The role of biodiversity in climate change adaptation

A report for the Office of the Commissioner for Sustainability and the Environment

August 2009

CANBERRA
environment and sustainability
resource centre

Office of the Commissioner for
Sustainability and the Environment

This report was prepared by Dane Wood on behalf of the Canberra Environment and Sustainability Resource Centre for the ACT Office of the Commissioner for Sustainability and the Environment.

The information contained in this report is correct to the best of our knowledge at the time of writing.

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Executive summary

This report collates recent existing data on the Australian Capital Territory's biodiversity in order to analyse and scope the capacity of biodiversity in adapting to climate change and global warming. It intends to provide a report that will ultimately assist research and preparation for the ACT State of the Environment Report with the purpose of educating the Canberra and wider ACT communities on the value of biodiversity for the 'bush capital' and warning of the risks associated with eradicating native plant and animal life and the consequences related to this.

The data used for this study was drawn from a wide range of sources to ensure the topic was scoped sufficiently to provide accurate results regarding the Territory's biodiversity and how successfully it has adapted to the changing climate. Statistics regarding flora, fauna, general biodiversity data and bushfire regeneration figures were drawn from the Centre for Plant Biodiversity Research (Australian National Botanic Gardens), the bushfire regeneration monitoring on Farrer Ridge report, the Australian Government Bureau of Rural Sciences, Molonglo Catchment Group, Ginninderra Catchment Group, Southern ACT Catchment Group, Countdown 2010 - Local and Regional Authorities and the Canberra Ornithological Group.

Collectively the information we have collected has provided us with sufficient data to produce a report that will inform the Office of the Commissioner of the scope, range and value of the region's biodiversity within the overall context of climate change adaptation.

We found that in response to bushfires and controlled burning throughout the Australian Capital Territory, the area's flora was quick to re-establish itself and was closely followed by the return of fauna. This is a positive sign in how the Territory's biodiversity has adapted over the years to regenerate quickly and has tailored itself to not only suit the changing climate but slow the process of global warming through quick restoration of carbon sequestering flora. Also noticed was the positive impact on the environment by particular native species that have had the opportunity to adapt over millions of years

when compared to the less suited domestic species such as cattle and sheep. Kangaroos in particular have proven to be the ideal species to help the natural environment revive and also assist in minimising the hazards which can lead to bushfires. There was sufficient additional literature to support the finding that biodiversity-rich environments not only regenerate faster, but can also play a part in preventing the spread of fire and control fires as a total system.

While the ACT is rich in biodiversity across the scope of flora and fauna, there is cause for concern from the long term perspective of preparation for climate change:

- Of the 47 species of mammals found in the ACT, less than half are commonly found, with 57.45% of the total declared as uncommon, scarce, insufficiently known or endangered.
- The reptile population returns similar statistics, with 59.32% of total species declared uncommon, scarce, rare or endangered.
- Of the amphibians population, 58.82% are uncommon, scarce or endangered, and a further 2 species of amphibians have been declared extinct.

The effects of climate change on the region are expected to include:

- higher temperatures
- increased winds in summers months
- drier average seasonal conditions
- increased frequency of extreme weather events including storms
- increased risk of bushfire

Given this, it is particularly relevant to examine the role of biodiversity in adapting to these conditions over time. After the 2003 bushfires the Farrer Ridge Landcare group undertook a study on the restoration of the landscape and found that native flora species recovered quickly. In response to this, there is a need for community education in the role of native species in gardens as a means of maintaining native habitat as the landscape undergoes the changes that will accompany the expected changes in climate.

Bushfire remains a crucial risk in the region. We found that an ecosystem containing a rich biodiversity recovered more quickly and provided greater ecosystem stability during the restoration period than an ecosystem which featured monoculture (such as the pine forests) or where biodiversity was lacking.

This report has concluded that as climate change progresses further, communities within the Australian Capital Territory will notice dramatic changes to the local climate. In order to address this, three key issues regarding the biodiversity of the ACT must be addressed. These are:

- protecting and nurturing the diverse ecosystems around the ACT
- better integration of the natural and human environments
- closely following the 18 year plan set out in the ACT Climate Change Strategy 2007 – 2025.

These points if addressed properly will have a beneficial effect on the local ecosystems and biodiversity and will increase the capacity of our landscapes to adapt to the process of climate change over a period of years.

1. Biodiversity: overview

> *Biodiversity has been described as the 'web of life', 'the variety of living things' or 'the different plants, animals and micro-organisms, their genes and ecosystems of which they are a part'.*
>
> *Biodiversity encompasses every living thing that exists on our planet and the environment in which they live. From the smallest one-cell microbe to the enormous majesty of the blue whale. From the depths of the Pacific Ocean to peaks of our tallest mountains, biodiversity forms part of an intricate and interdependent web of life in which we are all a part.*
>
> *http://www.environment.gov.au/biodiversity/month.html*

Biodiversity is the basis of all our resources for life. Environmental processes provide us with air to breathe, water to drink and food to eat, as well as materials to use in our daily lives and natural beauty to enjoy.

Ecosystems with a wide variety of plants and animals tend to be more stable. A highly diverse ecosystem is a sign of a healthy system. Since the entire living world relies on the natural environment, it is in our best interests and the interests of future generations to conserve biodiversity and our remaining resources.

The argument that some species have become extinct, with no obvious effect on the environment can be refuted by the fact that the Earth's systems are so complex that we are still learning about environmental processes and the role that biodiversity plays over generations. The loss of any part of the natural environment means that we may never know what use it was or how it could have been of a benefit to us in the future, primarily for the health of the Earth and its survival.

It is important to understand that environments are constantly changing. A healthy environment evolves and adapts to naturally changing conditions it is faced with.

Preservation of biodiversity is not necessarily about preserving everything currently in existence. It's more a question of 'walking lightly' on the Earth — a balance of respecting the natural changes that occur and of protecting species and environments from wanton extinction and destruction.

Life on Earth would be completely different if our planet's biodiversity were to be considerably affected which sums up why it is so valuable and important to maintain.

As the climate changes, extreme weather events such as storms, floods, droughts and heat waves are expected to become more intense and unpredictable. Healthy ecosystems play a crucial role in mitigating the impact of climate-induced disasters. For example, a biologically diverse and healthy forest ecosystem has a high capacity to absorb torrential rain. It provides tree cover and undergrowth that can reduce the erosive impact of intense precipitation, slow down the surface run-off and support the seepage of rain water into the soil and lower rock beds. These processes help reduce the risk of flash floods, mud slides and soil erosion. Conserving a patch of native vegetation may therefore be a key component of integrated disaster risk reduction in the face of climate change. Conserving healthy ecosystems and promoting the adaptive capacity of species helps ensure that urban and rural environments can retain their ‘fitness’ and continue to provide the ecosystem services so vital for their inhabitants, despite the uncertainties of a changing local climate.

