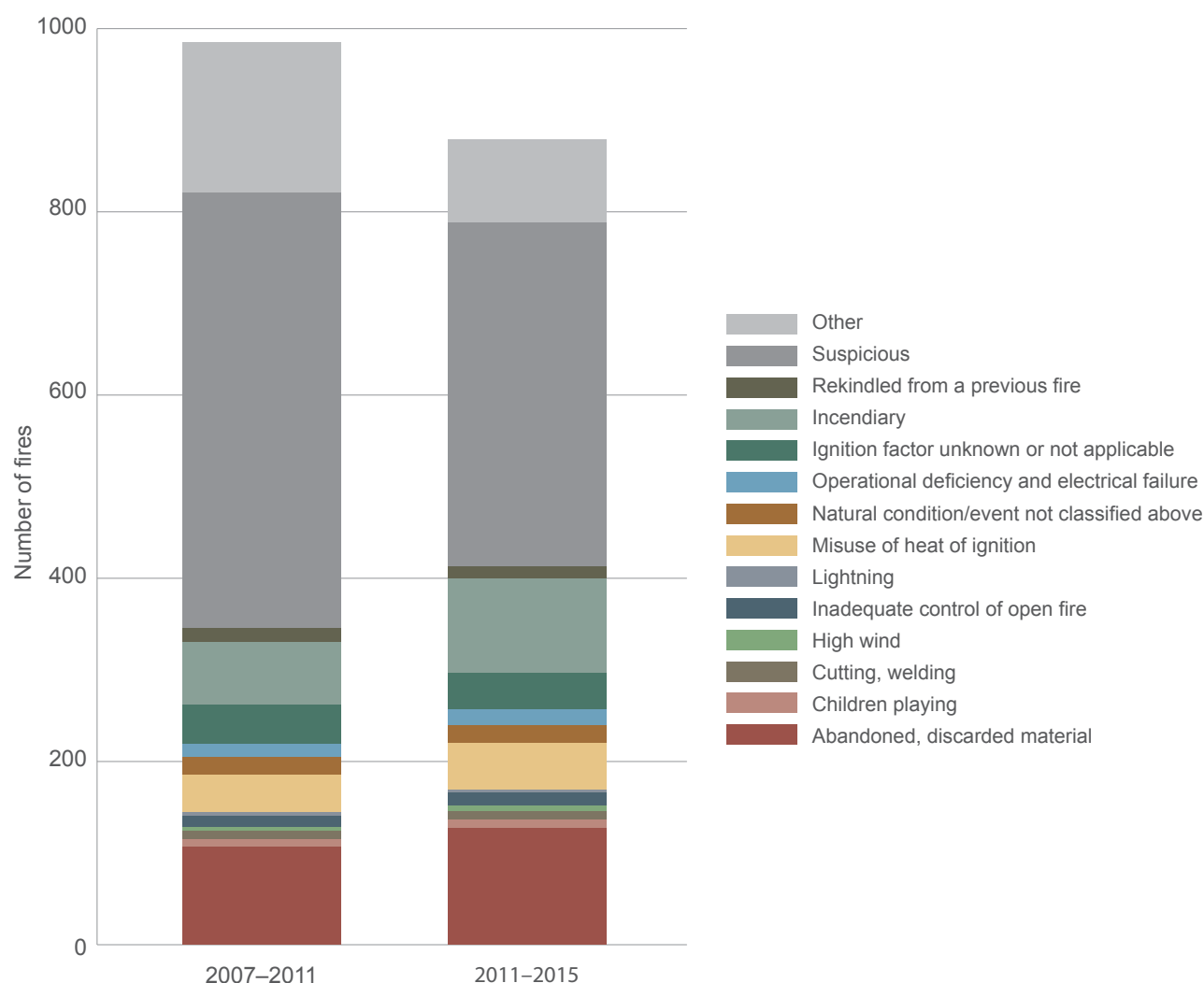
**Figure 7.37 ACT unplanned fires and yearly rainfall, 2004–2015**

### Causes and origins of bushfires

The SBMP requires the ESA to maintain records of bushfire:

- origins (where and when they originated)
- causes (sources and causes, if known).

The data suggest that there has been no change to the broad pattern of ignition factors for bushfires between 2007–2011 and 2011–2015 (Figure 7.38).



Source: Data provided by the ACT Emergency Services Agency

**Figure 7.38** Number of unplanned fires, by ignition factor, 2007–2015

### Number of planned fires and completion rate

In the ACT, planned fires play a primary role in the management of fuel. Planned fires are used for ecological purposes, or combined ecological and asset protection purposes.

The SBMP<sup>105</sup> states that 'ecological burning is the undertaking of prescribed burns for the primary purpose of enhancing biodiversity'. The SBMP lists the principles underpinning ecological burns:

- All areas will be assessed in the season before burning to confirm they have suitable cover and condition where ecological burning is warranted.

- All ecological burns aim to burn the grasslands below the woodland and not the riparian areas, fens or bogs.
- Some grassland areas will be burnt in areas identified for fuel management objectives.
- Ecological burns have only been identified on Territory and Municipal Services (TAMS) – managed land and do not include leased land.
- Generally, ecological burning will be undertaken at the same time as other burns in the area, unless a specific seasonal condition is required.

In addition, the 2012–13 *Ecological Guidelines for Fuel and Fire Management Operations*<sup>106</sup> provide a set of actions to guide the conservation of the





ACT's ecological assets, during the planning and implementation of the annual TAMS Bushfire Operational Plan. In summary, these guidelines specify that:

- prescribed burns should primarily be of a low intensity (<10% crown scorch) and patchy across the burn area
- the use of firefighting foam should be minimised near water bodies (presumably because of its toxicity to aquatic species)
- firefighting retardants should only be used in identified areas
- waterways, riparian zones, highland bogs and fens, and wetlands should be excluded from planned burns
- significant thickets of shrubby vegetation should not be burnt in spring, to avoid the primary bird nesting season
- burns in Button Wrinklewort habitat should be restricted to between April and November to avoid the summer flowering and fruiting season
- no burning of Black Cypress Pine should occur
- burning in areas of Smoky Mouse habitat should be of a low intensity and patchy
- no burning of Northern Corroboree Frog habitat, or Tarengo Leek Orchid and Tuggeranong Lignum locations should occur
- only low-intensity burns should occur in areas where the Showy Parrot-Pea is located.

This report is unable to report on the number of planned fires undertaken in the ACT for the primary

purpose of managing the ecological condition of an area. Fires are often undertaken for multiple purposes, including asset protection, ecological protection and conservation, making demarcation of these different purposes difficult. Small patch mosaic burning in the grasslands of Jerrabomberra East was undertaken in 2013 and 2014 for the primary purpose of reducing grass thatch and improving intertussock spacing for the endangered Grassland Earless Dragon.

In the ACT, fire ecologists from CPR assess and provide management advice on the potential impacts of planned fires on species and ecological communities. In 2011–2015, all pre-burn assessments met the ecological guidelines (Table 7.20). However, it is estimated that less than 25% of prescribed burns are subject to assessment pursuant to the guidelines.

It must be noted that a single fire not meeting ecological guidelines can have significant impacts. CPR has stated that in the 2014–15 fire season:

*Of particular interest was the Cotter River prescribed fire, conducted in the Upper Cotter. Several days of pre-burn field assessments were conducted to investigate the potential of adverse impacts of this activity resulting in the preparation of geographically explicit ecological guidelines. This fire escaped containment lines during the execution phase and unexpectedly impacted 255 ha of adjacent lands, and a range of ecological assets. Ongoing monitoring of the impacts of this fire has commenced and will continue through subsequent years. Environment and Planning Directorate<sup>107</sup>*

**Table 7.20 Prescribed burns subject to pre- and post-fire ecological assessment, 2011–2015**

Fire season	Planned prescribed burns subject to pre-assessment	Planned prescribed burns pre-assessed as meeting ecological guidelines	Prescribed burns completed	Planned prescribed burns subject to post-event monitoring
2011–12 <sup>a</sup>	NA	NA	NA	5
2012–13	39	39	47	7
2013–14	50	50	26	5
2014–15	83	83	22	10

NA = not available

a In 2011–12, the ACT region experienced La Niña weather patterns that resulted in well above average rains throughout the summer and autumn. This resulted in a high number of planned prescribed burns being abandoned, and the associated planned monitoring was similarly reduced, with only 5 of the planned 10 monitoring activities being undertaken.



## Direct environmental offsets

### Why is this indicator important?

Direct offsets are land added to environmental reserves to address potential development pressures. In the ACT, offsets provide 'environmental compensation' for 'a development that is likely to have adverse environmental impact on a protected matter'.<sup>108, r</sup>

Direct offsets are an indicator of land area added to the reserve system, and also of the areas of nationally significant ecological communities and/or protected matters given over to development.

### Current monitoring status and interpretation issues

In the ACT, offsets are categorised as those that are:

- required under the EPBC Act to compensate for the residual adverse impacts of an action on a matter of national environmental significance<sup>109</sup>
- required under the *ACT Planning and Development Act 2007* (the Planning Act) to provide environmental compensation for the likely impact on a declared protected matter.<sup>s</sup>

There are differences between offsets, which are part of:

- project-by-project development approvals under Parts 8 and 9 of the EPBC Act
- approvals made as part of a strategic assessment under Part 10 of the EPBC Act
- offset requirements under the Planning Act.

This indicator provides information on EPBC offsets only. To date, there have been no offsets required under the Planning Act.

Until early 2015, there was no systematic approach to the recording of offsets required under Parts 8 or 9 of the EPBC Act. This was problematic because it meant that the potential cumulative or combined impacts of development and the potential improvements to EPBC-listed ecological communities and species were not being recognised or addressed.

The ACT Government is in the process of redressing this issue. The ACT Environmental Offsets Policy Delivery Framework,<sup>110</sup> released in April 2015, provides for the development and maintenance of a publicly available register of offset sites. The register will record details such as the location of the offset, the relevant protected matters and ongoing management actions. There is also now an environmental offsets layer included on the ACT Government's interactive mapping service, ACTMAPI.<sup>t</sup>

### What does this indicator tell us?

Offsets under Part 9 of the EPBC Act that were approved in the ACT are summarised in Table 7.21. Detail about the offsets is provided where available.

r A 'protected matter' (*Planning and Development Act 2007*, s 111A) means a matter protected by the Commonwealth under the *Environment Protection and Biodiversity Conservation Act 1999* or a matter declared to be protected by the Minister. Planning and Development (Protected Matters) Declaration 2015 (no.1), DI2015-62, lists the species currently declared 'protected' by the Minister.

s The Minister may declare a matter to be a protected matter under s. 111A(2) of the *Planning and Development Act 2007*. As at 24 July 2015, there were no matters declared protected under this Act.

t [www.actmap.act.gov.au/html5.html](http://www.actmap.act.gov.au/html5.html)



**Table 7.21** ACT offsets under the *Environment Protection and Biodiversity Conservation Act 1999 (Cwlth)*, 2015

Location	Approval	Area affected	Matter of NES	Location (offset)	Size (offset)
Block 2 Section 5 and Block 2 Section 13, Lawson	EPBC 2010/5549	42 ha (in a 100-ha site)	Golden Sun Moth habitat Natural Temperate Grassland	Jarramlee (Macgregor West)	112 ha
Block 799, Gungahlin	EPBC 2010/5750	14.56 ha	Striped Legless Lizard habitat	Gungaderra and Mulanggari grasslands	Combined total 44.4 ha
Rural Block 2227, Hume	EPBC 2011/5808	9.8 ha (in a 35.69-ha site)	Box-Gum Woodland	Isaac Ridge Nature Reserve	No available data. The size of this offset is subject to the development and approval of an Offsets Management Plan
University of Canberra	EPBC 2013/6987	7.6 ha (in a 12.6-ha site)	Box-Gum Woodland	Pinnacle Nature Reserve	Not yet approved, but interim management plan suggests 15.5 ha Box-Gum Woodland
Campbell Section 5	EPBC 2012/6292	6.37 ha, based on an ACTMAPI estimate	Golden Sun Moth habitat and Natural Temperate Grassland	Yarralumla Equestrian Park offset area	No less than 4.6 ha of Golden Sun Moth habitat and no less than 0.5 ha of Natural Temperate Grassland
Watson	EPBC 2012/6418	4 ha	Box-Gum Woodland	Justice Robert Hope Park	No available data. The size of this offset is subject to the development and approval of an Offsets Management Plan

