

A Preliminary Biodiversity Survey of the Ginninderra Falls Area



A report commissioned by the Riverview Group

Prepared by Ginninderra Catchment Group

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Cover Image: Ginninderra Creek in the Ginninderra Falls area. Photo: David Wong, Ginninderra Catchment Group.

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Introduction

Background

The Ginninderra Falls area is a unique environment within the Australian Capital Territory (ACT) region, containing spectacular landscape, ecological and geological features not seen elsewhere in the region. The falls area held great significance for the local Aboriginal people, the Ngunawal, for thousands of years prior to European occupation of the area, and continues to be a highly significant site for Ngunawal custodians. The significance of the area was also appreciated by early Europeans living in the region. In a paper presented to a meeting to discuss the merits of Canberra as the national capital site in 1907, John Gale described the site as “the magnificent Ginninderra Falls”. This paper proved critical in Canberra being chosen as the nation’s capital over Dalgety. Whilst the natural, cultural heritage, geological and aesthetic values of Ginninderra falls are acknowledged to a degree, there is a lack of information on the site, including on the flora and fauna of the area. There have been some surveys conducted on the vegetation of the area (Jessop 2015) as well as flora and fauna surveys that have focussed on adjacent areas in the proposed development area and River Corridor (Kevin Mills and Associates 2009, 2013a, 2013b; Nash and Hogg 2013; Osborne and Wong 2013; Rowell 2013) but further study of the Ginninderra Falls area specifically is warranted.

Whilst threatened species (e.g. Pale Pomaderris *Pomaderris pallida*, Rosenberg's Goanna *Varanus rosenbergi*) and regionally significant or locally uncommon species (e.g. Tree Skink *Egernia striolata*) have been recorded or reported in the area, no comprehensive fauna surveys have been undertaken in the area to our knowledge. It is also likely that the endangered Spotted-tailed Quoll *Dasyurus maculatus maculatus* uses the area as the species has been recorded in suburbs of Belconnen including in the adjacent suburb of Macgregor (ACT Vertebrate Atlas). The Ginninderra Falls area is both close in proximity to these records and has habitat that is suitable for quolls. There may also be other species of interest present in the Ginninderra Falls area that have as yet not been recorded at the site. A preliminary assessment of the area conducted by NSW National Parks and Wildlife service identified Spotted-tailed Quoll and a number of other threatened species as being very likely to occur in the area.

The aim of the current survey is to increase the existing knowledge of the flora and fauna using survey techniques that can be undertaken rapidly and within the available budget and time constraints. It is by no means an exhaustive biodiversity survey of the area and more detailed survey work for mammals, frogs and reptiles could be undertaken in the future. No surveys for birds, bats or invertebrates were undertaken. These groups could be surveyed in future.

Study area

The study area takes in the Ginninderra Creek from the Ginninderra Falls down to the confluence of the Murrumbidgee River and the Ginninderra Creek as well as surrounding areas of forest and woodland that are mostly dominated by Callitris forest and woodlands (Black Cypress Pine *Callitris endlicheri* / Scribbly Gum *Eucalyptus rossii*) and Eucalypt open forest (Scribbly Gum *Eucalyptus rossii* / Red Stringybark *Eucalyptus macrorhyncha*). Most sites have a layer of shrubs of varying heights between 0.5m and 2m, depending on the site and a usually sparse ground layer of grasses forbs, geophytes (plants with an underground storage organ such as orchids and lilies), twiners and sedges.

Geology in the general area is dominated by Silurian-age volcanic geology from the Hawkins Volcanic Suite and the Laidlaw Volcanic Suite (Finlayson 2008). There is an abundance of surface rock in the area as well as large areas of complex rocky outcrops that provide habitat for a range of fauna. The geology of the study area is Ginninderra Porphyry and is distinct from adjacent geology types.

The study area, as well as the adjoining farmland, is zoned as E3 (Environmental Management). Probably as a result of the inaccessibility of the terrain, the study area has undergone much lower levels of human-induced disturbance when compared with adjacent farmland where land uses include agricultural and quarrying.