Canberra has been designed and built in a way that makes it easily accessible to a wide variation of biodiverse ecosystems. In living adjacent to these habitats comes the added responsibility of caring for the unique biodiversity that surrounds the city and is present throughout the Territory. With the added pressure of a dry, hot climate and strong winds there is the ever present risk of bushfires which makes it essential that there is an active biodiversity conservation plan which could engage the entire community.

2. Flora and fauna in the ACT

Current position

The Australian continent is home to between 600,000 and 700,000 species, many of which are found nowhere else in the world. About 84 per cent of our plants, 83 per cent of our mammals, and 45 per cent of our birds are endemic - that is, they are only found in Australia.

The marine environment is home to thousands of marine species, some of which are unique to Australia and all of which contribute to making Australia the most biodiversity rich developed country in the world.

2.1 Fauna

The fauna information has been gathered from previously conducted surveys, field trips, reports and studies. As data has been taken from an extensive range of different sources we believe that we have a sufficient scope to draw conclusions as to the distribution and status of Canberra's and the Australian Capital Territory's native and introduced wildlife. The Canberra Ornithologists Group has been collecting and recording birdlife around Canberra since the late 1960s and have the most reliable and up to date records. Previous State of the Environment reports and the Office for the Commissioner of the Environment have provided accurate field work and reports regarding the animal life around the ACT including introduced species.

Data was drawn from two time periods in order to compare and draw a conclusion as to whether or not climate change is affecting the ACT's fauna. The first period being early 2003, prior to the January fires whilst the second piece of data was drawn from 2008-09 and is used as the current model.

2.1.1 Mini case study: eastern grey kangaroos and biodiversity

This species has been chosen as a small case study into the value of a single species to overall biodiversity due, in part, to the recent contested and controversial cull in and around the ACT. The ACT government's Kangaroo Management Plan 2009 (draft) is the key document used for this study but on examination we are led to question the rationale given by the ACT government for the cull, particularly in nature reserves.

The eastern grey kangaroo in the Australian Capital Territory has been the subject of culls by the ACT Government since 1994 and the species, existing in large numbers in urban and peri-urban area, is commonly regarded as a 'pest' despite being integral to the biodiversity of the region and also one of Australia's most widely recognised native animals. Ecologist Dan Ramp of the University of New South Wales states the importance of kangaroos in protecting threatened and endangered species from decline and the consequences that will be faced should the culls continue in the same fashion over future years:

> *Native herbivores such as kangaroos and wombats, play a vital role in ecosystem functioning but are often victimized and treated with lack of concern because of socio-political factors and historical value judgements rather than heeding biological and ecological information.'*
>
> *'It is widely recognised that species and ecosystem function are strongly linked. Common species can play key roles in conferring short-term resistance to reductions in ecosystem functions, as rare and uncommon species are lost from the system. We now have entered earths sixth mass extinction event, this time human driven, and yet the setting aside of protected areas may not be sufficient to prevent this loss of biodiversity little research has rigorously quantified implications for biodiversity at local scales. Many species that are now considered common will be effected, but unless we target those 'sleeper' species through monitoring of their distributions and functioning in ecosystems, managers will only be able to be reactive to declines, rather than proactively preventing them.*
>
> *(D.Ramp, 2002)*

Being an animal native to Australia means that the kangaroo has flawlessly adapted to Australia's climate and environment.

Kangaroos assist in the reduction of bushfire hazard by eating dry grass that ignites easily. This is particularly relevant to the ACT due to prominent grasses in the region and the dry year-round climate. Because of their method of browsing, rather than cropping the grass, they do not disturb the root systems of perennials or native flora when they graze, unlike sheep and other domestic livestock which pull at the plant and remove the root. Because the roots systems are left intact, areas grazed by kangaroos regenerate quickly, even during drought or where the area has been severely grazed.

The ACT Kangaroo Management Plan 2009 (draft) rates eastern grey kangaroos with a dry sheep equivalent (DSE) of somewhere between .15 and .7, according to various estimates. We found that due to the fact that the grazing patterns of kangaroos are so different to those of domestic livestock species, and also to the fact that they are range animals, assigning them a DSE is an inaccurate method of establishing a comparison, as evidenced by the wide range of estimates. However, notwithstanding the inaccuracy of the comparison, this method of assigning a rating indicates that an adult kangaroo eats, at most, only 70% as much as an adult sheep which, combined with their method of browsing the grass, would appear to make the species a much more appropriate animal to control grasslands vegetation in and around Canberra.

We also found that the draft Management Plan tended to place an arbitrary separation between kangaroos and the environment, evident in such headings as "Managing environmental impacts of kangaroos in grassy ecosystems" (p. 101), which appears to regard kangaroos as a negative element on grasslands rather than an integral part of a total grassland ecosystem.

Areas grazed by kangaroos are less likely to have problems with erosion and thus, waterways will be less affected by heavy siltation, which can lead to infestations of woody weed species such as willow or blackberry. This provides greater opportunity for the growth of native flora which, in turn, provides habitat and food for native fauna.

Kangaroos, and their predecessors from the pre-human era of the megafauna, have been endemic to the Australian environment for at least 16 million years and they have

evolved to be perfectly suited to their natural habitat. Their soft padded feet and long tail are vital to the ecological health of the land, as regenerators of native grasses. Any seedling that falls into the long tapering footprint of the kangaroo is buried into the hole left by the toenail. Covered and with moisture concentrated at one point, the germinated seedling has a chance of survival. Their tail drags along behind them while they are grazing, pressing the ground, rolling seeds into the earth. Kangaroos play an important role in biological diversity and ecological integrity. Their urine and faeces are a natural fertilizer, not excessively high in nitrogen which pollutes ground and surface water like livestock waste, essential to the health of the land and biodiversity.

The most recent kangaroo culls in the ACT, conducted over a period of some months on Department of Defence land at Majura, ACT nature reserves and private lands has resulted in the loss of an estimated 9000 eastern grey kangaroos. While the pressure on grasslands to sustain large populations of a single species is obvious, it must be noted that kangaroo populations in the natural environment are self-regulating according to the prevailing conditions and that human intervention in this process may be disruptive to the natural breeding cycle and also to the wider ecosystem which relies on kangaroo populations for grassland rehabilitation after drought and fire.