ha = hectare; NES = National Environmental Significance

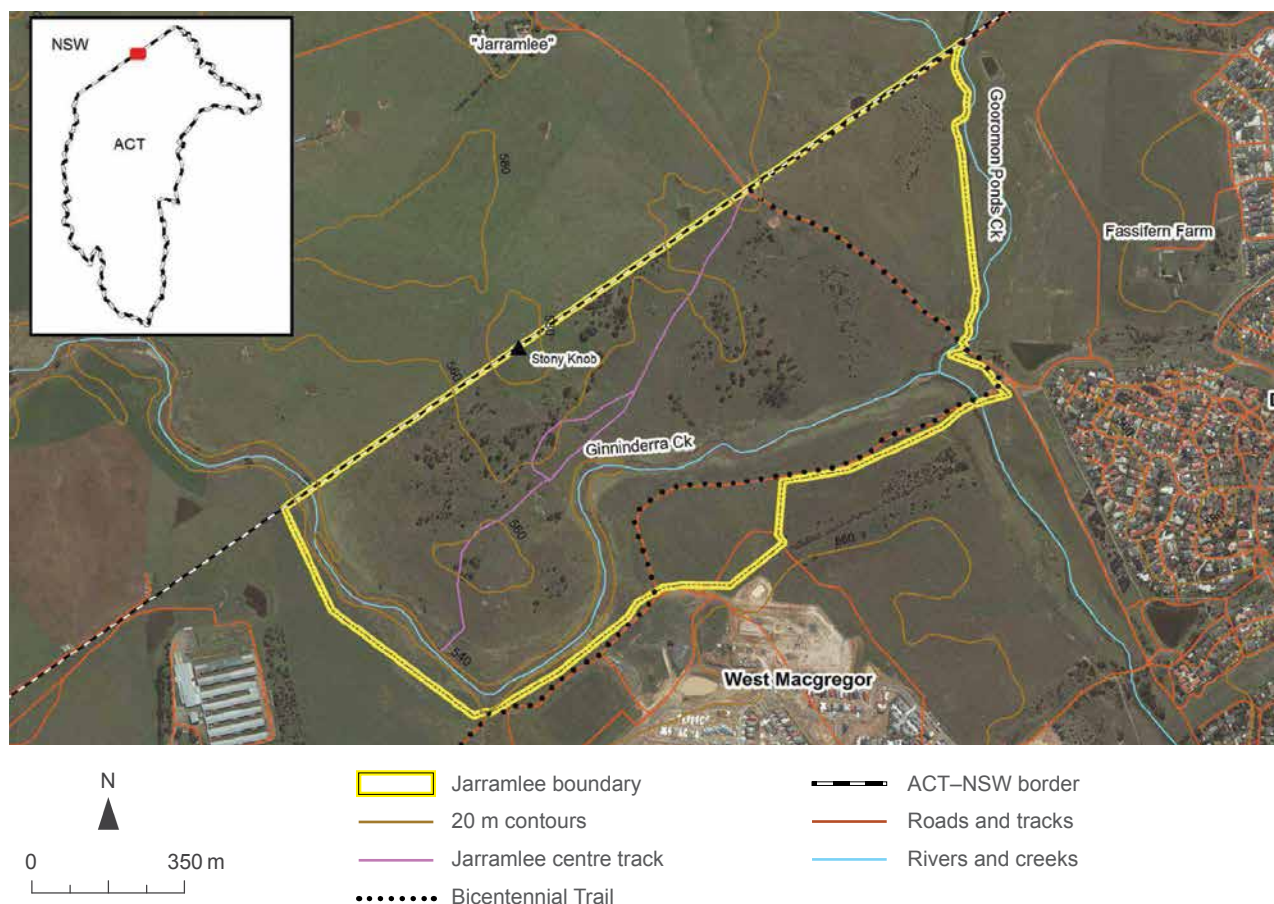
Source: ACT Environment and Planning Directorate, [www.planning.act.gov.au/topics/design\\_build/da\\_assessment/environmental\\_assessment/offsets\\_register](http://www.planning.act.gov.au/topics/design_build/da_assessment/environmental_assessment/offsets_register)



### Jarramlee offset 2013

The Jarramlee offset is 112 ha and located on the north-western boundary of the ACT (Figure 7.39). The offset met the requirements of the approval decision (EPBC 2010/5549) for the Lawson Residential Estate (Block 2 Section 5 and Block 2 Section 13, Lawson). It compensates for impacts to the Golden Sun Moth habitat and Natural Temperate Grassland at Lawson.<sup>111</sup>

The reserve borders rural grazing land within both the ACT (agisted and leased land) and NSW (freehold). It is also less than 200 m from the suburbs of Dunlop and West Macgregor. The property is contiguous with the West Macgregor offset site (EPBC 2010/5520), approximately 1.1 km south-west of the Dunlop Grasslands Nature Reserve and 2.6 km north-east of the Woodstock Nature Reserve.



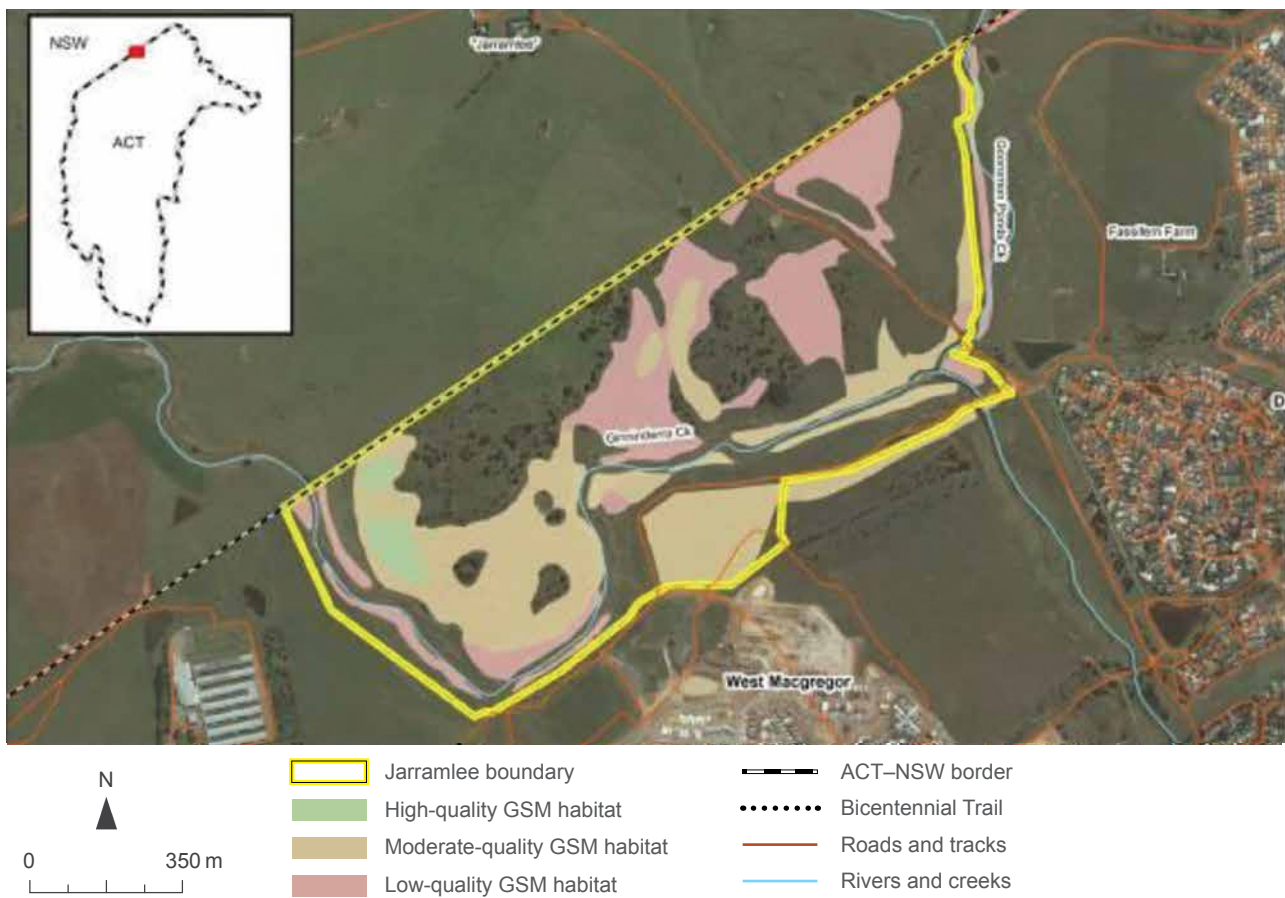
**Figure 7.39 Jarramlee offset 2013**

The Jarramlee offset includes (Figure 7.40):

- 1.8 ha of high-quality Golden Sun Moth habitat
- 26.4 ha of medium-quality Golden Sun Moth habitat
- 20.0 ha of low-quality Golden Sun Moth habitat.

Jarramlee also has significant (potential) connectivity benefits for the Golden Sun Moth (see 'Connectivity of terrestrial native vegetation' in Section 7.3.1).





GSM = Golden Sun Moth

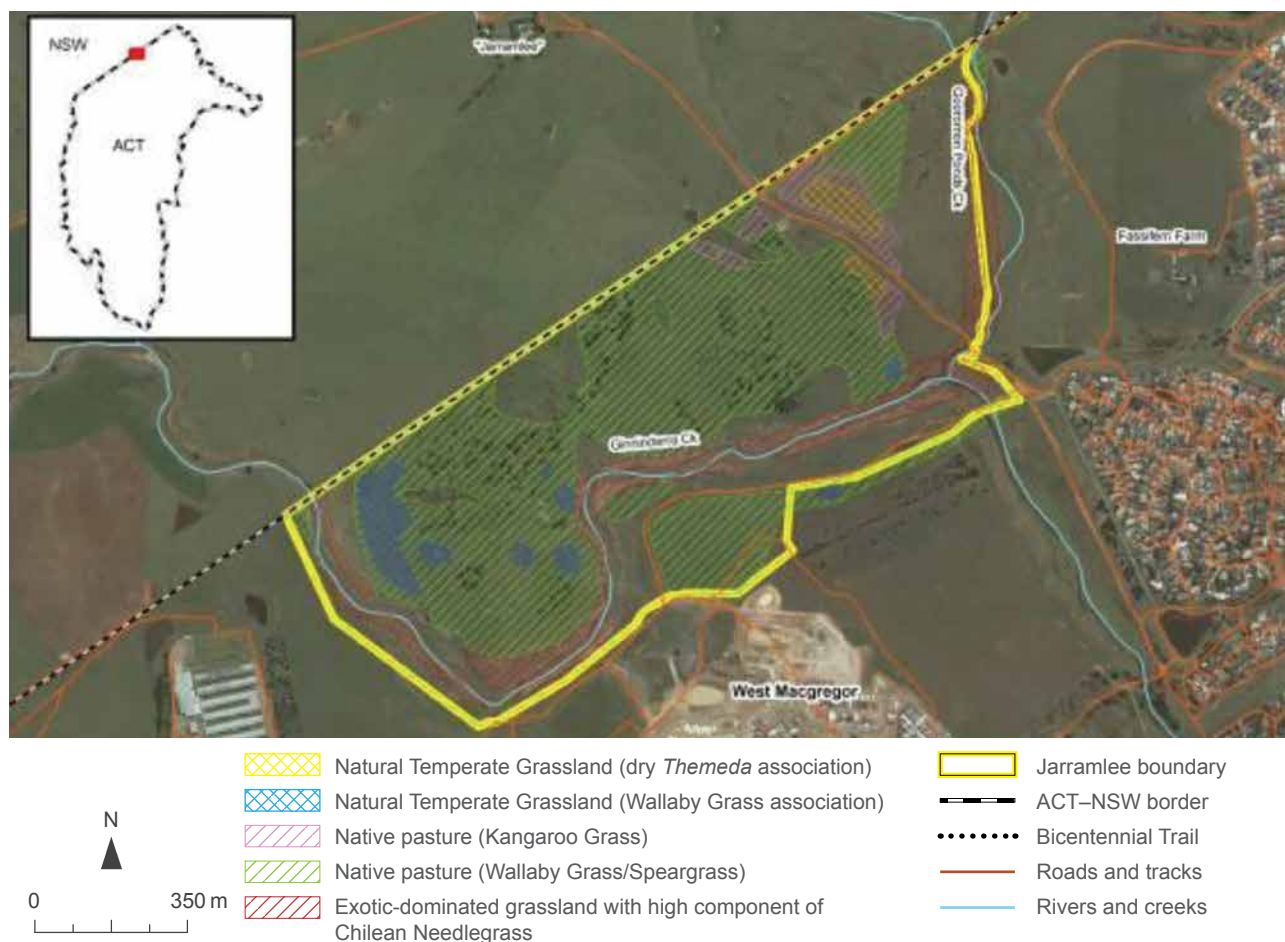
**Figure 7.40 Golden Sun Moth habitat in Jaramlee, quality and extent**

A total of 4.65 ha of Natural Temperate Grassland is located in small patches primarily within the north-eastern and western corners of the reserve (Figure 7.41). These patches are dominated by either Kangaroo Grass (*Themeda australis*) or wallaby grasses (*Rytidosperma* spp.). They are surrounded by lower-quality native pasture. Rehabilitation of these areas may lead to an increase in the extent of Natural Temperate Grassland.<sup>112</sup>



The Golden Sun Moth is an endangered species in the ACT

Photo: ACT Government



**Figure 7.41** Natural Temperate Grassland in Jaramlee, quality and extent

#### Extension to Gungaderra and Mulangarri nature reserves

In 2011, the Land Development Agency obtained a conditional approval to develop cabin, camping and possible hotel accommodation on Block 799, Gungahlin.<sup>u</sup>

The development affects Striped Legless Lizard and Golden Sun Moth habitat. The approval conditions included the following offsets for these two species:

- protect Striped Legless Lizard habitat
  - at a ratio of approximately 3:1 for habitat to be removed, which adjoins an existing conservation area in North Canberra that is known to contain habitat for the species; or
  - at a ratio of approximately 4:1 for habitat to be removed, if the offset area does not adjoin an existing conservation area in North Canberra that is known to contain habitat for the species.
- protect Golden Sun Moth habitat
  - in perpetuity at a ratio of 3:1; or
  - contribute to research in, or improved management of, existing grassland reserves that contain habitat for the Golden Sun Moth.

<sup>u</sup> [www.environment.gov.au/epbc/notices/assessments/2010/5750/2010-5750-approval-decision.pdf](http://www.environment.gov.au/epbc/notices/assessments/2010/5750/2010-5750-approval-decision.pdf)



### Extension to Isaacs Ridge Nature Reserve (expansion of the Mugga Lane Resource Management Centre)

In 2013, ACT NOWaste received approval under the EPBC Act to expand the putrescible waste landfill facility on Rural Block 2227, Hume, provided that an offset for the loss of up to 9.8 ha of Box-Gum Woodland was incorporated into the Isaacs Ridge Nature Reserve for conservation purposes.<sup>v</sup> The size of this offset is subject to the development and approval of an Offsets Management Plan.