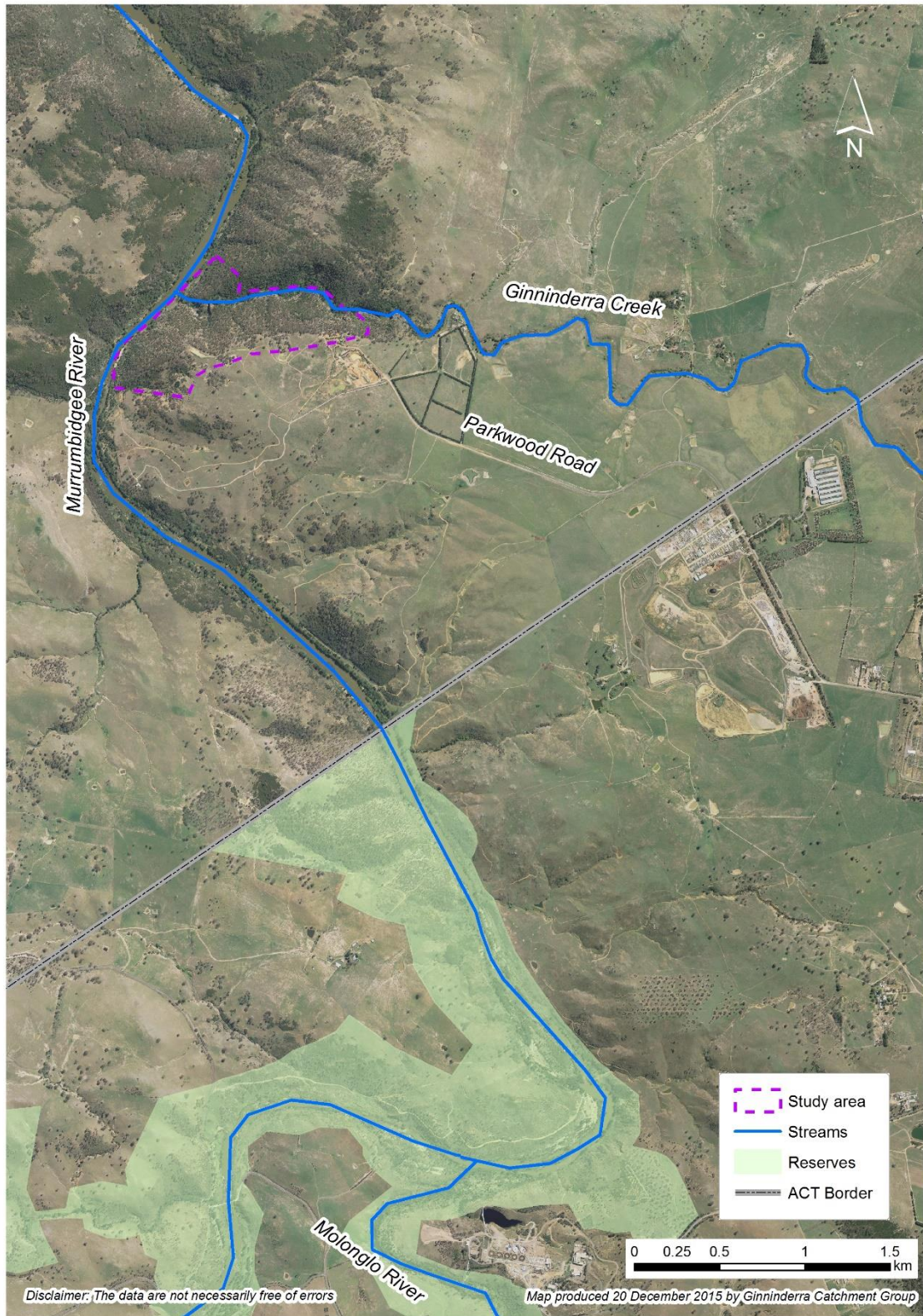


Figure 1: Map showing study area and surrounding land.