2.1.2 Native mammals found in the ACT

Data drawn from the 2000 ACT Commissioner for the Environment has been categorised as widespread, localised or insufficiently known. We have identified a gap in the data in

that there appears to not be a more recent census and in the mapping of the wildlife populations not stating exactly where the fauna is localised to.

Common name	Scientific name (Genus and species)	Distribution
Platypus	Ornithorhynchus anatinus	W
Short-beaked echidna	Tachyglossus aculeatus	W
Eastern grey kangaroo	Macropus giganteus	W
Red necked wallaby	Macropus rufogriseus	W
Swamp wallaby	Wallabia bicolor	W
Common wombat	Vombatus ursinus	W
Common brushtail possum	Trichosurus vulpecula	W
Greater glider	Petauroides volans	L
Brown antechinus	Antechinus stuartii	W
Common		
Dusky antechinus	Antechinus swainsonii	W
Water rat	Hydromys chrysogaster	W
Bush rat	Rattus fuscipes	W
Gould's wattled bat	Chalinolobus gouldii	W
Chocolate wattled bat	Chalinolobus morio	W
White-striped freetail-bat	Nyctonomus australis	W
Lesser long-eared bat	Nyctophilus geoffroyi	W
Gould's long-eared bat	Nyctophilus gouldi	W
Large forest bat	Vespadelus darlingtoni	W
Southern forest bat	Vespadelus regulus	W
Little forest bat	Vespadelus vulturnus	W
Uncommon		
Wallaroo	Macropus robustus	L
Dingo, wild dog	Canis familiaris	W
Bobuck	Trichosurus caninus	L
Common ringtail	Pseudocheirus peregrinus	W
Yellow-bellied glider	Petaurus australis	L
Sugar glider	Petaurus breviceps	W
Feathertail glider	Acrobates pygmaeus	IK
Eastern pygmy possum	Cercartetus nanus	W
Yellow-footed antechinus	Antechinus flavipes	L
Broad-toothed rat	Mastacomys fuscus	L
Common bentwing-bat	Miniopterus schreibersii	L
Eastern false pipistrelle	Falsistrellus tasmaniensis	L?,IK
Little red fruit-bat	Pteropus scapulatus	?
Scarce		

Common name	Scientific name (Genus and species)	Distribution
Koala	Phascolarctos cinereus	W
Brush-tailed phascogale	Phascogale tapoatafa	IK
Tiger quoll	Dasyurus maculatus	W
Brown rat	Rattus norvegicus	L
Smoky mouse	Pseudomys fumeus	IK
Yellow-bellied sheathtail-bat	Saccolaimus flaviventris	IK
Eastern horseshoe bat	Rhinolophus meghaphyllus	IK
Large-footed myotis	Myotis macropus	IK
Eastern broad-nosed bat	*Scotorepens orion	L, IK
Abundance Insufficiently Known		
Squirrel glider	*Petaurus norfolcensis	
Common dunnart	Sminthopsis murina	
Southern freetail-bat	Mormopterus planiceps	
Scarce (Vagrant)		
Grey-headed fruit-bat	Pteropus poliocephalus	
Scarce, Declared Endangered		
Brush-tailed rock wallaby	Petrogale penicillata	L

2.1.3 Native Reptiles found in the ACT

Common name	Scientific name (Genus and species)	Distribution
Common		
Eastern snake-necked tortoise	Chelodina longicollis	W
Common legless lizard	Delma inornata	W
Bearded dragon	Pogona barbata	W
Jacky lizard	Amphibolurus muricatus	W
Eastern water dragon	Physignathus lesueurii	L
Blotched blue-tongued lizard	Tiliqua nigrolutea	W
Common blue-tongue lizard	Tiliqua scincoides	W
Three-lined skink	Bassiana duperreyi	W
Robust skink	Ctenotus robustus	W
Copper-tailed skink	Ctenotus taeniolatus	W
Cunningham's skink	Egernia cunninghami	W
Black rock skink	Egernia saxatilis	L
White's skink	Egernia whitii	L
Heatwole's water skink	Eulamprus heatwolei	W
Highland water skink	Eulamprus tympanum	W
Three-toed skink	Hemiergis decresiensis	W
Delicate skink	Lampropholis delicata	W

Common name	Scientific name (Genus and species)	Distribution
Spotted grass skink	Lampropholis guichenoti	W
Boulenger's skink	Morethia boulengeri	W
Coventry's skink	Pseudemoia coventryi	L
Grass skink	Pseudemoia entrecasteauxii	L
Highland copperhead	Austrelaps ramsayi	W
Red-bellied black snake	Pseudechis porphyriacus	W
Eastern brown snake	Pseudonaja textilis	W
Uncommon		
Marbled gecko	Christinus marmoratus	IK
Stone gecko	Diplodactylus vittatus	IK
Pink-tailed legless lizard	Aprasia parapulchella	L
Burton's legless lizard	Lialis burtonis	W
Shingleback	Trachydosaurus rugosus	L
Mountain dragon	Tympanocryptis diemensis	L
Jacky lizard	Amphibolurus muricatus	W
Nobbi dragon	Amphibolurus nobbi	L
Red-throated skink	Bassiana platynota	IK
Four-fingered skink	Carlia tetradactyla	W
Robust skink	Ctenotus robustus	W
Copper-tailed skink	Ctenotus taeniolatus	W
Spotted ctenotus	Ctenotus uber	L
Alpine water skink	Eulamprus kosciuskoi	L
Maccoy's skink	Hemiergis maccoyi	L
Grey's skink	Menetia greyii	W
Grass skink	Pseudemoia pagenstecheri	IK
Bog skink	Pseudemoia rawlinsoni	L
Spencer's skink	Pseudemoia spenceri	W
Weasel skink	Saproscincus mustelina	L
Blind snake	Ramphotyphlops nigrescens	W
White-lipped snake	Drysdalia coronoides	W
Black-headed snake	Suta spectabilis	W
Mainland tiger snake	Notechis scutatus	L
Scarce		
Murray turtle	Emydura macquarii	L
Common scaly-foot	Pygopus lepidopodus	IK
Earless dragon	Tympanocryptis lineata	L
Rosenberg's monitor	Varanus rosenbergi	W
Lace monitor	Varanus varius	W
Tree skink	*Egernia striolata	IK
Eastern small-eyed snake	Rhinoplocephalus nigrescens	W