### Extension to the Pinnacle Nature Reserve (University of Canberra Public Hospital development)

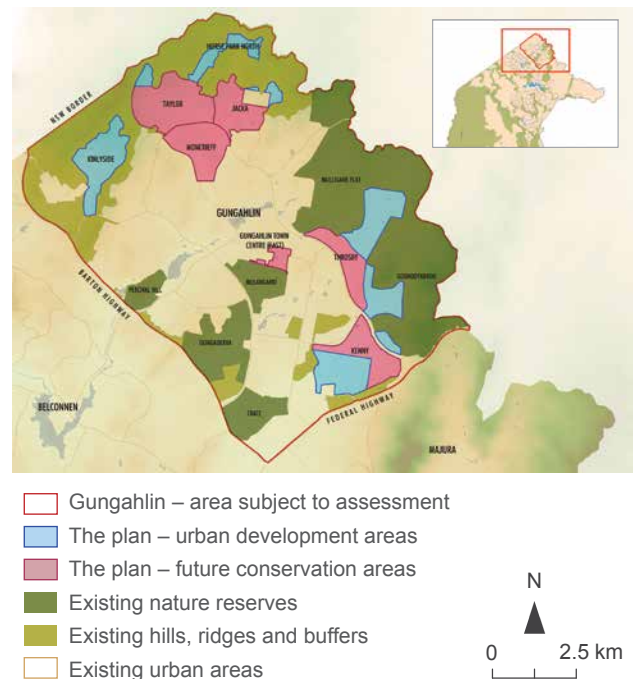
In 2014, the Australian Government approved an application by the ACT Health Directorate to construct a new subacute hospital on the grounds of the University of Canberra in Bruce, provided that an offset for the loss of up to 7.6 ha of Box-Gum Woodland was incorporated into the Pinnacle Nature Reserve for conservation purposes.<sup>w</sup> The size of this offset is subject to the development and approval of an Offsets Management Plan. The interim management plan refers to an offset area of 15.5 ha of Box-Gum Woodland.

### Gungahlin Strategic Assessment

On 20 June 2013, the Gungahlin Strategic Assessment Plan was endorsed by the Australian Government Minister for the Environment. The plan provides for urban and related development in the Gungahlin district, including protection and management of defined conservation areas.<sup>113</sup>

Figure 7.42 shows the Gungahlin Strategic Assessment area, as well as areas designated for development and conservation. Table 7.22 summarises the total area affected within each suburb as a result of direct actions under the plan. Table 7.23 shows the hectares of listed ecological community and species to be affected by the development.

Tables 7.22 and 7.23 do not include disturbance to certain areas adjacent to the urban areas for the purpose of bushfire hazard management, or indirect impacts such as increased levels of noise, light, human activity, weeds and other invasive species.



**Figure 7.42 Gungahlin Strategic Assessment area**

Under the endorsed Gungahlin Strategic Assessment Plan, the Australian Government approved a range of direct offsets (Table 7.24).

<sup>v</sup> [www.environment.gov.au/epbc/notices/assessments/2011/5808/2011-5808-approval.pdf](http://www.environment.gov.au/epbc/notices/assessments/2011/5808/2011-5808-approval.pdf)

<sup>w</sup> [www.environment.gov.au/epbc/notices/assessments/2013/6987/2013-6987-approval-decision.pdf](http://www.environment.gov.au/epbc/notices/assessments/2013/6987/2013-6987-approval-decision.pdf)

**Table 7.22** Areas affected by the Gungahlin Strategic Assessment Plan

Suburb	Area affected (ha)
Gungahlin Town Centre (east)	36
Horse Park north broadacre	0
Jacka	150
Kenny	173
Kenny broadacre	–
Kinlyside	–
Moncrieff	191
Taylor	280
Throsby	132
<b>Total</b>	<b>962</b>

– = not applicable

**Table 7.23** Summary of impacts to matters of National Environmental Significance

Protected matter of NES	Approximate area (ha)
Box–Gum Woodland	126
Golden Sun Moth	180
Superb Parrot	0 (direct)
Striped Legless Lizard	up to 20
Pink-Tailed Worm Lizard	0

ha = hectare; NES = National Environmental Significance

**Table 7.24** Direct offsets approved under the endorsed Gungahlin Strategic Assessment Plan

Listed matter	Size of impact (ha)	Location of offset	Size of offset (ha)	Offset conditions
Box–Gum Woodland	126	Kinlyside, Kenny and Throsby	About 104	Improving the condition of sites that do not meet the listing definition
Golden Sun Moth	180		≤140 of areas that are suitable	None
Superb Parrot	Indirect impacts		–	All currently known breeding sites and the majority of potential nesting sites within 100 m will be protected
Striped Legless Lizard	20	West Kenny	Exact area not specified	Establishment of a new nature reserve. Improvement in condition of 111 ha

ha = hectare





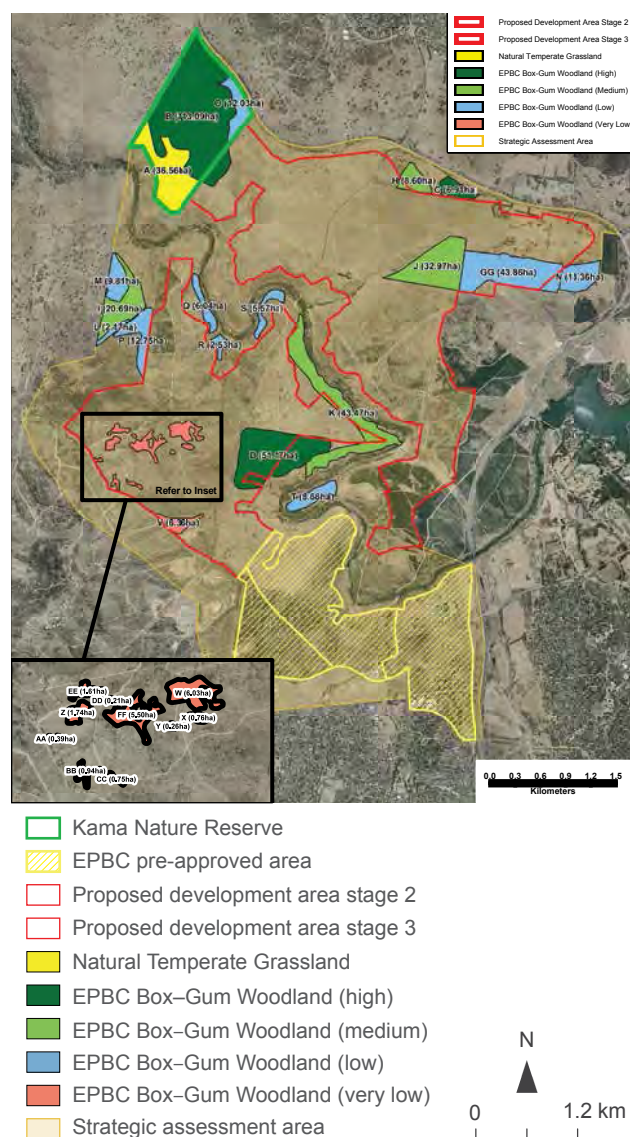
In late 2011, the Australian Government endorsed and subsequently approved 'all actions associated with urban development in East Molonglo as described in the Molonglo Valley Plan for the Protection of Matters of National Environmental Significance (NES) provided such action takes place wholly within the strategic assessment area in East Molonglo'.<sup>x</sup>

Figure 7.43 shows the extent and condition of EPBC-listed Box-Gum Woodland in relation to the strategic assessment and development areas. Figure 7.44 shows the extent and condition of Pink-Tailed Worm Lizard habitat in relation to the strategic assessment and development areas. Figure 7.45 shows the areas that will be used to offset the residual impacts of development actions on Box-Gum Woodland and Pink-Tailed Worm Lizard habitat.



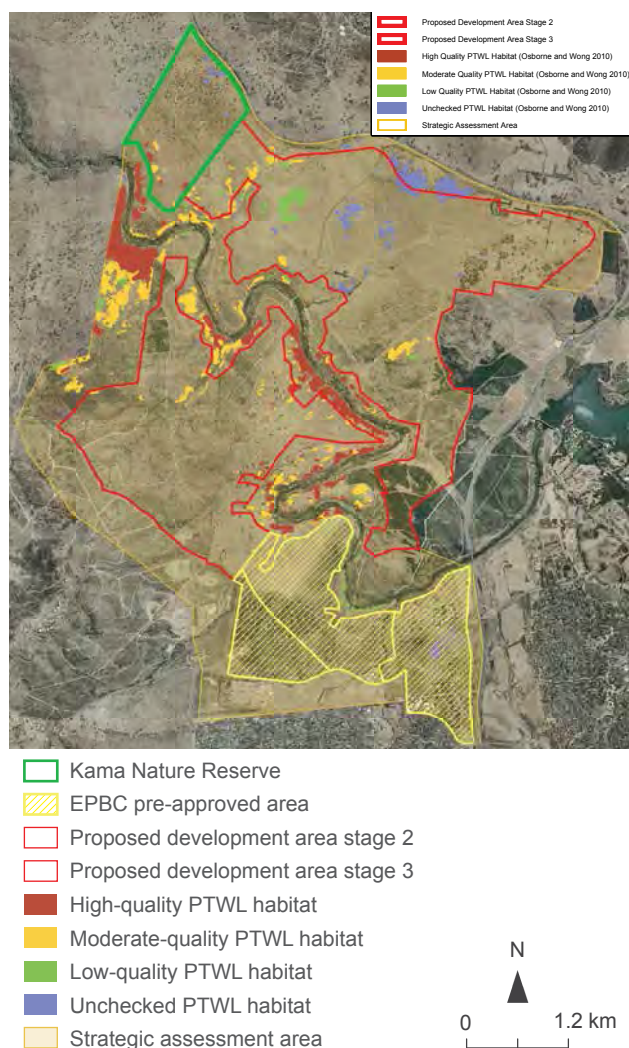
Box-Gum Woodland at the site of the Molonglo development

Photo: ACT Government



**Figure 7.43** EPBC-listed Box–Gum Woodland areas, extent and condition

x [www.environment.gov.au/system/files/pages/b42a89fd-8b94-43do-8721-81bo1ff35a57/files/molonglo-approval-instrument.pdf](http://www.environment.gov.au/system/files/pages/b42a89fd-8b94-43do-8721-81bo1ff35a57/files/molonglo-approval-instrument.pdf)



PTWL = Pink-Tailed Worm Lizard

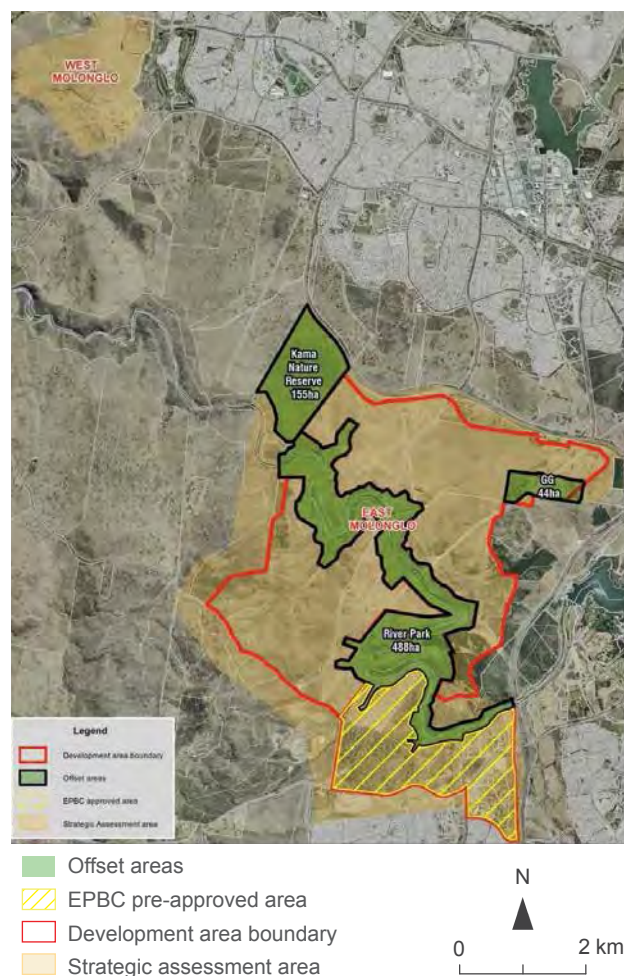
**Figure 7.44 Pink-Tailed Worm Lizard habitat, extent and condition**

### Indirect environmental offsets

#### Why is this indicator important?

Indirect offsets indicate that there is no compensatory site available for direct offsetting. In a hierarchy of priorities, indirect environmental offsets are a measure of last resort. They are invoked only where other management actions – avoid, mitigate and directly offset – are not available.

Recording the extent and type of indirect offsets is important, because this process is likely to affect the



**Figure 7.45 Areas that will be used to offset the impact of development of Box-Gum Woodland and Pink-Tailed Worm Lizard habitat**

state of biodiversity in both the short and long terms. In the short term, there has been a loss in the extent of certain habitat types, but there is a presumption that there will be a long-term improvement in the state of biodiversity as a result of the indirect offsets (with some uncertainty, because we cannot predict the effects of education and other investments on biodiversity). Therefore, the extent and type of use of the indirect offsets approach is an indicator of both some short-term negative effects and some longer-term possible benefits.