Methods

Reptile and frog survey

Active searches were undertaken at eight sites, using quadrats of 50 x 100m, between 15 September and 18 September 2015. One additional meandering active search was also undertaken by two people for 30 minutes (Figure 4). Searches were undertaken between approximately 9:00am and 11:30am. Each site was surveyed by three people, evenly spaced along the short side of the quadrat and, searching lengthways along the quadrat in a band of ground approximately 15-20 m wide in order to cover the whole quadrat. Available substrate (e.g. rocks, logs, fallen bark) were searched and replaced carefully in the original position. Vertebrates found under rocks were identified where possible and recorded. Binoculars were used to search for basking reptiles. Incidental sightings in September and October in or near the study area were also recorded.

A single survey was undertaken for calling frogs on the night of 15 September 2015. For this survey, the Ginninderra Creek was walked from the lower Ginninderra Falls to the confluence of Ginninderra Creek over a period of two hours starting just after dark, with two observers stopping at sites where frogs would be likely to be calling (e.g. still pools).



Figure 2: Example of habitat at one of the active search sites (GF7). The site is Black Cypress Pine *Callitris endlicheri* /Scribbly Gum *Eucalyptus rossii* forest/woodland with a low shrubby understorey, sparse cover of grass and abundant surface rock, litter and logs. Photo: David Wong, Ginninderra Catchment Group.

Camera trapping

Camera trapping sites (Figure 4), were selected in a range of vegetation and habitat types to give the greatest opportunity to record a broad range of species. Habitat preference of threatened species (e.g. Rosenberg's Goanna and Spotted-tailed Quoll) was considered however the primary aim was to record as broad a range of fauna as possible.

Cameras were set for 49 days from the 9 September to 28 October 2015. Four traps (Cam 02, Cam 04, Cam 06 and Cam 08) remained in the original set up position for the seven week monitoring period. Cam 01, Cam 03, Cam 05, Cam 07, Cam 09 and Cam 10 were moved after three weeks and were renamed as Cams 11-16. Cam 17 was set up an additional day following the sighting of a juvenile Rosenberg's Goanna at a burrow near a termite mound during collection of cameras. This equated to a total of 491 camera nights (one camera night = a 24 hour period for which a camera was set up).

The terrain presented some problems relating to access with some areas deemed too dangerous to survey safely within the scope of this project. It should be noted that many of these areas would be excellent habitat for Spotted-tailed Quolls and a survey targeting this species should be undertaken in future.

As the main aim was to record as many fauna species as possible, traps were baited with a variety of attractants including standard oat, honey and peanut butter mix in bait holders, chicken wings placed under rocks and; fish sauce placed on rocks within the field of view of the camera. Traps were rebaited during camera checks and, at some traps, a second bait holder containing chicken hearts was added at the 3 week mark.

Cameras were set up on the tree nearest to the bait between 0.5m -1.5m off the ground to get the best view of the selected area (Figure 3). Baits were placed as close to the centre of the camera's field of view as possible. Plants that were likely to cause false triggers were removed or rocks placed on top of them (without harming the plant), for the duration survey period.

Taxa in photos were identified by trained staff and students at CIT as well as by GCG staff. Identifications of each of the two independent groups of identifiers were then cross-referenced and re-assessed where identifications differed. When clear identifications were made they were recorded to species level. Where identification was uncertain, camera captures were recorded to the most precise level of classification possible (e.g. "unidentified macropod"). Camera captures that were too unclear to identify were recorded as "unidentified". Each trigger consisted of 3 photos at 5 second intervals. Multiple triggers (caused by an animal of the same species, in the same size class, within 10mins of the previous trigger) were recorded as a single camera capture (e.g. a rat that triggered the camera 20 times in an hour would be recorded as just one camera capture).