Common name	Scientific name (Genus and species)	Distribution
Bandy-bandy	*Vermicella annulata	IK
Rare		
Diamond python	Morelia spilota	IK
Uncommon, Declared Vulnerable		
Striped legless lizard	Delma impar	L
Scarce, Declared Endangered		
Eastern lined earless dragon	Tympanocryptis lineata pinguicolla	L

2.1.4 Native Amphibians found in the ACT

Common name	Scientific name (Genus and species)	Distribution
Common		
Eastern banjo frog	Limnodynastes dumerilii	W
Spotted grass frog	Limnodynastes tasmaniensis	W
Burrowing Frog	Neobatrachus sudelli	IK
Plains froglet	Crinia parinsignifera	W
Common eastern froglet	Crinia signifera	W
Orange-groined toadlet	Uperoleia laevigata	W
Peron's tree frog	Litoria peronii	W
Uncommon		
Brown-striped frog	Limnodynastes peronii	L
Broad-palmed frog	Litoria latopalmata	L, IK
Lesueur's frog	Litoria lesueuri	W
Scarce		
Brown toadlet	Pseudophryne bibronii	IK
Northern corroboree frog	Pseudophryne pengilleyi	L
Cotter River frog	Litoria sp. affin phyllochroa	L, IK
Abundance Insufficiently Known		
Southern toadlet	Pseudophryne dendyi	
Declared Vulnerable		
Corroboree frog	Pseudophryne corroboree	
Extinct		
Green and golden bell frog	Litoria aurea	
Green and golden bell frog	Litoria raniformis	

2.1.5 Native Fish and their known distribution in the ACT

Common name	Scientific name	Known places of distribution, including places where fish are stocked	Distribution category
Murray Cod	Maccullochella peelii peelii	Parts of the Murrumbidgee, Molonglo, Queanbeyan, Cotter, and Paddys Rivers and Tuggeranong, Ginninderra, and Jerrabomberra Creeks	L
Trout Cod	Maccullochella macquariensis	Parts of the Murrumbidgee and Cotter Rivers	L
Macquarie Perch	Macquaria australasica	Murrumbidgee, Molonglo, Cotter and Paddys Rivers	L
Silver perch	Bidyanus bidyanus	Parts of the Murrumbidgee, Molonglo, Queanbeyan and Cotter Rivers and Ginninderra Creek	L
Golden perch	Macquaria ambigua	Parts of the Murrumbidgee, Molonglo and Queanbeyan Rivers and Tuggeranong, Ginninderra and Jerrabomberra Creeks	L
Freshwater catfish	Tandanus tandanus	Parts of the Molonglo River and Ginninderra Creek	L
Two-spined blackfish	Gadopsis bispinosus	Parts of the Murrumbidgee and Cotter Rivers	L
Western carp gudgeon	Hypseleotris klunzingeri	Parts of the Murrumbidgee, Molonglo, Queanbeyan and Cotter Rivers and Ginninderra and Jerrabomberra Creeks	L
Mountain galaxias	Galaxias olidus	Parts of the Murrumbidgee, Molonglo, Qyeanbyean, Cotter, Paddys, Tidbinbilla, Orroral, Nass and Gudgenby Rivers and Tuggeranong, Ginninderra, Jerrabomberra Creeks	L
Australian smelt	Retropinna semoni	Parts of the Murrumbidgee and Molonglo Rivers	IK
Short-finned eel	Anguilla australis	Parts of the Murrumbidgee River	IK
Murray River Crayfish	Euastacus armatus	Parts of the Murrumbidgee, Queanbeyan, Cotter and Paddys River and Ginninderra Creek	IK

2.1.6 Recorded number of birds for March 2009

(Canberra Ornithologists Group)

Species	Total
1 Australian Magpie	1367
2 Crimson Rosella	1249
3 Australian Raven	941

4	Galah	912
5	Striated Pardalote	877
6	Sulphur-crested Cockatoo	875
7	Pied Currawong	863
8	Superb Fairy-wren	859
9	Red Wattlebird	808
10	Eastern Rosella	752
11	Magpie-lark	737
12	Grey Fantail	711
13	Common Starling	684
14	Weebill	637
15	Spotted Pardalote	582
16	Yellow-faced Honeyeater	561
17	White-throated Treecreeper	535
18	Yellow-rumped Thornbill	506
19	Black-faced Cuckoo-shrike	477
20	Rufous Whistler	475
21	Noisy Miner	472
22	Crested Pigeon	462
23	Laughing Kookaburra	443
24	Australian Wood Duck	426
25	Grey Shrike-thrush	418
26	Willie Wagtail	397
27	Buff-rumped Thornbill	390
28	Pacific Black Duck	348
29	Brown Thornbill	336
30	Noisy Friarbird	335
31	Welcome Swallow	333
32	White-winged Chough	326
33	Common Myna	302
34	Silvereye	301
35	White-browed Scrubwren	298
36	Red-rumped Parrot	289
37	White-eared Honeyeater	272
38	Striated Thornbill	264
39	White-plumed Honeyeater	258
40	Dusky Woodswallow	237
41	Grey Butcherbird	214
42	Masked Lapwing	201
43	Common Blackbird	195
44	White-naped Honeyeater	188
45	Golden Whistler	187
46	White-throated Gerygone	185
47	Sacred Kingfisher	175
48	Eurasian Coot	175
49	White-faced Heron	175
50	Olive-backed Oriole	170
51	Grey Teal	164
52	Australian King-Parrot	164
53	Little Pied Cormorant	163
54	Scarlet Robin	159

55 Common Bronzewing	159
56 Speckled Warbler	157
57 Purple Swamphen	157
58 Dusky Moorhen	155
59 Australasian Grebe	152
60 Grey Currawong	152
61 Horsfield's Bronze-Cuckoo	150
62 Black Swan	147
63 Eastern Spinebill	145
64 Red-browed Finch	145
65 Australian Reed-Warbler	136
66 Mistletoebird	135
67 Nankeen Kestrel	135
68 Wedge-tailed Eagle	134
69 Pallid Cuckoo	134
70 Brown-headed Honeyeater	131
71 Leaden Flycatcher	129
72 White-winged Triller	125
73 Flame Robin	121
74 House Sparrow	121
75 Gang-gang Cockatoo	118
76 Rock Dove	115
77 Australasian Pipit	112
78 European Goldfinch	108
79 Western Gerygone	96
80 Little Raven	95
81 Australasian Shoveler	94
82 New Holland Honeyeater	94
83 Tree Martin	92
84 Australian White Ibis	91
85 Rufous Songlark	90
86 Eastern Yellow Robin	86
87 Diamond Firetail	86
88 Eurasian Skylark	84
89 Brown Goshawk	83
90 Little Corella	83
91 Brown Treecreeper	81
92 Southern Whiteface	80
93 Great Cormorant	77
94 Australasian Darter	76
95 Fuscous Honeyeater	73
96 Silver Gull	73
97 Straw-necked Ibis	73
98 Double-barred Finch	72
99 Fan-tailed Cuckoo	70
100 Brown Falcon	67
101 Varied Sittella	67
102 Dollarbird	63
103 Yellow-tailed Black-Cockatoo	62
104 Little Black Cormorant	59
105 Australian Pelican	56