### Current monitoring status and interpretation issues

For EPBC-listed matters of NES, indirect offsets or compensatory measures can include education and training, research or projects that relate to the matter of NES that is affected.

For ACT-protected matters, in addition to education, training or research, compensatory measures may include broad habitat processes that improve outcomes for a broad range of species, not just the species impacted by the development. This might include providing funds for improving general connectivity or for establishing buffer areas around significant habitat areas.

As for direct offsets, indirect offsets are intended to produce a 'conservation gain'. However, in the ACT, there are no objective criteria or quantitative benchmarks to establish whether a conservation gain has been achieved. There is also no way of establishing to which approved impact the indirect offsets apply. This is because, for all indirect offsets approved to date, the link or relationship between the indirect offset and the ecological community or species affected is indeterminate.

The development and design of indirect offsets approved as part of the Gungahlin Strategic Assessment approval is subject to cost-benefit analysis.<sup>114</sup> The plan does not contain a methodology for conducting such a cost-benefit analysis.<sup>114</sup> A cost-benefit analysis, as applied to the use of indirect offsets, requires the ability to:

- quantify the conservation outcomes achieved by the indirect offset
- place a monetary value on the conservation outcome.

There has been no allocation of resources to gather necessary information or conduct the necessary assessments for either of these steps.

Note that this indicator reports on indirect offsets as commitments made to the Australian Government. It does not report on the status of implementation or timing of delivery of the offsets. The 2013–14 TAMS annual report reports on the implementation and progress of less than half of these offsets; no other information denoting implementation or progress status was available for this indicator.

### What does this indicator tell us?

Indirect offsets have been used in the ACT on a statutory basis only since December 2011. On this date, the ACT Government received its first EPBC Act approval decision for a plan endorsed as part of a strategic assessment (under s. 146B).

Since the latest ACT State of the Environment Report, two strategic assessments have been approved containing indirect offsets.

### Gungahlin Strategic Assessment Biodiversity Plan

The Gungahlin Strategic Assessment Biodiversity Plan contains the following indirect offsets.<sup>y</sup> These indirect actions are conditions of the Australian Government's approval for the development of Gungahlin:

- Establishment of a Gungahlin Strategic Plan Implementation Team to oversee implementation of (direct and indirect) offset measures, with responsibilities for implementation, procurement, monitoring, reporting, application of the principles of adaptive management and associated measures under the plan.
- Collection and collation of baseline ecological and biophysical information for all new reserve areas in addition to new areas of hills, ridges and buffers as identified in the avoidance measures.<sup>z</sup>

y The Australian Government approval for the taking of actions in accordance with the Gungahlin Strategic Assessment Biodiversity Plan can be found at [www.environment.gov.au/system/files/pages/b58dc6ac-a4f2-4a9e-9dad-4fo752e0fo50/files/gungahlin-approval-notice\\_o.pdf](http://www.environment.gov.au/system/files/pages/b58dc6ac-a4f2-4a9e-9dad-4fo752e0fo50/files/gungahlin-approval-notice_o.pdf). The Gungahlin Strategic Assessment Biodiversity Plan ([www.environment.gov.au/system/files/pages/b58dc6ac-a4f2-4a9e-9dad-4fo752e0fo50/files/gungahlin-biodiversity-plan\\_o.pdf](http://www.environment.gov.au/system/files/pages/b58dc6ac-a4f2-4a9e-9dad-4fo752e0fo50/files/gungahlin-biodiversity-plan_o.pdf)) refers to 'indirect offsets'. Note that the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) Environmental Offsets Policy (October 2012) no longer refers to indirect offsets. The term 'other compensatory measures' is used for 'actions that do not directly offset the impacts on the protected matter' (see [www.environment.gov.au/epbc/publications/epbc-act-environmental-offsets-policy](http://www.environment.gov.au/epbc/publications/epbc-act-environmental-offsets-policy)).

z The *Gungahlin Strategic Assessment Annual Report 2013–2014*<sup>115</sup> indicates that this was not undertaken because the existing survey data were subsequently considered to be adequate.



- Research into the management of the Superb Parrot in proximity to urban development, particularly in relation to producing a population viability analysis. The plan states that the aim of this project is to support a research project to better understand factors such as nest site fidelity, annual breeding success and factors that influence it, breeding strategies (eg polygamy or monogamy), fecundity, and population dynamics over time.
- Infrastructure in protected areas to be designed to minimise impacts on matters of NES. Should any infrastructure or groundworks be required within protected areas, the implementation team must be consulted during design and approval of Construction Environment Management Plans (CEMPs).
- Urban design to mitigate impacts to adjacent areas and managed during construction with comprehensive CEMPs. Actions in relation to design and construction include
  - preconstruction surveys to determine clearing boundaries and identify rehabilitation actions, such as for woody debris relocation
  - geotechnical, surface water and groundwater assessment to minimise impact to local hydrological systems
  - preclearing ecological inspections and procedures to be followed for wildlife rescue and relocation
  - clearing outside of threatened bird species' breeding seasons, and clearing of hollow-bearing trees to have fauna rescue procedures in place
  - ensuring that all developments are surrounded by an edge road to minimise the requirements for bushfire hazard management, to improve passive surveillance and to control invasive species
  - placing low-intensity land uses in areas that might otherwise result in disturbance to species during critical lifecycle stages (eg Superb Parrot breeding)
  - selecting materials to limit noise and light incursion into reserved or retained natural areas
  - placing transport and utility infrastructure in a way that reduces or avoids ongoing impacts to adjoining areas from either operation or periodic maintenance
  - placing recreational facilities, including playgrounds and bike/pedestrian paths, in areas that do not lead to inappropriately increased human activity adjacent to sensitive areas
  - selecting appropriate plants for landscaping, including considering species that will provide future foraging or shelter opportunities to wildlife. Particular consideration is to be given to improving connectivity and flight paths for species such as the Superb Parrot, which disperse south to the Belconnen district and the Molonglo Valley
  - liaising with appropriately qualified professionals, experienced in the biology and management of the matters of NES known to occur in Gungahlin, during the design stages before construction starts, to ensure that optimal design solutions are prescribed.
- Control programs for ruderal species (those encouraged by urban development that are not usually a focus of control) such as the European Wasp (which may prey on Golden Sun Moths), Common Myna, Noisy Miner and stray cats; declaration of further cat containment areas and a funded compliance program; and landscape-scale coordinated cross-tenure feral animal and weed control program.
- Salvage and relocation of structural habitat elements, such as fallen logs, targeting Superb Parrot and other woodland birds during construction. Plantings to improve connectivity and wildlife movement along Gungahlin and Sullivans creeks, targeting Superb Parrot movement corridors.



### Molonglo Valley Plan for the Protection of Matters of National Environment Significance

The Molonglo Valley Plan for the Protection of Matters of NES contains the following indirect offsets. These indirect actions are conditions of the Australian Government's approval for the development of Molonglo.

One indirect offset is a research project examining the long-term survival of Pink-Tailed Worm Lizards in an urbanised landscape. The research project will adopt a three-stage approach:

- Mount Taylor, a reserve unit within Canberra Nature Park, is surrounded by an urban matrix (housing, roads, facilities, easements, etc). The first stage of the study will look at habitat disturbance, including fragmentation, and the effects of habitat proximity to urban areas. The project will also develop low-impact survey and monitoring techniques for the species. The outcomes of this research will be applied to management within the East Molonglo strategic assessment area.
  - The results of the Mount Taylor study will be incorporated into the second stage of the project. The second stage will involve
    - extensive survey work, to determine population densities in areas of low-, moderate- and high-quality Pink-Tailed Worm Lizard habitat in the strategic assessment area
    - field trials, to be conducted in areas of low-quality habitat only, involving different methods of translocation
    - research and field trials, involving methods for reducing habitat fragmentation and increasing connectivity.
  - Monitoring the Pink-Tailed Worm Lizard in the strategic assessment area is vital to ensure the long-term survival of the population. Monitoring also provides a warning system if the population or habitat begins to show any signs of decline. This third stage of the project provides a link between the second stage of the research and the monitoring of Pink-Tailed Worm Lizard in the strategic assessment area. Where population and habitat monitoring show any change from baseline data, the results of the second stage research will be applied to establish possible causes and to mitigate adverse impacts.
- Another indirect offset is an off-site restoration project involving seed collection from within the strategic assessment area, with the aim of using it as a resource for Box-Gum Woodland restoration within a degraded area of woodland in the strategic assessment area. Seed is also to be stored for potential use in future restoration projects. The program is to be delivered through six key restoration stages:
- Site assessment and recommendations. Field visits will be conducted to Box-Gum Woodland sites that will be lost to development and to sites that will be kept and improved, to identify the presence and frequency of native and exotic plant species. Following assessment, recommendations will be made of which species to introduce, reintroduce or increase under-represented populations. The project will investigate the merits and processes of translocating Box-Gum Woodland species from areas to be lost into a designated area within the strategic assessment area (especially key understorey species). It will also develop a seed supply and propagation works plan, drawing on the availability of plant material for collection from nearby sites of higher quality.
  - Rehabilitation scoping study. The project will scope a woodland revegetation and restoration plan that will incorporate development stages, weed management and local knowledge about species availability and successful re-establishment approaches.
  - Seed supply and plant rescue for future use at a designated area within the strategic assessment area. This will involve the identification of current provenance stock in regional seed banks that would be suitable for use in high-conservation Box-Gum Woodland restoration; the collection, processing and storage of needed seed in accordance with the national code of practice, FloraBank<sup>116</sup>; and rescuing plants or collecting plant material from species of significance that will be destroyed – this may involve establishing temporary or permanent seed production areas in consultation with the ACT Government.
  - Plant production. The project will seasonally propagate plants in accordance with the rehabilitation plan (eg quantities and species).

## 7 Biodiversity



- On-ground rehabilitation works. The project will deliver staged works in accordance with the rehabilitation plan and appropriate season.
- Monitoring and evaluation. Finally, the project will establish benchmark data and monitor rehabilitation success using scientifically credited performance measurements already adopted by regional leaders in rehabilitation assurance. Throughout the duration of the 30-year plan, results will be used to review on-ground ecological performance and, where relevant, implement best-practice change or modification.

The last direct offset is a project to monitor the condition of the Box–Gum Woodland patches each year (total area of 45.4 ha, see Figure 7.43) on the western boundary of East Molonglo to ensure that fuel hazard management is not negatively affecting the Box–Gum Woodland values. Should the monitoring show that, for two consecutive years, more than 30% of the combined area no longer meets the EPBC Act–listing criteria, then the ACT Government will establish an offset site within two years that will include a minimum of 90.8 ha of EPBC Act–listed Box–Gum Woodland established as a nature reserve. The plan does not specify where this offset would be located.

## Assessment summaries for indicators of biodiversity pressures

Indicator	Reasoning	Assessment grade					Confidence	
		Very low	Low	Moderate	High	Very high	In state grade	In trend grade
Distribution (and abundance where possible) of non-indigenous species (plants and vertebrate animals) identified as pests	Plant and animal pests are generally accepted to be major threats to biodiversity. In the human-populated parts of the ACT, cats and Indian Mynas appear to be having major impacts. However, confidence in either grade or trend cannot be high, because there is little specific assessment of the effects of pests and weeds on biodiversity							
Fire	Although fire can have a major impact on biodiversity, it appears that fire planning and management has limited and will limit this impact within the ACT. Uncertainty about grade and trend comes from the limited data on effects of fire on biodiversity in the ACT							
Direct environmental offsets	By definition, it is assumed by the ACT Government that offsets will result in a net zero or positive impact on biodiversity in the long term. There can be limited confidence in grade and trend because insufficient data have been collected to assess the cumulative impacts of multiple offsets							





Indicator	Reasoning	Assessment grade					Confidence	
		Very low	Low	Moderate	High	Very high	In state grade	In trend grade
Indirect environmental offsets	By definition, it is assumed by the ACT Government that offsets will result in a net zero or positive impact on biodiversity in the long term. Confidence in grade and trend cannot be assessed because we know of no investigations of whether indirect offsets have achieved their desired outcomes							

Recent trends		Improving		Stable	Confidence		Adequate high-quality evidence and high level of consensus
		Deteriorating		Unclear			Limited evidence or limited consensus
							Evidence and consensus too low to make an assessment



Vegetation clearance at the Molonglo development is clearly visible from Mount Stromlo  
Photo: Office of the Commissioner for Sustainability and the Environment



## Resilience to pressures

A resilience assessment involves looking at the systems, networks, human resources and feedback loops involved in maintaining environmental values (see Chapter 10).

The ACT systems that support biodiversity are not highly resilient.

Although the ACT does have strong reserve networks and landscape strategies intended to help maintain biodiversity, the codification of conservation values in legislation and action focuses on species and ecological communities known to be under threat, with less specification of desired management outcomes for species and communities not under threat. Similarly, while there is public debate about conserving biodiversity, this debate often focuses on large fauna and iconic species, with less focus on the full suite of biodiversity.

In addition, although threats that have an immediate or visible effect on biodiversity are well recognised – such as invasive weeds and pest animal species, diseases, climate change and land development – incremental processes that occur over long periods are not as well understood.

There is also a lack of systematic monitoring of biodiversity pressures and outcomes, and a lack of clear definition of thresholds at which biodiversity may change dramatically.