At the completion of the first stage of identification, images of species that were classed as "unidentified" or "to be confirmed" were sent to experts for verification (e.g. all Rosenberg's Goanna and unconfirmed lizards were verified by Dr Will Osborne). The date, time, species identification and ID numbers for photos were collated in a spreadsheet. A table showing the list of sites and number of each species recorded was produced.

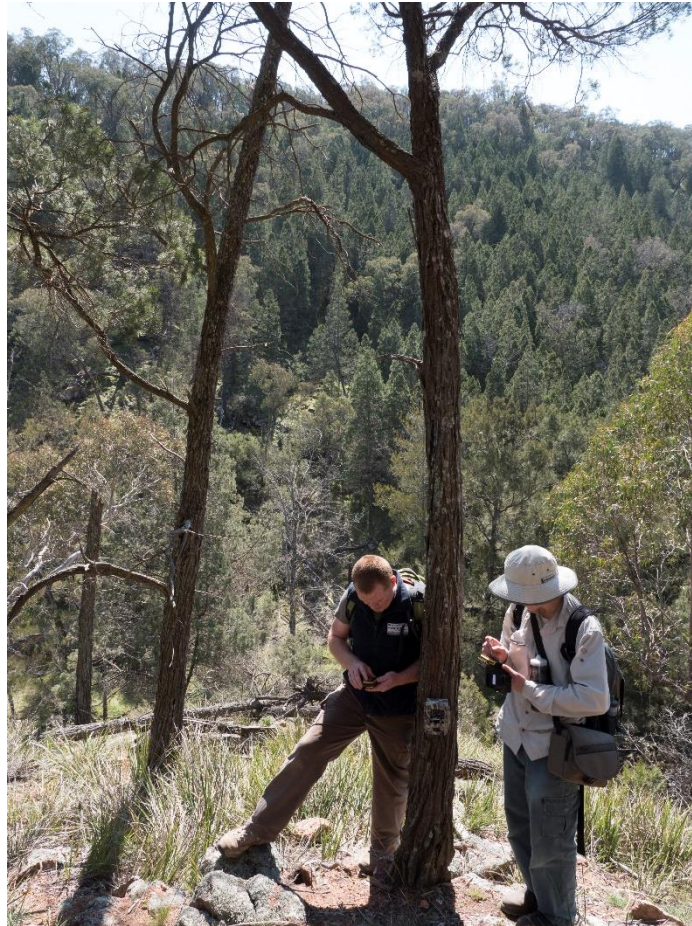


Figure 3: Example of camera trap (Camera 06) set to capture animals moving along a well-used fauna path. *Photo: Karissa Preuss, Ginninderra Catchment Group.*

Vegetation survey

A meandering transect, approximately 1850m in length (Figure 4), was undertaken on 24 September 2015 with three plant experts identifying all species sighted. The area of coverage was generally up to 30m on either side of the line walked, but on occasion, plants were detected up to 50m off the transect. Species that were not recorded by Jessop (2015) in late November 2014 were added to the plant list for the area. Plants opportunistically recorded during visits to the study area during September and October 2015 were also added to the list. A number of species noted by members of the Australian Native Plants Society (ANPS) during visits to the site were also added to the list.

Threatened species

Locations of threatened species sightings were recorded. Known and probable habitat in the area was mapped and other relevant information such as existing knowledge about home range was mapped where appropriate.

Other species and communities of interest or conservation concern

Species not classified as threatened but of particular interest in the area or the region were identified and their areas mapped where possible. Conservation issues are discussed.