106	Whistling Kite	55
107	Rainbow Bee-eater	51
108	Hardhead	51
109	Superb Lyrebird	51
110	Satin Bowerbird	50
111	Australian Hobby	49
112	Little Eagle	49
113	Collared Sparrowhawk	48
114	Chestnut Teal	44
115	Australian Shelduck	44
116	Eastern Great Egret	43
117	Fairy Martin	43
118	Black-fronted Dotterel	41
119	Superb Parrot	39
120	Shining Bronze-Cuckoo	38
121	Crested Shrike-tit	37
122	Yellow Thornbill	37
123	Golden-headed Cisticola	35
124	Peregrine Falcon	32
125	Little Grassbird	31
126	Jacky Winter	31
127	Satin Flycatcher	30
128	Hooded Robin	29
129	Hoary-headed Grebe	28
130	Eastern Koel	28
131	Royal Spoonbill	26
132	Red-capped Robin	25
133	Black-winged Stilt	25
134	Rainbow Lorikeet	24
135	Pink-eared Duck	24
136	Latham's Snipe	24
137	Black-shouldered Kite	23
138	White-fronted Chat	23
139	Glossy Ibis	20
143	Rufous Fantail	20
144	Yellow-tufted Honeyeater	20
145	Blue-billed Duck	18
146	Little Wattlebird	18
147	Spotted Quail-thrush	18
148	Southern Boobook	17
149	Peaceful Dove	17
150	White-browed Woodswallow	16
151	Red-backed Kingfisher	16
152	Brown Songlark	15
153	Brown Quail	15
154	Rose Robin	15
155	Eastern Whipbird	14
156	Sharp-tailed Sandpiper	14
157	Cattle Egret	13
158	Red-kneed Dotterel	13
159	Crescent Honeyeater	13

160	Baillon's Crake	13
161	Pilotbird	12
162	Black-tailed Native-hen	12
163	Tawny Frogmouth	12
164	Major Mitchell's Cockatoo	12
165	Pied Cormorant	11
166	Swamp Harrier	11
167	Common Greenfinch	11
168	Brush Cuckoo	10
169	Freckled Duck	10
170	Long-billed Corella	9
171	Red-capped Plover	9
172	White-bellied Sea-Eagle	9
173	Yellow-billed Spoonbill	8
174	Powerful Owl	8
175	Pied Butcherbird	8
176	Red-browed Treecreeper	8
177	Swift Parrot	8
178	Bar-tailed Godwit	8
179	Australian Spotted Crake	8
180	Nankeen Night-Heron	7
181	Australian Little Bittern	7
182	Spotless Crake	7
183	Stubble Quail	7
184	Masked Woodswallow	7
185	Domestic Goose	7
186	White-throated Needletail	7
187	Intermediate Egret	6
188	Whiskered Tern	6
189	Banded Lapwing	6
190	Northern Mallard	5
191	Muscovy Duck	5
192	Bassian Thrush	5
193	Spotted Dove	5
194	Little Friarbird	5
195	Black-chinned Honeyeater	5
196	Buff-banded Rail	4
197	Red-necked Avocet	4
198	Australian Owlet-nightjar	4
199	White-fronted Honeyeater	4
200	Crow & Raven species	3
201	Great Crested Grebe	3
202	Emu	3
203	Black-eared Cuckoo	3
204	Diamond Dove	3
205	Lewin's Rail	3
206	Cicadabird	3
207	Brush Bronzewing	2
208	Barking Owl	2
209	Black Falcon	2
210	Spotted Harrier	2

211 Glossy Black-Cockatoo	2
212 Olive Whistler	2
213 Double-banded Plover	2
214 Azure Kingfisher	1
215 Cockatiel	1
216 Pacific Golden Plover	1
217 Chestnut-rumped Heathwren	1
218 White-bellied Cuckoo-shrike	1
219 Zebra Finch	1
220 Musk Lorikeet	1
221 Australian Painted Snipe	1
222 Turquoise Parrot	1
223 Wonga Pigeon	1
224 Channel-billed Cuckoo	1
225 Red-necked Stint	1
226 White-headed Pigeon	1
227 White-cheeked Honeyeater	1
228 Horsfield's Bushlark	1
229 Little Egret	1
230 Fork-tailed Swift	1
231 Black Honeyeater	1
232 Grey Goshawk	1

2.2 Flora

Flora statistics have been predominately gathered from the Census of the Vascular Plants of the Australian Capital Territory kept by the Centre of Plant Biodiversity Research, with the remaining information drawn from various reports and case studies held in particular ACT sites.

Family	Number of Species	Number of Native Species
ACERACEAE	1	0
ADIANTACEAE	2	2
AGAVACEAE	1	0
AIZOACEAE	1	0
ALISMATACEAE	2	1
ALLIACEAE	1	0
AMARANTHACEAE	11	2

ANARCARDIACEAE	1	0
ANTHERICACEAE	9	9
APIACEAE	25	18
APOCYNACEAE	1	0
AQUIFOLIACEAE	1	0
ARALIACEAE	3	2
ASCLEPIADACEAE	1	0
ASPARAGACEAE	1	0
ASPHODELACEAE	2	2
ASPLENIACEAE	5	5
ASTERACEAE	185	123
AZOLLACEAE	1	1
BERBERIDACEAE	4	0
BETULACEAE	2	0
BLECHNACEAE	8	8
BORAGINACEAE	14	4
BRASSICACEAE	38	12
BUDDLEJACEAE	1	0
CACTACEAE	4	0
CAESALPINIACEAE	1	1
CALLITRICHACEAE	1	0
CAMPANULACEAE	16	16
CAPRIFOLIACEAE	4	1
CARYOPHYLLACEAE	35	11
CASUARINACEAE	4	4
CENTROLEPIDACEAE	1	1
CHENOPODIACEAE	13	4
CISTACEAE	1	0
CLUSIACEAE	4	2
COLCHICACEAE	3	3
CONVOLVULACEAE	3	2
CRASSULACEAE	9	5
CUCURBITACEAE	2	0
CUPRESSACEAE	3	1