Measurement of biodiversity principally occurs in short-term, site-specific studies conducted when a major development is proposed, with little systematic or long-term landscape-scale monitoring (with the exception of some key research sites, such as Mulligans Flat). There is a lack of clarity on thresholds at either the ecosystem-, landscape- or species-specific scales, and the lack of baseline data makes it particularly difficult to identify thresholds. The ACT Scientific Committee responds to queries and suggestions, and investigates threatening processes. However, this process focuses on existing threats to biodiversity, rather than on proactive monitoring and action to prevent these thresholds being reached. Some thresholds are reasonably well defined – for example, thresholds relating to landscape connectivity and fire risk are considered in planning. Other thresholds relating to ecosystem function

are harder to identify in both the ACT and other regions. Resourcing of monitoring programs linked to the development of knowledge on thresholds is a challenge.

This challenge, together with a lack of resourcing for systemic and adaptive management, leads to outcomes in which management investment typically occurs after a species or ecological community is already under threat, reducing effectiveness.

On a positive note, there are strong networks underpinning some aspects of biodiversity management. For example, the Territory-Wide Risk Assessment process (focused on fire) and some key networks help manage biodiversity issues at a landscape scale. There is also engagement with universities and stakeholders on key issues, and strong public interest in aspects of biodiversity. However, regional biodiversity networks beyond ACT borders are limited in terms of resourcing and presence, and maintaining volunteers in groups such as volunteer firefighting and Landcare can be difficult. A key challenge for all networks is availability of ongoing resourcing; often short-term allocation of funding makes long-term planning problematic.



Close up of the endangered Murrumbidgee Bossiaea. During the reporting period an action plan was created to define conservation measures for the species in accordance with the Nature Conservation Act

Photo: ACT Government





## 7.4 Response

There is clear evidence of the ACT's commitment to biodiversity protection.

A significant proportion of the ACT environment is protected; 55.22% of the Territory's total 235 813 ha is contained in areas permanently designated as either nature reserve or national park. This is more than 10% higher than any other Australian jurisdiction and significantly higher than the national average of 17.88%.<sup>117</sup>

The ACT also has a comprehensive legislative and policy framework to conserve, maintain and improve biodiversity within these protected areas.

However, outside of protected areas, although there has been progress in conservation of natural resources (land, soil and water), progress in conservation of biodiversity, including both habitats and species, remains a challenge. This is particularly the case on rural leases (see Section 5.4). In addition, pressures leading to habitat loss and modification, for both terrestrial and aquatic ecosystems, continue to present a serious threat to the ACT's biodiversity, with a high number of threatened and endangered species and ecological communities.

The ACT Government manages the pressures affecting biodiversity in the ACT in a variety of ways, which are examined in detail in Chapter 10. Particular features of biodiversity management and responses from the reporting period are included in this section.

### 7.4.1 Legal and policy framework

#### ACT

In the ACT, there are several laws that relate to biodiversity:

- *Planning and Development Act 2007*. The object of the Planning and Development Act is to provide a planning and land system that contributes to the orderly and sustainable development of the ACT. Under this Act, sustainable development means the effective integration of social, economic and environmental considerations in decision-making. In relation to biodiversity, the Planning and Development Act prescribes
  - how environmental compensation may be made to offset the impact of developments that have a significant adverse environmental impact on protected matters
  - how and under what circumstances environmental assessments must be carried out.
- *Nature Conservation Act 2014*. The main object of the Nature Conservation Act is to protect, conserve and improve the biodiversity of the ACT. The Act states that this is to be achieved by
  - promoting and supporting the management, maintenance and enhancement of biodiversity of local, regional and national significance
  - promoting the involvement of, and cooperation between, Aboriginal and Torres Strait Islander people, landholders, other community members and governments in conserving, protecting, enhancing, restoring and improving biodiversity
  - encouraging public appreciation, understanding and enjoyment of biodiversity
  - recognising and promoting Aboriginal and Torres Strait Islander peoples' role in, and knowledge of, the conservation and ecologically sustainable use of biodiversity.



- *Pest Plants and Animals Act 2005*. This aims to protect the ACT's land and aquatic resources from impacts caused by pest animals and plants.
- *Heritage Act 2004*. The Heritage Act aims to protect significant heritage and prescribes that natural heritage is significant if its biodiversity, geology, landform or other naturally occurring element(s) have scientific value.
- *Emergencies Act 2004*. The Emergencies Act directs all levels of bushfire planning in the ACT.

In the ACT, four strategies relate to biodiversity:

- *ACT Nature Conservation Strategy 2013–23*<sup>76</sup> (prescribed by the Nature Conservation Act). This strategy provides direction on how to better integrate and extend conservation efforts beyond reserves to include natural areas across a range of land uses and tenures, and cross-border, to ensure that ecosystems remain healthy and well managed.
- *ACT Pest Animal Management Strategy 2012–2022*.<sup>118</sup> This strategy provides the key principles, objectives and strategic actions for reducing the damage caused by pest animals.
- *ACT Weeds Strategy 2009–2019*.<sup>119</sup> This strategy provides authoritative guidance to all parties involved in addressing weeds, with clearly stated objectives and identified priorities.
- *Strategic Bushfire Management Plan 2014–19* (prescribed by the Emergencies Act). The SBMP provides the strategies by which critical ecological communities in the ACT can be managed to conserve their ecological values.
- *ACT Environmental Offsets Policy 2015*. This policy is a requirement under the *Planning and Development Act 2007* and is implemented through a range of provisions under the Act, such as
  - consideration of matters of NES through environmental assessment processes for referral to the ACT Conservator of Flora and Fauna and the Australian Government Minister for the Environment
  - administration of the EPBC Act
  - conditions of approval for protected matters as part of development approvals
  - development of guidelines to assist in the development and consideration of environmental offsets

- calculation of offsets and maintenance of the offsets register
- development of offsets management plans.

In addition, the Nature Conservation Act establishes the position of the Conservator of Flora and Fauna, who must prepare and implement a Biodiversity Research and Monitoring Program every two years, and prepare a report at the end of the program.

Each year, an assessment is made of the natural assets described in the TAMS Bushfire Operational Plan. This assessment informs the development of five-yearly regional fire plans by ensuring that fuel management activities, including prescribed burns, slashing and grazing, are consistent with biodiversity conservation objectives, and that prescribed appropriate mitigation measures minimise potentially unfavourable environmental outcomes.

## Australian Government

The Australian Government has biodiversity legislation that is applicable to the ACT.

The EPBC Act protects matters of NES. These matters include Commonwealth-listed threatened species, and ecological communities that inhabit or could potentially inhabit the ACT, and migratory bird species that fly through the ACT.

In the EPBC ACT, protection is given effect through two mechanisms:

- Development actions that may affect matters of NES must be assessed by the Australian Government Minister for the Environment.
- Strategic assessments are conducted that consider landscape-scale effects of development; unlike project-by-project assessments, which look at individual actions (such as construction and operation of a pipeline or wind farm), strategic assessments can consider a much broader set of actions (eg large urban growth areas such as Molonglo or Gunghalin).

The EPBC Act also promotes a partnership approach to environmental protection and biodiversity conservation through bilateral agreements with the ACT. On 16 June 2014, an agreement between the Australian Government and the ACT was executed that



related to environmental assessment.<sup>aa</sup> According to the statement of reasons that were issued as part of this agreement, the Australian Government Minister for the Environment declared that the agreement:<sup>ab</sup>

- minimises duplication of environmental assessment processes
- provides more efficient and effective environmental assessment processes
- strengthens intergovernmental cooperation
- promotes a partnership approach to environmental protection and biodiversity conservation.

### 7.4.2 Management of pressures

A number of projects specifically designed to protect ACT fauna, flora and ecological communities have been conducted during the reporting period.

The ACT Government has partnered with Greening Australia to improve the condition, extent and connectivity of more than 1500 ha of lowland woodland areas across the ACT and adjacent to NSW. The six-year \$2.155 million Building Restored Resilient Landscapes in the ACT and Greater Goorooyarroo project, funded through the Australian Government Biodiversity Fund, commenced in 2011. To date, the program has improved the condition, extent and connectivity of more than 1500 ha of lowland woodland areas. In 2013–14, on-ground works were focused on the Majura Valley, Kowen Plateau and Greater Goorooyarroo region adjacent to the ACT–NSW border. Activities included revegetation, weed and feral animal control, training and community engagement.

In the Tharwa Fish Habitat Project, two trial artificial log jams were constructed to enable channel deepening, improve habitat and improve ability of fish to pass through a river section. Monitoring of two log jams constructed in 2013 to improve fish

habitat showed that water depth between the log jams had increased substantially from 40 cm before construction to 2.7 m after construction. Fish sampling found the log jams to be a hotspot for juvenile cod, with large numbers of juvenile Murray Cod and a juvenile Trout Cod (an endangered species) caught. Fish habitat has also been improved in five river reaches through the installation of 50 artificial fish habitats, dubbed ‘cod caves’. These were 500-kg cement balls with holes and caves that provide small places for fish to hide, live and breed. In 2013, cod caves were trialled in the Molonglo River to improve fish habitat. Fish are now inhabiting the caves.

Monitoring of a new population, and only the second extant population, of the critically endangered Ginninderra Peppercress commenced, and seed was banked with the ANBG. In addition, a large population of this endangered plant was translocated into Crace Nature Reserve, with extensive public participation and involvement of the Australian Minister for the Environment.

Monitoring of the Brindabella Midge Orchid continued. Seed was collected from the population in Namadgi National Park in collaboration with the ANBG, and research was conducted to propagate the species. Survey and monitoring were also undertaken for ACT rare or declared flora, including the Tarengo Leek Orchid, Canberra Spider Orchid and Small Purple Pea.

Vegetation mapping of more than 146 000 ha has been completed at Kowen, Majura and Jerrabomberra, and is in progress in other areas including Namadgi National Park.

Plantings of Drooping Sheoak (*Allocasuarina verticillata*) were completed to improve and increase habitat for Glossy Black Cockatoos, in partnership with Greening Australia and the Isaacs Ridge–Mount Mugga Mugga ParkCare Group.

Three new action plans were prepared with input from the ACT Scientific Committee and released in November 2013: Glossy Black Cockatoo, Little Eagle and Murrumbidgee Bossiaea. A revised action plan for the (possibly extinct) Smoky Mouse was also completed.

aa [www.environment.gov.au/system/files/pages/478185ae-cc4e-4504-9cd8-28158749d5c6/files/act-assessment-bilateral-agreement.pdf](http://www.environment.gov.au/system/files/pages/478185ae-cc4e-4504-9cd8-28158749d5c6/files/act-assessment-bilateral-agreement.pdf)

ab [www.environment.gov.au/system/files/pages/478185ae-cc4e-4504-9cd8-28158749d5c6/files/act-assessment-bilateral-agreement-statement-reasons.pdf](http://www.environment.gov.au/system/files/pages/478185ae-cc4e-4504-9cd8-28158749d5c6/files/act-assessment-bilateral-agreement-statement-reasons.pdf)



The initial two-year survey into the effects of Eastern Grey Kangaroo grazing on vegetation and reptiles within the ACT was completed. The Eastern Grey Kangaroo movement study, using GPS collars and digital mapping, continued at key sites around Canberra. Several community ParkCare groups conducted their own grazing studies, and hundreds of volunteers participated in kangaroo counts.

Development of reserve profiles continued for approximately 40 reserves under the Canberra Nature Park Plan of Management, in close coordination with the preparation of reserve operational plans by TAMS.

Preparation of an ACT Sphagnum Bogs and Fens Draft Management Plan commenced. The plan will provide a management framework for management actions and the monitoring of bogs, including adaptive management for climate change, in the ACT alpine sphagnum bogs and associated fens ecological community. The plan will include the Ginini Flats Ramsar Wetlands.

The *ACT Nature Conservation Strategy 2013–23* was implemented during this reporting period. There have already been some progress and achievements:

- development of baseline information on landscape function; planning and restoration activities for enhancing connectivity; development of a weed alert and surveillance project; and protection of species and ecological communities through planning, monitoring and restoration activities
- soil landscape mapping at 1:100 000 scale, due to be completed by the end of 2015
- work on a hydrogeological landscape framework
- vegetation mapping of the Kowen Plateau and Murrumbidgee Valley (completed), and Namadgi National Park at 1:25 000 scale (due to be completed in 2015–16)
- incorporation of habitat connectivity mapping for wildlife into a connectivity GIS layer on ACTMAPi
- the launch of the Atlas of Living Australia ACT and Southern Tablelands Weed Spotter website,<sup>ac</sup> and a weed identification and mapping application on 12 June 2014
- planning for a biennial forum on nature reserves

- a range of research, monitoring and on-ground projects for protection of species and ecological communities
- biodiversity and climate change funding projects, and the Regional Delivery program, which continued to contribute to on-ground implementation of the ACT Nature Conservation Strategy.

## Plant pests

Under the Pest Plants and Animals Act, the Minister may prepare a pest plant management plan for a pest plant that outlines the requirements for suppression or destruction of the pest plant (if it is achievable) or containment of the pest plant (if suppression or destruction is impractical).

In July 2014, two pest plant management plans were issued, for Chinese Fairy Grass and Fireweed.<sup>120,121</sup>

## Chinese Fairy Grass

Chinese Fairy Grass is a hardy, rhizomatous, clumping perennial grass that is currently only known from one planting in the Australian National University near Fellows Oval. Other than in the ACT, no state or territory has yet formally listed this species.

A weed risk assessment was undertaken on the species in 2014, and reported that it was feasible to control at this stage and that eradication is the desirable outcome. Given the environments in which the species has naturalised in Australia and overseas, it is highly probable that it would find many suitable areas for establishment in the ACT. Chinese Fairy Grass primarily invades disturbed sites, but can be invasive in natural situations. For the ACT, it has been assessed as being a moderate threat to native species and ecological communities.