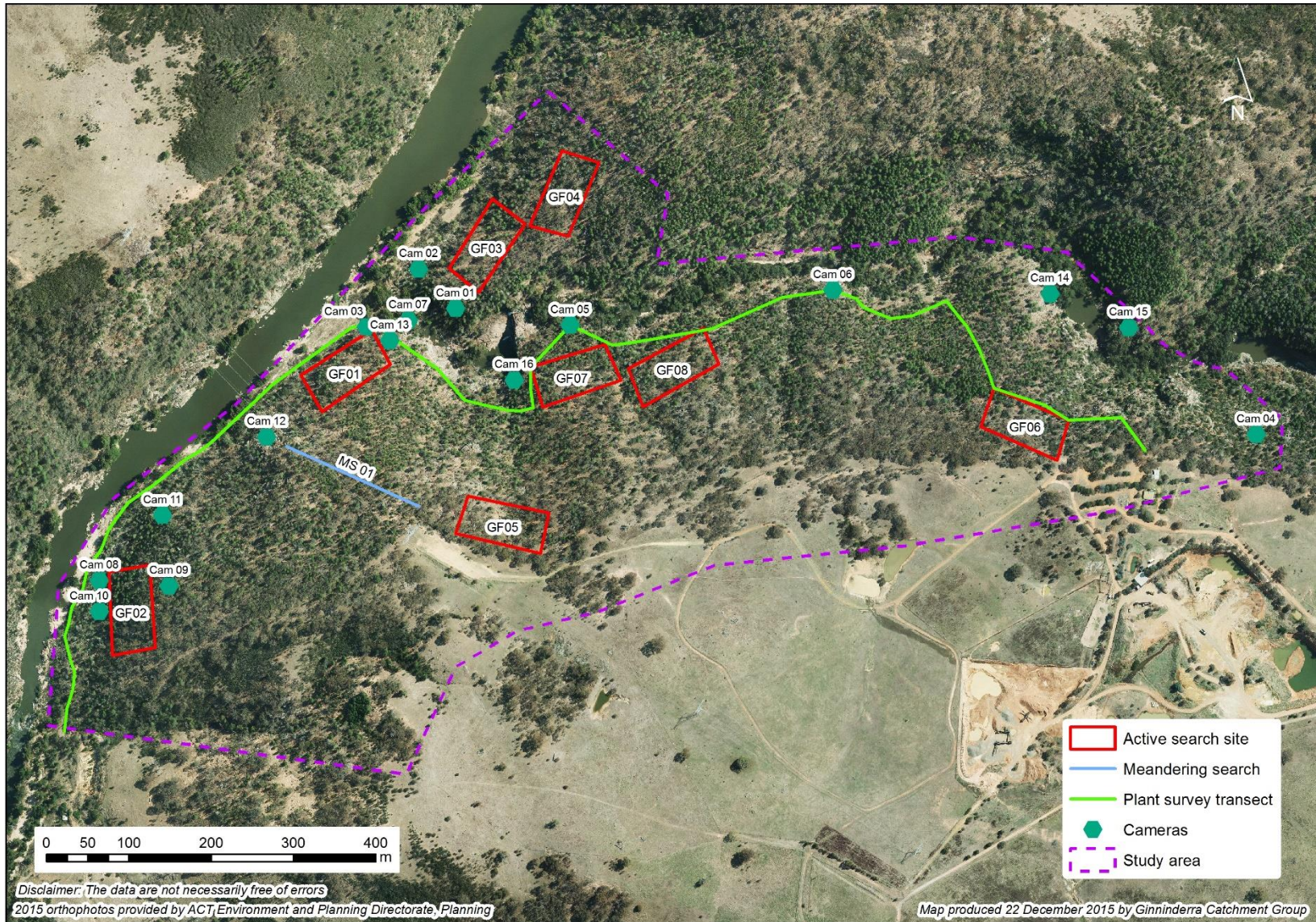


Figure 4: Locations of camera traps, active search and visual encounter sites, meandering search transect and plant species search transect.

Results

Reptile and Frog survey

Twenty-one reptile species from seven families were recorded during the survey period (Table 1). Eight species of reptile and two species of frog were detected in the active searches and meandering search. Six species of reptile were detected on camera traps and nine species of reptile were recorded as incidental sightings. A number of threatened, rare and uncommon species were detected. These included: the Pink-tailed Worm-lizard *Aprasia parapulchella* (listed as Vulnerable in the ACT and nationally and as Endangered in Victoria); Rosenberg's Goanna *Varanus rosenbergi* (listed as vulnerable in NSW and SA and as Threatened in Victoria); Burton's Legless Lizard *Lialis burtonis*; Nobbi Dragon *Amphibolurus nobbi*, Eastern Stone Gecko *Diplodactylus vittatus* and Tree Skink *Egernia striolata*.