CYATHEACEAE	1	1
CYPERACEAE	63	57
DENNSTAEDTIACEAE	4	4
DICKSONIACEAE	2	2
DILLENIACEAE	3	3
DROSERACEAE	2	2
DRYOPTERIDACEAE	1	1
ELATINACEAE	1	1
EPACRIDACEAE	22	22
ERICACEAE	2	0
ERIOCAULACEAE	1	1
EUPHORBIACEAE	11	7
FABACEAE	95	54
FAGACEAE	1	0
FUMARIACEAE	3	0
GENTIANACEAE	9	6
GERANIACEAE	16	11
GLEICHENIACEAE	1	1
GOODENIACEAE	5	5
GRAMMITIDACEAE	1	1
HALORAGACEAE	13	13
HYACINTHACEAE	1	0
HYDROCHARITACEAE	3	2
HYMENOPHYLLACEAE	1	1
HYPOXIDACEAE	3	3
IRIDACEAE	5	1
ISOETACEAE	1	1
JUNCACEAE	34	31
JUNCAGINACEAE	1	1
LAMIACEAE	20	13
LAURACEAE	2	2
LEMNACEAE	3	3
LENTIBULARIACEAE	3	3
LINACEAE	3	1

LOGANIACEAE	2	2
LOMANDRACEAE	5	5
LORANTHACEAE	5	5
LUZURIAGACEAE	1	1
LYCOPODIACEAE	1	1
LYTHRACEAE	2	2
MALVACEAE	8	2
MARSILEACEAE	4	4
MENYANTHACEAE	1	1
MIMOSACEAE	32	25
MONIMIACEAE	1	1
MYRTACEAE	53	50
NYCTAGINACEAE	1	0
OLEACEAE	2	0
ONAGRACEAE	11	5
OPHIOGLOSSACEAE	3	3
ORCHIDACEAE	115	115
OXALIDACEAE	8	3
PAPAVERACEAE	9	0
PASSIFLORACEAE	1	1
PEDALIACEAE	1	0
PHORMIACEAE	5	5
PHYTOLACCACEAE	1	0
PINACEAE	3	0
PITTOSPORACEAE	8	7
PLANTAGINACEAE	10	6
PLATANACEAE	1	0
POACEAE	238	114
PODOCARPACEAE	1	1
POLEMONIACEAE	2	0
POLYGALACEAE	22	12
POLYPODIACEAE	1	1
PORTULACACEAE	6	5
POTAMOGETONACEAE	4	4

PRIMULACEAE	3	2
PROTEACEAE	22	17
PTERIDACEAE	1	1
RANUNCULACEAE	20	15
RESEDACEAE	1	0
RESTIONACEAE	2	2
RHAMNACEAE	15	15
ROSACEAE	29	7
RUBIACEAE	20	15
RUTACEAE	11	11
SALICACEAE	10	0
SANTALACEAE	6	6
SAPINDACEAE	2	2
SCROPHULARIACEAE	31	18
SIMAROUBACEAE	1	0
SINOPTERIDACEAE	6	6
SOLANACEAE	16	2
SPARGANIACEAE	1	1
STACKHOUSIACEAE	2	2
STERCULIACEAE	1	1
STYLIDIACEAE	4	4
THYMELAEACEAE	11	11
TREMANDRACEAE	2	2
TYPHACEAE	2	2
ULMACEAE	5	0
URTICACEAE	4	3
VALERIANACEAE	2	0
VERBENACEAE	5	3
VIOLACEAE	9	6
WINTERACEAE	2	2
XANTHORRHOEACEAE	1	1
ZYGOPHYLLACEAE	1	0

3. The role of biodiversity in post-bushfire regeneration

The Canberra bushfires of 2003 caused severe damage to the outskirts of Canberra. Almost 70% of the Australian Capital Territory's pasture, forests and nature parks were severely damaged or destroyed. After burning for a week beginning on the 8th of January around the edges of the ACT, the fires entered the suburbs of Canberra on the 18th January 2003.

Following these fires the first signs of recovery were in the natural world. This recovery was documented in the published photographic essay, *Ring Of Fire 2003*, where a photographic record was taken of the regeneration of the flora immediately following the fires. With a large portion of the ACT's flora and fauna destroyed it was important for a quick recovery in order for the Territory's biodiversity to redevelop and assist in the mitigation of climate change.

The combination of the Australian Capital Territory's climate, landscape and land use makes it one of the most bushfire prone environments on earth. Living in this environment presents a challenge to humans and other species in terms of remaining aware of how quickly fire will spread once it catches. Canberra and the ACT are well-known for hot dry summers and strong winds.

Geoscience Australia image showing the extent of the 2003 fires

Most of the ACT's native plants and animals have lived with heathland and grassland ecosystems and have adaptations that enable them to regenerate naturally after fire. These include woody cones to protect seeds, buds protected by thick bark or found fire for generations and need it to survive and flourish. Many plants in forest, woodland, on underground roots and the ability of the plant to release seed, which is then stored in the soil.

Native fauna also assists in the regeneration of plants after bushfires. Unlike cattle and sheep,

native Australian animals will graze on the dry grasses that are found so prominently around the ACT and which prove to be the one of the biggest fire hazards faced because of its ability to ignite and spread so rapidly.

Kangaroos, wallabies, wombats and all other herbivorous animals benefit the environment in this way, by grazing they are assisting in keeping dry, dead grasses under control and their nutrient-rich faeces then distribute grass seeds throughout their range areas assisting the regeneration of new grasses.

3.1 Mini case study: Farrer Ridge Landcare Study

Following the 2003 fires, the Farrer Ridge Landcare Group undertook a study into the restoration of the Farrer Ridge environment. The following is a summary of their findings.

Farrer Ridge is a narrow ridge approximately 7km long and 3km wide lying at the southern end of the Woden Valley. It is part of Canberra Nature Park and contains a great diversity of plants with over 160 native species identified in the area. Since 1989, Farrer Ridge Parkcarers have cared for and improved the ridge by removing woody weeds, planting additional trees and shrubs, mapping and monitoring the vegetation and improving the paths and tracks.