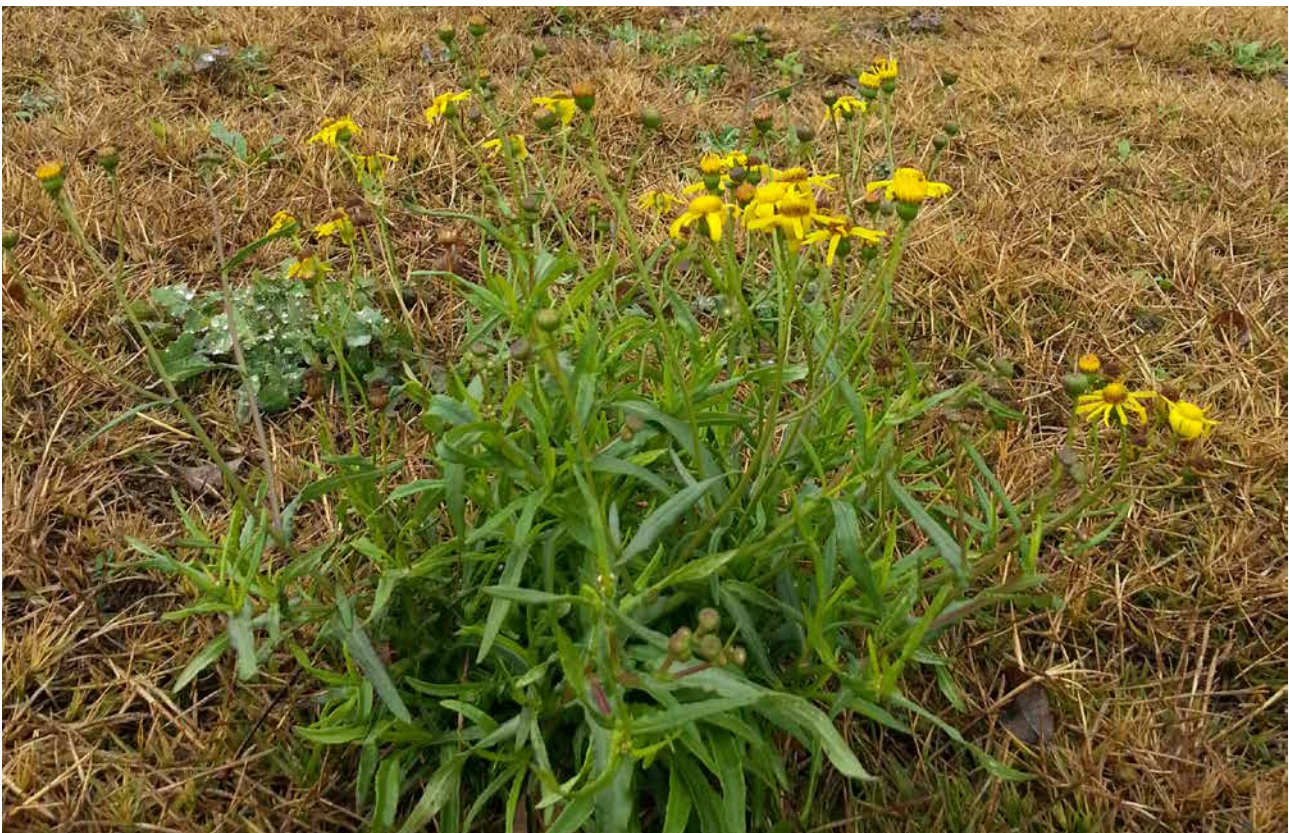
ac <http://root.ala.org.au/bdrs-core/act-esdd/home.htm>





### Fireweed

Fireweed has recently arrived in the ACT. There are large patchy and scattered infestations (10–20% cover) on nature strips in the new suburbs of Crace, Franklin and Forde. These infestations are of considerable concern because they are located close to Mulligans Flat Nature Reserve, Mulangarri Grasslands Nature Reserve, Gungahlin Hill Nature Reserve and the Mitchell grasslands. When the species was discovered in 2013–14, the ACT Biosecurity Plan was activated and a pest plant eradication program was put in place. This involved herbicide applications, hand-pulling and continued monitoring (S Hughes, Senior Manager, Biosecurity, Rural Services and Partnerships, pers comm, 30 September 2015). There are two other isolated infestations in suburban ACT: one site at Commonwealth Park and one plant confirmed in Mount Mugga–Mugga Nature Reserve (see Figure 7.46).



Fireweed in flower

Photo: ACT Government





**Figure 7.46** Maps showing location of Fireweed infestations in the ACT





**Figure 7.46** *continued*

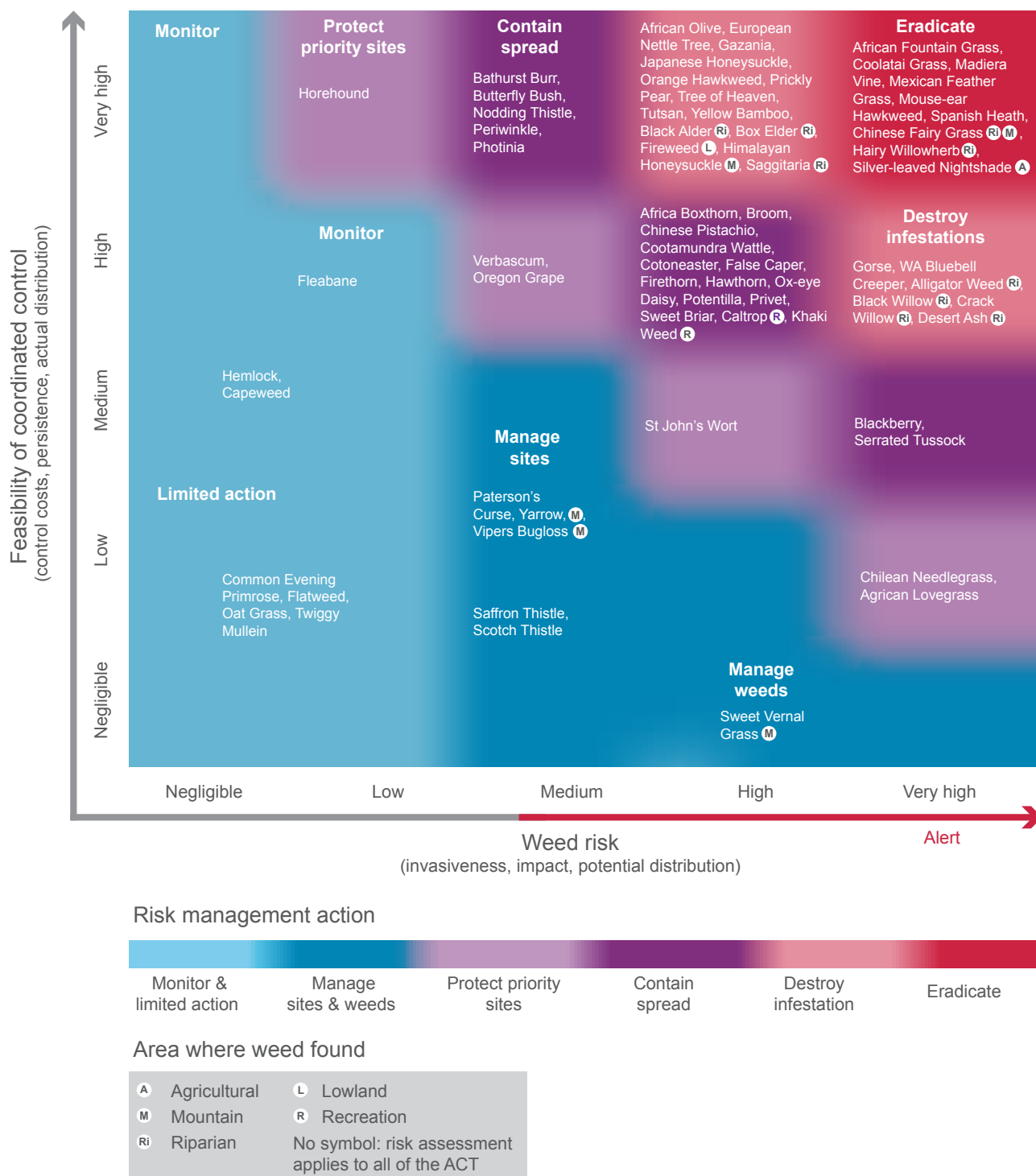
Although the preferred habitats of Fireweed are disturbed sites (roadsides, railway easements and 'waste' areas, and grazed pasturelands), it has also been recorded in open woodlands, native grasslands, suburban bushland and parks. Many current Fireweed infestations are close to ACT nature reserves, including endangered grassland and open woodland reserves that have suitable soils, adequate levels of precipitation and other climatic factors, and open or 'intertussock' spaces. There is therefore a high probability that these important reserves will be conducive to Fireweed establishment.

### Declared pest plants

In April 2015, the Minister issued the Pest Plants and Animals (Pest Plants) Declaration 2015, which identifies the pest plants that must be suppressed and contained.<sup>122</sup>

In 2014–15, a weed risk management action framework was adopted by the PCS, which was based on a system developed by the NSW Department of Primary Industries into which weed data from the ACT were applied (Figure 7.47).<sup>98</sup> This framework is used to prioritise where investment in weed control is directed.

## 7 Biodiversity



**Figure 7.47 Feasibility of weed control in the ACT**



### Weed control

In 2013–14, more than 16 000 ha of the ACT received some form of control action by the PCS (see 'Pressures', 'Pest plants'). As a result, from 2012 to 2015, there has been a large decline in the patchy cover class (10–50% density) and less decline in

the scattered cover class (1–10% density); and a corresponding increase in the lightly scattered or isolated (<1%) cover class (Table 7.25). The increase in the dense cover class (>50% density) reflects primary control work tackling African Lovegrass and St John's Wort infestations.

**Table 7.25 Percentage of invasive weed control in each density class, by year**

Year	Density			
	<1%	1–10%	10–50%	>50%
2012–13	0	37	53	10
2013–14	25	25	25	25
2014–15	25	25	25	25



# References

1. Lindenmeyer D (2011). *What makes a good farm for wildlife?*, CSIRO Publishing, Melbourne, 4.
2. Daily G.C, in Lindenmeyer D.B (2011), (1997). *What makes a good farm for wildlife?*, Collingwood.
3. Australian Museum (2015). *What is biodiversity?*, <http://australianmuseum.net.au/what-is-biodiversity>.
4. Wilderness Society (2015). *Australia's Biodiversity – a summary*, <https://www.wilderness.org.au/articles/australias-biodiversity-summary>.
5. Clarke GM & Spier-Ashcroft F (2015). *A review of the conservation status of selected Australian non-marine invertebrates*, Canberra, [www.environment.gov.au/system/files/resources/ce834791-26aa-47d0-9470-7c63dcdeff8f/files/non-marine-invertebrates.pdf](http://www.environment.gov.au/system/files/resources/ce834791-26aa-47d0-9470-7c63dcdeff8f/files/non-marine-invertebrates.pdf).
6. Australian Bureau of Statistics (2010). *Year book Australia, 2009–10*, cat. no. 1301.0, ABS, Canberra.
7. Atlas of Living Australia (2015). *Australian Capital Territory. All species*, [http://regions.ala.org.au/States%20and%20territories/Australian%2520Capital%2520Territory#group=ALL\\_SPECIES&subgroup=&from=1850&to=2015&tab=speciesTab](http://regions.ala.org.au/States%20and%20territories/Australian%2520Capital%2520Territory#group=ALL_SPECIES&subgroup=&from=1850&to=2015&tab=speciesTab).
8. Australian National Herbarium (2012). *Census of the vascular plants, hornworts, liverworts and slime moulds of the Australian Capital Territory*, [www.cpbr.gov.au/cpbr/ACT-census-2012/index.html](http://www.cpbr.gov.au/cpbr/ACT-census-2012/index.html).
9. Millennium Ecosystem Assessment (2005). *Ecosystems and Human Well-being: Biodiversity Synthesis*, Washington, DC.
10. Fuller RA, Irvine KN, Devine-Wright P, Warren PH & Gaston KJ (2007). Psychological benefits of greenspace increase with biodiversity. *Biology Letters* 3(4):390–394, doi: 10.1098/rsbl.2007.0149.
11. Australian Bureau of Statistics (2010). Australia's biodiversity. In: *Year book Australia, 2009–10*, ABS, Canberra.
12. Cardinale BJ, Duffy JE, Gonzalez A, Hooper DU, Perrings C, Venail P, Narwani A, Mace GM, Tilman D, Wardle DA, Kinzig AP, Daily GC, Loreau M, Grace JB, Larigauderie A, Srivastava DS & Naeem S (2012). Biodiversity loss and its impact on humanity. *Nature* 486(7401):59–67, doi: 10.1038/nature11148.
13. Hajjar R, Jarvis DI & Gemmill-Herren B (2008). The utility of crop genetic diversity in maintaining ecosystem services. *Agriculture, Ecosystems & Environment* 123(4):261–270, doi: 10.1016/j.agee.2007.08.003.
14. Faith D, Magallón S, Hendry A, Conti E, Yahara T & Donoghue M (2010). Ecosystem services: an evolutionary perspective on the links between biodiversity and human well-being. *Current Opinion in Environmental Sustainability* 2:66–74.
15. Chapman A (2009). *Numbers of living species in Australia and the world*, Australian Government Department of the Environment, Water, Heritage and the Arts, Canberra.
16. ACT Environment and Sustainable Development (2013). *Conservation planning and research program report 2011–13*, technical report 29, ACT Government, Canberra, [www.environment.act.gov.au/\\_\\_data/assets/pdf\\_file/0010/576172/Conservation-Planning-And-Research-Program-Report-2011-2013\\_web.pdf](http://www.environment.act.gov.au/__data/assets/pdf_file/0010/576172/Conservation-Planning-And-Research-Program-Report-2011-2013_web.pdf).
17. Canberra Ornithologists Group (2015). Annual bird report: 1 July 2013 to 30 June 2014 – Brown Treecreeper *Climacteris picumnus*. *Canberra Bird Notes* 40(1):56.
18. ACT Scientific Committee (2015). *State of the environment report 2015: peer review report*, Canberra, [www.environmentcommissioner.act.gov.au/publications/soe](http://www.environmentcommissioner.act.gov.au/publications/soe).
19. Canberra Ornithologists Group (2015). Annual bird report: 1 July 2013 to 30 June 2014 – Hooded Robin *Melanodryas cucullata*. *Canberra Bird Notes* 40(1):82.
20. Conservation Planning and Research Unit & Environment and Sustainable Development Directorate (2013). *ACT Lowland Woodland Conservation Strategy – implementation report first published: March 2004, Action Plan 27*, Canberra, [www.environment.act.gov.au/cpr/conservation\\_and\\_ecological\\_communities/lowland\\_woodlands/woodlands\\_strategy](http://www.environment.act.gov.au/cpr/conservation_and_ecological_communities/lowland_woodlands/woodlands_strategy).
21. Olsen J, Debus S & Judge D (2014). Declining Little Eagles *Hieraaetus morphnoides* and increasing rabbit numbers near Canberra: is secondary poisoning by pindone the problem? *Corella* 37(2):33–35.
22. Canberra Ornithologists Group (2015). *Canberra Bird Notes*, (1). [www.canberrabirds.org.au/publications/canberra-bird-notes/](http://www.canberrabirds.org.au/publications/canberra-bird-notes/)



23. Atlas of Living Australia (2015). *Grantiella picta* (Gould, 1838), *Painted Honeyeater*, [http://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:5a3e6d46-d1b3-47e1-b51f-5faf225b40f2#tab\\_records](http://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:5a3e6d46-d1b3-47e1-b51f-5faf225b40f2#tab_records).
24. ACT Flora and Fauna Committee (2015). *Recommendation for declaration of a vulnerable species Scarlet Robin* (*Petroica multicolor*), unpublished report.
25. ACT Environment and Planning Directorate (2015). *Scarlet Robin*, [www.environment.act.gov.au/cpr/conservation\\_and\\_ecological\\_communities/threatened\\_species\\_factsheets/factsheets2/scarlet-robin](http://www.environment.act.gov.au/cpr/conservation_and_ecological_communities/threatened_species_factsheets/factsheets2/scarlet-robin).
26. Umwelt (2015). *Monitoring of the 2014 Superb Parrot breeding event, Australian Capital Territory. Throsby, Central Molonglo and Spring Valley Farm*, final report to ACT Government, unpublished.
27. Thistleton J (2014). *Scientists warn that Superb Parrots still vulnerable*, [www.canberratimes.com.au/act-news/canberra-centenary/scientists-warn-that-superb-parrots-still-vulnerable-20141228-127xf2.html](http://www.canberratimes.com.au/act-news/canberra-centenary/scientists-warn-that-superb-parrots-still-vulnerable-20141228-127xf2.html).
28. Canberra Ornithologists Group (2015). Annual bird report: 1 July 2013 to 30 June 2014 – Superb Parrot *Polytelis swainsonii*. *Canberra Bird Notes* 40(1):48.
29. Canberra Ornithologists Group (2015). Annual bird report: 1 July 2013 to 30 June 2014 – Swift Parrot *Lathamus discolor*. *Canberra Bird Notes* 40(1):49.
30. Canberra Ornithologists Group (2015). Annual bird report: 1 July 2013 to 30 June 2014 – Varied Sittella *Daphoenositta chrysoptera*. *Canberra Bird Notes* 40(1):69.
31. Canberra Ornithologists Group (2015). Annual bird report: 1 July 2013 to 30 June 2014 – White-Winged Triller *Lalage tricolor*. *Canberra Bird Notes* 40(1):71.
32. Australian Government Department of the Environment (2015). *Species Profile and Threats Database*. *Aprasia parapulchella* – *Pink-Tailed Worm Lizard*, *Pink-Tailed Legless Lizard*, [www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon\\_id=1665](http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1665).
33. Mulvaney M (2012). *The extent and significance of Gungahlin's biodiversity values*, technical report 24, Environment and Sustainable Development Directorate, ACT Government, Canberra, [www.environment.act.gov.au/\\_\\_\\_data/assets/pdf\\_file/0010/576847/Gungahlin\\_Biodiversity\\_KF-MM\\_final\\_version.pdf](http://www.environment.act.gov.au/___data/assets/pdf_file/0010/576847/Gungahlin_Biodiversity_KF-MM_final_version.pdf).
34. Osborne W & Wong D (2012). *Examining the long term survival of Pink-Tailed Worm Lizards (Aprasia parapulchella) in Canberra Nature Park: a case study in an urbanised landscape. Habitat and distribution in the Mount Taylor Reserve – 1990–2011*, unpublished report Commissioned by the Environment and Sustainable Development Directorate, Institute for Applied Ecology, University of Canberra.
35. Riverview Group, Osbourne W & Wong D (2013). *The extent of habitat for the vulnerable Pink-tailed Worm Lizard (Aprasia parapulchella) in the West Belconnen – Ginninderra Creek investigation area: confirmatory distribution surveys and mapping*, unpublished report, Institute for Applied Ecology, University of Canberra.
36. Moore D & Jessop R (2013). *Pialligo south Pink-Tailed Worm Lizard survey*, unpublished report, Land Development Agency.
37. Eco Logical Australia (2011). *Targeted Striped Legless Lizard surveys for parts of Symonston and Jerrabomberra Valley*, prepared for the Environment and Sustainable Development Directorate, ACT Government, Canberra, 18.
38. Ryan K, Jekabsons M, Beitzel M & Evans L (2013). *Murray River crayfish monitoring in the Australian Capital Territory*, unpublished report.
39. Water Resources Act (2007). *Water Resources Environmental Flow Guidelines 2013 Disallowable Instrument DI2013-4 made under the Water Resources Act 2007, Section 12*, Canberra.
40. Lintermans M, Broadhurst B & Clear R (2013). *Assessment of the potential impacts on threatened fish from the construction, filling and operation of the Enlarged Cotter Dam Phase 1 (2010–2012): final report*, report to ACTEW Corporation, Institute for Applied Ecology, University of Canberra.
41. Eco Logical Australia (2011). *Symonston Golden Sun Moth and Perunga Grasshopper surveys 2011*, prepared for ACT Environment and Sustainable Development Directorate.
42. Planning Conservation and Land (2011). *Preliminary risk assessment – Molonglo Valley Stage 2*, unpublished report.
43. Anonymous (2014). *Crace – case study 1 EPD*, unpublished, Environment and Planning Directorate.
44. Anonymous (2015). *Endangered Brush-Tailed Wallaby a step closer to reintroduction in ACT*. ABC News Online, 18 June 2015, [www.abc.net.au/news/2015-05-08/brush-tailed-rock-wallaby-a-step-closer-to-reintroduction-in-act/6456256](http://www.abc.net.au/news/2015-05-08/brush-tailed-rock-wallaby-a-step-closer-to-reintroduction-in-act/6456256).





45. ACT Government (2015). *Brush-Tailed Rock-Wallaby (Petrogale penicillata): an endangered species*, Action Plan, ACT Government, Canberra.
46. Eldridge MDB (2011). The changing nature of rock-wallaby (*Petrogale*) research 1980–2010. *Australian Mammalogy* 33:i–iv.
47. Australian Government Department of the Environment (2015). *Species Profile and Threats Database*. *Anthochaera phrygia* – *Regent Honeyeater*, [www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon\\_id=82338](http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=82338)
48. Osbourne W, Doucette L & Gilbert M (2012). *Monitoring Grassland Earless Dragons at the Jerrabomberra Nature Reserves 2011, 2012 & 2013*, update prepared for Canberra Nature Park southside, ACT Government, Canberra.
49. Australian Government Department of the Environment (2015). *Species Profile and Threats Database*. *Pseudophryne pengilleyi* – *Northern Corroboree Frog*, [www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon\\_id=66670](http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=66670).
50. Australian Government Department of the Environment (2015). *Species Profile and Threats Database*. *Macquaria australasica* – *Macquarie Perch*, [www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon\\_id=66632](http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=66632).
51. Ebner B, Lintermans M & Dunford M (2011). A reservoir serves as refuge for adults of the endangered Macquarie Perch. *Lakes and Reservoirs: Research & Management* 16(1):23–33, doi: 10.1111/j.1440-1770.2011.00463.x.
52. Australian Government Department of the Environment (2013). *Conservation advice: Bidyanus bidyanus (Silver Perch)*, Department of the Environment, Canberra, [www.environment.gov.au/biodiversity/threatened/species/pubs/76155-conservation-advice.pdf](http://www.environment.gov.au/biodiversity/threatened/species/pubs/76155-conservation-advice.pdf).
53. John D, Koehn F, Lintermans M, Jarod P, Lyon A, Ingram B, Gilligan D, Todd C & Douglas J (2013). Recovery of the endangered trout cod, *Maccullochella macquariensis*: what have we achieved in more than 25 years. *Marine and Freshwater Research* 64:822–837.
54. Hogg D (2015). *The influence of the Golden Sun Moth on the planning and development of Canberra*, presentation to the Environment Institute of Australia and New Zealand forum on the state of native animals in the ACT, Canberra.
55. Mulvaney M (2012). *Golden Sun Moth (GSM) ACT Strategic Conservation Management Plan*, unpublished report prepared for the ACT Flora and Fauna Committee.
56. Hogg D & Moore D (2011). *Block 799, Gungahlin, ACT. EPBC 2010/5750. Preliminary documentation*, report prepared for the Land Development Agency, Canberra.
57. Australian Government Department of the Environment (2015). *Species Profile and Threats Database*. *Gentiana baeuerlenii* – *Baeuerlen's Gentian*, [www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon\\_id=12001](http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=12001).
58. Briggs J & Müller W (1999). *Effects of fire and short term domestic stock grazing on the endangered perennial forb, Swainsona recta, in a secondary grassland bordering the Australian Capital Territory*, unpublished report for Environment ACT.
59. Kitchen M (2014). *Native plant species and community research, monitoring and mapping in the ACT*, presentation to the Environment Institute of Australia and New Zealand forum on the state of native animals in the ACT, Canberra.
60. Maguire O & Mulvaney M (2011). *Box–Gum Woodland in the ACT*, technical report 25, ACT Government, Canberra.
61. Armstrong R, Turner K, McDougall K, Rehwinkel R & Crooks J (2013). Plant communities of the upper Murrumbidgee catchment in New South Wales and the Australian Capital Territory. *Cunninghamia* 13(1):125–265.
62. Umwelt (2014). *Vegetation survey of Box–Gum Woodland at Kenny, ACT*, unpublished report to the ACT Government.
63. Mulvaney M (2014). *Uncommon plant survey of Canberra Nature Park*, technical report 29, Environment and Planning Directorate, ACT Government, Canberra.
64. Rehwinkel R (2007). *A Method to Assess Grassy Ecosystem Sites: Using floristic information to assess a site's quality*
65. Rehwinkel R (2007). *A method to assess grassy ecosystem sites: using floristic information to assess a site's quality*, NSW Department of Environment and Climate Change, New South Wales, pp 15–19
66. Hodgkinson K (2014). *Condition of selected natural temperate grassland sites in urban and peri-urban Canberra*, final report to the Commissioner for Sustainability and the Environment, ACT, Canberra, [www.envcomm.act.gov.au/\\_\\_data/assets/pdf\\_file/0009/661608/Final-report-edited-on-a-subset-of-14-natural-temperate-grassland-sites-in-urban-and-peri-urban-Canberra.pdf](http://www.envcomm.act.gov.au/__data/assets/pdf_file/0009/661608/Final-report-edited-on-a-subset-of-14-natural-temperate-grassland-sites-in-urban-and-peri-urban-Canberra.pdf).