On January 18th 2003 Farrer Ridge was almost completely burned by the bushfires which devastated the southern part of the ACT, with only a few small pockets untouched where some of the kangaroo population managed to find refuge. Because Farrer Ridge contains a number of uncommon, rare and endangered plant species, the Parkcarers decided that it would be useful to monitor how the ridge responded to the bushfire and the speed and amount of recovery that could be observed over a 5 year period.
Four sites were monitored covering the different vegetation zones of Farrer Ridge. Photographic records of the site were made three times in 2003, then twice yearly in 2004, 2005 and 2006 and then once in 2008 to record the changes in vegetation. In addition, records were kept of:

• The number of eucalypt, acacia and shrub species growing within 1 metre of the boundaries of the site;

• The identity of all species of trees, shrubs, grasses and weeds growing within the site;

• The structural diversity of the area based on a visual assessment of the amount of tree cover, tall shrubs, short shrubs, ground herbage, logs, rocks and forest litter.

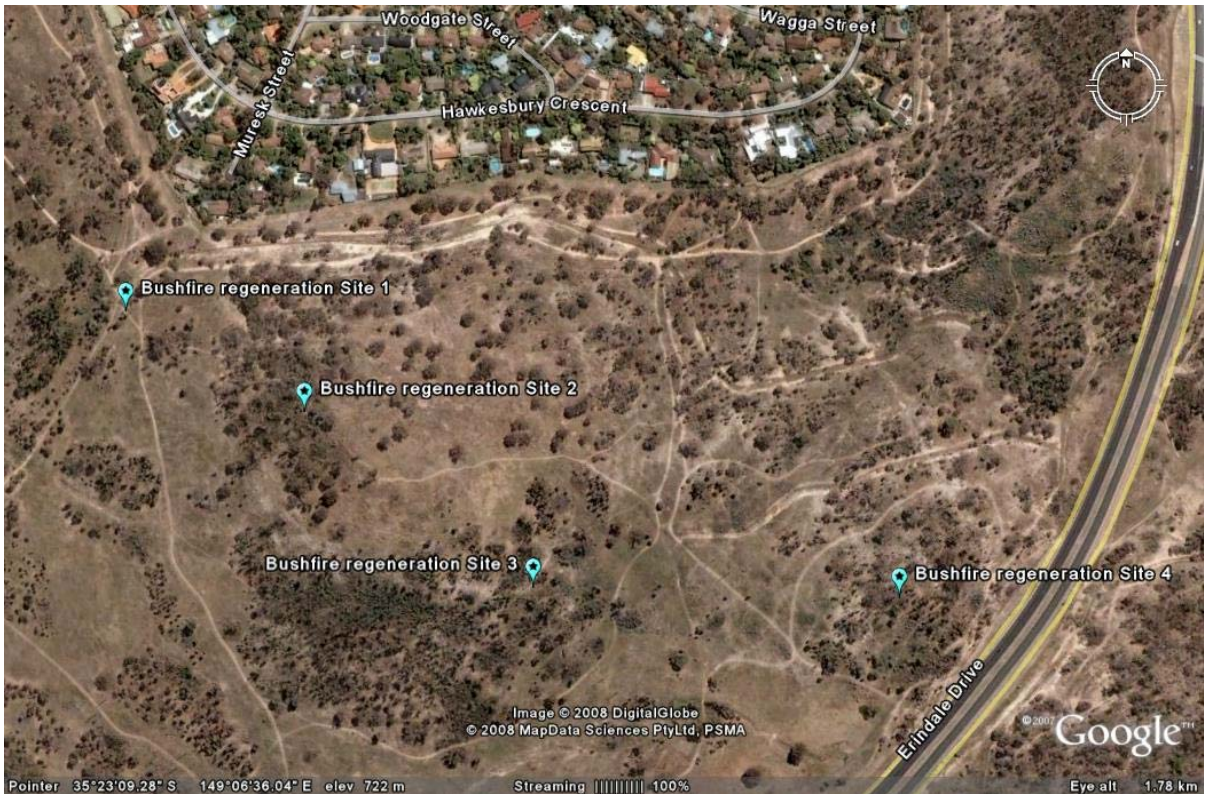
Whilst the 2003 bushfires destroyed most of the vegetation and biodiversity on Farrer Ridge, a large proportion has recovered or is in the process of recovering. Just a few weeks after the fires many plants were showing signs of recovery while new plants were sprouting from seeds in the ground. By the end of 2005, over 90% of all the species identified on Farrer Ridge were showing signs of recovery. In addition, some species not previously discovered on the Ridge were found. This may have been due to the reduction in vegetation and greater access to light, as well as the additional minerals in the soil from the fire, producing ideal conditions for growth for some plant species.

Native tree, shrub & herb regeneration on Farrer Ridge

Year regenerated	***No.***	***Species %***
2003	52	39.10
2004	28	21.05
2005	41	30.83
2006	3	2.26
2007	0	0.0
Not found since fires	9	6.77

Total native plants 133

Farrer Ridge and the four monitoring sites



3.2 Biodiversity and bushfire prevention and control

Additional to the benefit of biodiversity in the restoration of post-bushfire landscape, it has an important role in maintaining the ability of the environment to reduce the incidence of fires. Contrary to a commonly held belief, the NSW Conservation Council and the Australian Conservation Foundation reported in 2004 that:

> *Between July 1995 and July 2003, 2301 fires occurred in NSW National Parks. Of these 2301 fires, 11% spread from national parks to private property, whereas 22% of these fires started on private land and spread to national parks. In other words, twice the number of fires that left National Parks for private property entered National Parks from private property. 89% of fires in National Parks were contained within Park boundaries.*

The Australian environment is well-suited to the extremes of climate that have been a feature of the continent for millennia. Rather than posing a fire risk, the natural environment does, in fact, prevent and contain bushfires more effectively than

environments containing more introduced species and less native biodiversity. A 2001 report by leading meterologists found that global warming was a key factor in the severity of the 2002 drought. The report compares the 2002 drought with the four other major droughts since 1950 and has found higher temperatures caused a marked increase in evaporation rates from soil, watercourses and vegetation. The report warns that higher temperatures and drier conditions have created greater bushfire danger than previous droughts (Williams, Karoly and Tapper, 2001).

The reports into the 2003 bushfires in the ACT indicated that the pine plantations were problematic in both their combustibility and proximity to the urban environment. This could be regarded as an example of where a monoculture provided the ideal conditions for fire, and while the existence of bushland close to the urban environment is generally and popularly regarded as a bushfire hazard, our scoping of the literature found that the maintenance and active conservation of biodiversity-rich ecosystems in and around the Canberra area could well assist in future fire management plans both in terms of fire prevention as well as post-fire landscape restoration.