67. Vivian L & Baines G (2014). *Research update 2014/4: longitudinal study of groundcover flora condition in select grassy ecosystem sites*, ACT Environment and Planning Directorate, Canberra.
68. ACT Department of Territory and Municipal Services (2007). *Ribbons of life: ACT aquatic species and riparian zone conservation strategy*, Action Plan 29, Canberra, [www.environment.act.gov.au/cpr/conservation\\_and\\_ecological\\_communities/aquatic\\_species\\_and\\_riparian\\_zone\\_conservation\\_strategy](http://www.environment.act.gov.au/cpr/conservation_and_ecological_communities/aquatic_species_and_riparian_zone_conservation_strategy).
69. Johnston L, Skinner S, Ishiyama L & Sharp S (2009). *Survey of vegetation and habitat in key riparian zones: Murrumbidgee River, ACT*, technical report 22, ACT Government, Canberra.
70. Peden L, Skinner S, Johnston L, Frawley K, Grant F & Evans L (2011). *Survey of vegetation and habitat in key riparian zones in tributaries of the Murrumbidgee River in the ACT: Cotter, Molonglo, Gudgenby, Naas and Paddys Rivers*, technical report 23, ACT Government, Canberra.
71. Barrett T & Love J (2012). *Fine scale modelling of fauna habitat and connectivity values in the ACT region*, prepared for Conservation Planning and Research, Environment and Sustainable Development Directorate, ACT Government, Environment and Sustainable Development Directorate, ACT Government, Canberra, [www.environment.act.gov.au/\\_\\_data/assets/pdf\\_file/0011/576794/Fine\\_scale\\_modelling\\_of\\_fauna\\_habitat\\_and\\_connectivity\\_values\\_in\\_ACT\\_Final\\_for\\_trish.pdf](http://www.environment.act.gov.au/__data/assets/pdf_file/0011/576794/Fine_scale_modelling_of_fauna_habitat_and_connectivity_values_in_ACT_Final_for_trish.pdf).
72. Barrett T & Love J (2012). *Fine scale modelling of fauna habitat and connectivity values in the ACT region*, prepared for Conservation Planning and Research, Environment and Sustainable Development Directorate, ACT Government, Environment and Sustainable Development Directorate, ACT Government, Canberra, 10, [www.environment.act.gov.au/\\_\\_data/assets/pdf\\_file/0011/576794/Fine\\_scale\\_modelling\\_of\\_fauna\\_habitat\\_and\\_connectivity\\_values\\_in\\_ACT\\_Final\\_for\\_trish.pdf](http://www.environment.act.gov.au/__data/assets/pdf_file/0011/576794/Fine_scale_modelling_of_fauna_habitat_and_connectivity_values_in_ACT_Final_for_trish.pdf).
73. Convention on Biological Diversity, <https://www.cbd.int>.
74. Dunlop M, Hilbert DW, Stafford Smith M, Davies R, James CD, Ferrier S, House A, Liedloff A, Prober SM, Smyth A, Martin TG, Harwood T, Williams KJ, Fletcher C & Murphy H (2012). *Implications for policymakers: climate change, biodiversity conservation and the National Reserve System*, CSIRO Climate Adaption Flagship, Canberra, 9.
75. Sattler P & Taylor M (2008). *Building nature's safety net 2008: progress on the Directions for the National Reserve System*, WWF Australia, Sydney.
76. ACT Environment and Sustainable Development Directorate (2013). *ACT nature conservation strategy 2013–23*, Canberra, [www.environment.act.gov.au/\\_\\_data/assets/pdf\\_file/0004/576184/ACT-Nature-Conservation-Strategy\\_web.pdf](http://www.environment.act.gov.au/__data/assets/pdf_file/0004/576184/ACT-Nature-Conservation-Strategy_web.pdf).
77. Jain M, Flynn D, Prager C, Hart G, Devan C, Ahrestani F, Palmer M, Bunker D, Knops J, Jouseau C & Naeem S (2013). The importance of rare species: a trait-based assessment of rare species contributions to functional diversity and possible ecosystem function in tall-grass prairies. *Ecology and Evolution* 4(1):104–112.
78. ACT Government (2015). *ACT Flora and Fauna Committee annual report 1 July 2013 to 30 June 2014*, unpublished report.
79. Heritage (Decision about Registration of Cotter Caves and Surrounds) Notice 2011.
80. Canberra Ornithologists Group (2015). Annual bird report: 1 July 2013 to 30 June 2014 – Australian Painted Snipe *Rostratula australis*. *Canberra Bird Notes* 40(1):40.
81. Canberra Ornithologists Group (2015). Annual bird report: 1 July 2013 to 30 June 2014 – Black Falcon *Falco subniger*. *Canberra Bird Notes* 40(1):34.
82. Canberra Ornithologists Group (2015). Annual bird report: 1 July 2013 to 30 June 2014 – Crested Shrike-Tit *Falcunculus frontatus*. *Canberra Bird Notes* 40(1):71.
83. Canberra Ornithologists Group (2015). Annual bird report: 1 July 2013 to 30 June 2014 – Powerful Owl *Ninox strenua*. *Canberra Bird Notes* 40(1):53.
84. Malcolm R & Francis A (2015). Bird enthusiasts flock to see Australia's largest owl devour ringtail possums, sulphur-crested cockatoos in suburban Canberra park. ABC News Online, 4 March, [www.abc.net.au/news/2015-03-03/powerful-owl-spotted-in-suburban-canberra-park/627744](http://www.abc.net.au/news/2015-03-03/powerful-owl-spotted-in-suburban-canberra-park/627744).
85. Canberra Ornithologists Group (2015). Annual bird report: 1 July 2013 to 30 June 2014 – White-Bellied Sea-Eagle *Haliaeetus leucogaster*. *Canberra Bird Notes* 40(1):29.
86. NSW Office of Environment and Heritage (2015). *Threatened species: Kydra dampiera – profile*, [www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=20057](http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=20057).
87. Canberra Ornithologists Group (2015). Annual bird report: 1 July 2013 to 30 June 2014 – Diamond Firetail *Stagonopleura guttata*. *Canberra Bird Notes* 40(1):88.
88. Canberra Ornithologists Group (2015). Annual bird report: 1 July 2013 to 30 June 2014 – Dusky Woodswallow *Artamus cyanopterus* *Canberra Bird Notes* 40(1):74.



89. Canberra Ornithologists Group (2015). Annual bird report: 1 July 2013 to 30 June 2014 – Flame Robin *Petroica phoenicea*. *Canberra Bird Notes* 40(1):81.
90. Australian Aquatic Biological (2015). *Riek's crayfish* *Euastacus riei* (first breeding record), [www.aabio.com.au/rieks-crayfish-euastacus-rieki-first-breeding-record](http://www.aabio.com.au/rieks-crayfish-euastacus-rieki-first-breeding-record).
91. Natural Resource Management Ministerial Council (2010). *Australia's biodiversity conservation strategy 2010–2030*, Australian Government Department of Sustainability, Environment, Water, Population and Communities, Canberra.
92. Eyles K & Mulvaney M (2014). *Responsible pet ownership and the protection of wildlife: options for improving the management of cats in the ACT*, a background paper prepared for the ACT Responsible Cat Ownership Steering Committee, Invasive Animals CRC, ACT Government & Australian National University, Canberra.
93. ACT Parks and Conservation Service (n.d.). *Vertebrate pest management annual report 2013–14*, unpublished report.
94. ACT Department of Territory and Municipal Services (2015). *Feral horse management*, [www.tams.act.gov.au/parks-conservation/plants\\_and\\_animals/Biosecurity/pest-animals/feral\\_horse\\_management](http://www.tams.act.gov.au/parks-conservation/plants_and_animals/Biosecurity/pest-animals/feral_horse_management).
95. ACT Environment and Recreation (2007). *Namadgi National Park feral horse management plan 2007*, ACT Government, Canberra, [www.tams.act.gov.au/\\_\\_data/assets/pdf\\_file/0005/441455/NNP-Feral-Horse-Mgt-Plan-2007.pdf](http://www.tams.act.gov.au/__data/assets/pdf_file/0005/441455/NNP-Feral-Horse-Mgt-Plan-2007.pdf).
96. ACT Department of Territory and Municipal Services (2015). *Environmental restoration programs*, [www.tams.act.gov.au/parks-conservation/plants\\_and\\_animals/Biosecurity/pest-animals/indianmynabirds](http://www.tams.act.gov.au/parks-conservation/plants_and_animals/Biosecurity/pest-animals/indianmynabirds).
97. Canberra Indian Myna Action Group Inc (2015). *Who are we?*, [www.indianmynaaction.org.au](http://www.indianmynaaction.org.au).
98. ACT Department of Territory and Municipal Services (2014). *TAMS invasive weeds – operations plan 2014–2015*, ACT Government, Canberra.
99. Richardson F, Richardson R & Shepherd R (2011). *Weeds of the south-east, an identification guide for Australia*, RG and FJ Richardson, Victoria, 6.
100. Taylor S & Thomson J (n.d.) 2013–2014 ACT weed atlas, version 4, Natural Resource Protection and Programs Unit, ACT Parks and Conservation Service, unpublished.
101. Emergency Services Agency (2009). *Strategic Bushfire Management Plan for the ACT: bushfire policy and management framework. Supporting information: part two*, ACT Government, Canberra.
102. Country Fire Authority (2015). *How fire behaves*, [www.cfa.vic.gov.au/plan-prepare/how-fire-behaves](http://www.cfa.vic.gov.au/plan-prepare/how-fire-behaves)
103. Emergency Services Agency (2009). *Strategic Bushfire Management Plan for the ACT: bushfire policy and management framework. Supporting information: part one*, ACT Government, Canberra.
104. NSW Office of Environment and Heritage & ACT Government (2014). *Australian Capital Territory climate change snapshot*, NSW OEH, Sydney, [www.environment.act.gov.au/\\_\\_data/assets/pdf\\_file/0009/671274/ACTsnapshot\\_WEB.pdf](http://www.environment.act.gov.au/__data/assets/pdf_file/0009/671274/ACTsnapshot_WEB.pdf).
105. Emergency Services Agency (2009). *Strategic Bushfire Management Plan for the ACT: bushfire policy and management framework. Supporting information: part two*, ACT Government, Canberra, 38.
106. Kitchen M & Matthews H (2012). *2012–13 ecological guidelines for fuel and fire management operations*, Canberra, [www.tams.act.gov.au/\\_\\_data/assets/pdf\\_file/0011/411113/2\\_2012-13\\_Ecological\\_Guidelines\\_FINAL\\_for\\_web.pdf](http://www.tams.act.gov.au/__data/assets/pdf_file/0011/411113/2_2012-13_Ecological_Guidelines_FINAL_for_web.pdf).
107. (EPD) CRU (2015). *Bushfire Operations Plan Monitoring 2011–15*.
108. *Planning and Development ACT 2007* (ACT), s 111C.
109. Australian Government Department of the Environment (n.d.). *EPBC Act environmental offsets policy*, [www.environment.gov.au/epbc/publications/epbc-act-environmental-offsets-policy](http://www.environment.gov.au/epbc/publications/epbc-act-environmental-offsets-policy).
110. ACT Environment and Planning Directorate (2015). *ACT environmental offsets policy delivery framework*, ACT Government, Canberra, [www.environment.act.gov.au/\\_\\_data/assets/pdf\\_file/0010/629119/ACT-Environmental-Offsets-Framework-ACCESS.PDF](http://www.environment.act.gov.au/__data/assets/pdf_file/0010/629119/ACT-Environmental-Offsets-Framework-ACCESS.PDF).
111. Land Development Agency (2013). *Lawson offset strategy*, Economic Development Directorate, ACT Government, Canberra, [www.planning.act.gov.au/topics/design\\_build/da\\_assessment/environmental\\_assessment/offsets\\_register](http://www.planning.act.gov.au/topics/design_build/da_assessment/environmental_assessment/offsets_register).
112. Rowell A (2013). *Surveys of natural temperate grassland and Golden Sun Moth at Lawson south offset area, Jarramlee/West Macgregor. December 2012 to February 2013*, INDESCO, Canberra.
113. Australian Government Department of Sustainability, Environment, Water, Population and Communities (2013). *Notification of decision to endorse the Gungahlin Strategic Assessment Biodiversity Plan (June 2013)*, Canberra, Australian Capital Territory, DSEWPac, Canberra.



114. Umwelt (2013). *Gungahlin strategic assessment: biodiversity plan*, prepared for the ACT Economic Development Directorate and the ACT Environment and Sustainable Development Directorate, ACT Government, Canberra, 44, [www.economicdevelopment.act.gov.au/\\_\\_data/assets/pdf\\_file/0007/480175/8024\\_Ro1\\_V9-The-Plan.pdf](http://www.economicdevelopment.act.gov.au/__data/assets/pdf_file/0007/480175/8024_Ro1_V9-The-Plan.pdf).
115. ACT Chief Minister, Treasury and Economic Development (2014). *Gungahlin strategic assessment annual report 2013–2014: annual report for the Gungahlin strategic assessment and biodiversity plan for the period of 1 July 2013 to 30 June 2014*, ACT Government, Canberra, [www.economicdevelopment.act.gov.au/\\_\\_data/assets/pdf\\_file/0008/674333/Gungahlin-Strategic-Assessment-Annual-Report-2013-2014A.pdf](http://www.economicdevelopment.act.gov.au/__data/assets/pdf_file/0008/674333/Gungahlin-Strategic-Assessment-Annual-Report-2013-2014A.pdf).
116. Mortlock W (c. 1998). *Model code of practice for community-based collectors and suppliers of native plant seed*, FloraBank, Canberra, [www.florabank.org.au/files/documents/Model%20Code%20of%20Practice%20for%20community-based%20collectors%20and%20suppliers%20of%20native%20plants.pdf](http://www.florabank.org.au/files/documents/Model%20Code%20of%20Practice%20for%20community-based%20collectors%20and%20suppliers%20of%20native%20plants.pdf).
117. Australian Government Department of the Environment (2015). *CAPAD 2014*, [www.environment.gov.au/land/nrs/science/capad/2014](http://www.environment.gov.au/land/nrs/science/capad/2014).
118. ACT Environment and Sustainable Development Directorate (2015). *ACT pest animal management strategy 2012–2022*, ACT Government, Canberra, [www.environment.act.gov.au/\\_\\_data/assets/pdf\\_file/0008/575117/PAMS\\_WEB.pdf](http://www.environment.act.gov.au/__data/assets/pdf_file/0008/575117/PAMS_WEB.pdf).
119. ACT Department of the Environment, Climate Change, Energy and Water (2009). *ACT weeds strategy 2009–2019*, ACT Government, Canberra, [www.environment.act.gov.au/\\_\\_data/assets/pdf\\_file/0007/575071/ACT-Weeds-Strategy-2009-2019.pdf](http://www.environment.act.gov.au/__data/assets/pdf_file/0007/575071/ACT-Weeds-Strategy-2009-2019.pdf).
120. Pest Plants and Animals (Chinese Fairy Grass) Management Plan 2014 (No 1) (ACT).
121. Pest Plants and Animals (Fireweed) Management Plan 2014 (No 1) (ACT).
122. Pest Plants and Animals (Pest Plants) Declaration 2015 (No 1) (ACT).