4. The role of biodiversity in climate change adaptation in the ACT

Biodiversity plays a crucial role in assisting the landscape not only adapt to climate change but in the mitigation of some of the effects of global warming.

As climate change progresses further, communities within the Australian Capital Territory will notice dramatic changes to the local climate. In order to mitigate climate change the ACT Government must look at key areas that directly associate to our biodiversity and climate change. Protecting the varying ecosystems around the ACT, including the populations of native animals and closely following the 18 year plan set out in the ACT Climate Change Strategy 2007-2025 will be vital.

As they grow, plants, fungi and soil bacteria work together to bind carbon dioxide gas from the atmosphere into the soil, wood and other organic matter. This process 'sequesters' carbon dioxide from the atmosphere, thereby helping to reduce the amount of this greenhouse gas, which is most responsible for global warming. The release of CO2 through deforestation and land use change accounts for as much as 25% of total human-induced greenhouse gas emissions. Maintaining local biodiversity and increasing urban green space, in particular forest areas, therefore are significant and effective contributions towards protecting the global climate.

Kangaroos become valuable to the conservation of biodiversity more so because of the fact they don't tear up the roots of the grasses they eat unlike cattle, sheep and other domestic grazers. By just eating the grasses above the soil it enables the plant to re-grow and prevents erosion in the meantime. Government statistics show that kangaroos only exert 1-8% of grazing pressure on land and in fact help the land by co-existing with livestock. Unlike livestock they do not produce greenhouse gases (methane, nitrous oxide), drink massive quantities of water, cause soil erosion, loss of soil nutrients and soil ecosystems leading to deserts.

The fact that kangaroos have been adapting over 16 million years from megafauna to the current time proves that adaption to climate change is possible providing they can adapt

to a healthy ecosystem. The question on whether the ACT Government can provide a healthy ecosystem for biodiversity to adapt to remains to be seen. We have found no evidence to support the theory that kangaroos constitute an ecological hazard and in fact as part of a healthy ecosystem could be an asset in the mitigation of climate change

The ACT Governments Weathering the Change document as a part of the ACT Climate Change Strategy 2007 - 2025 states that:

> *"The ACT Government accepts the overwhelming scientific evidence that the use of our planet and its resources has already and will continue to change our climate. The Government also accepts that unless action is taken now, climate change will seriously damage our quality of life, our natural environment and our economy."*

The Government is preparing for these climatic changes:

- higher temperatures
- increased winds in summers months
- drier average seasonal conditions
- increased frequency of extreme weather events including storms
- increased risk of bushfire

4.1 Conservation of biodiversity in the ACT and region

Given the government's preparations for the effects of climate change on the human environment, there is a pressing need to accept the role of biodiversity in adapting to the likely conditions which will eventuate. Taking active steps towards a biodiversity conservation plan for the ACT and its catchments and wider bioregion would be a positive means of preparing for, and adapting with the changes. Organisations such as the three catchment groups, the ANU's Fenner School of Environment and Society, the CSIRO's Sustainable Ecosystems and community-based environment organisations such as the Conservation Council and the Canberra Environment and Sustainability Resource

Centre and their member groups are working on region-specific biodiversity projects that could be of benefit to the government in a biodiversity conservation plan.

It has been noted throughout the preparation of this report through discussions with representatives of the above organisations that in recent years, and particularly since the introduction of tighter water restrictions as a result of prolonged drought, Canberra residents are increasingly favouring native gardens with mulch rather than water-intensive gardens featuring a lot of exotic plants and lawns. The result of this, as documented by the Canberra Ornithologists Group, smaller wildlife censuses such as Frogwatch and studies by ANU students and researchers, is an increasing native bird, amphibian and reptile population in the urban area. In April 2008, a rare spotted quoll was found in a backyard in suburban Belconnen further strengthening the argument for the Canberra urban area as a biodiversity sanctuary rather than confining 'nature' to beyond the city limits. Providing habitat for native fauna in the urban area, including well-managed wildlife corridors and reserves, is one means of reducing the risk of further endangering the species currently under threat and of enhancing the natural environment for other more prevalent native species.

The role of biodiversity conservation in enhancing the capacity of our environment to adapt to the effect of climate change cannot be understated, with the two major potential climate-related hazards identified for this region being lack of water and increased fire risk. The Canberra Environment and Sustainability Resource Centre proposes a community-based seasonal wildlife census as a means of monitoring and mapping native fauna across the region and also in ascertaining numbers, concentrations and seasonal movements in relation to such factors as temperature fluctuations, water availability and responses to storms or other extreme climatic events.

In relation to the increased risk of bushfire in and around Canberra, any biodiversity conservation plan must include kangaroos as an integral part of the solution rather than regarding them as a problem to be managed. Importantly they feed on the dry grasses of which pose the highest risk of ignition during periods of high and extreme bushfire danger. Other native fauna which are frequently regarded as a 'pest' in the urban area but

which contribute towards a biodiverse environment and one which enables the landscape to adapt to change include brushtail possums, sulphur crested cockatoos and galahs.

Ecosystems with a wide variety of plants and animals are more stable. A highly diverse ecosystem is a sign of a healthy system. Since the entire living world relies on the natural environment, it is in our best interests and the interests of future generations to conserve biodiversity and our remaining resources.

Specific programs currently running in the ACT with the aim of conserving, monitoring or protecting biodiversity include (this list is meant to be indicative only and omits the vast amount and range of projects and studies being undertaken through the universities):

- Frogwatch (Ginninderra Catchment Group)
- Community Engagement in Conservation at the Bush/Urban Interface (CCSERAC)
- Striped legless lizard action plan (Canberra International Airport)
- Woodland Bird Monitoring Project (Canberra Ornithologists Group)
- West Kambah Environmental Learning Precinct (CROWK)
- ACT Landkeepers (Greening Australia)
- Waterwatch and Waterbug (Sthn ACT Catchment Group)
- Molonglo River Rescue (Molonglo Catchment Group with collaborators under CFOC program)

While there is a large number of targeted biodiversity programs engaging a wide sector of the community, there are some notable gaps which appear as weaknesses in the ACT's overall capacity to maintain, enhance and conserve biodiversity:

- there is no overarching conservation strategy, so individual projects, while effective, do not necessarily have links with other complementary projects
- most of the projects being undertaken focus on small areas or single species

One of the great strengths of the current range of projects is that it covers such a wide sector of the ACT and regional community, including government, non-government, community and corporate interests.

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