Figure 5: Juvenile Stone Gecko *Diplodactylus vittatus*. Photo: David Wong, Ginninderra Catchment Group.

Camera trapping

A total of 4012 triggers (12029 photos) were recorded over the 491 camera nights (across 17 sites). After reviewing all photos the triggers were refined to 743 camera captures (Table 2). The survey identified 22 species including six reptile species, five pest animal species, four species of macropod, three bird species, two species of possum, wombats and echidnas. Rarer camera captures are highlighted in Table 2.

Of particular importance are the two camera captures of Rosenberg's Goanna *Varanus rosenbergi* at sites Cam 02 and Cam 07. Other significant camera captures include Tree Skink *Egernia striolata* one camera capture being the only record of this species during the biodiversity survey; Echidna *Tachyglossus aculeatus* with 14 camera captures at seven sites (indicating a substantial resident population). Echidnas were also frequently sighted incidentally during field surveys. Numbers of

camera captures of the introduced species European Red Fox *Vulpes vulpes* (37 camera captures at 8 sites) and Black Rat *Rattus rattus* (235 camera captures at 11 sites) were high.

Vegetation survey

Our surveys took the total number of species recorded in the in study area in 2014 (Jessop 2015) from 118 to 207 (see Appendix 1 for full species list). An additional 89 species were added to the plant species list recorded by Jessop (2015) during the late spring of 2014 (76 of these additional species were native). Of these, one threatened species Pale Pomaderris *Pomaderris pallida* and 11 rare, uncommon or significant species (based on a list of proposed protected species obtained from the ACT Government) were added to the species list. Some of the species classified by Jessop (2015) as rare were reclassified as not rare based on the ACT Government list and advice from experts (i.e. *Diurus sulphurea*, *Pterostylis* sp. and *Casuarina cunninghamiana* subsp. *cunninghamiana*). In addition, Small Crowea *Crowea exalata* subsp. *exalata* was classified as a rare or uncommon plant owing to the small number of records in the ACT region.

Rare, uncommon or significant species included trees: Currawang *Acacia doratoxylon*; Shrubs: Mountain Hickory *Acacia penninervis*, Varnish Wattle *Acacia verniciflua*, *Bertya rosemarinifolia*, Common Fringe Myrtle *Calytrix tetragona*, Tree Pomaderris *Pomaderris intermedia*, Pale Pomaderris *Pomaderris pallida* and Small Crowea *Crowea exalata* subsp. *exalata* and; forbs ferns and geophytes¹: Bristly Cloak Fern *Cheilanthes distans*, Shining Pennywort *Hydrocotyle sybthorpioides*, Yam Daisy *Microseris lanceolata*.

Six declared pest plant species were recorded in this survey and the previous survey (Jessop 2015). These were: Thistle *Carduus* sp., Paterson's Curse *Echium plantagineum*, African Love Grass *Eragrostis curvula*, St John's Wort *Hypericum perforatum*, Sweet Briar *Rosa rubiginosa*

The lists of Jessop (2015) and GCG and the Australian Native Plants Society complemented each other with unique species associated with each survey.

Threatened species

Two threatened reptiles and one threatened plant were recorded during the survey. These were: Pink-tailed Worm-lizard (Vulnerable – Cwlth, ACT, NSW; Endangered – VIC); Rosenberg's Goanna (Vulnerable – NSW, SA; Threatened in Victoria) and Pale Pomaderris *Pomaderris pallida* (Vulnerable – Cwlth, NSW).

Pink-tailed Worm Lizard *Aprasia parapulchella*

We recorded five Pink-tailed Worm-lizards at 3 sites (GF02, GF07 and GF08). Based on these findings, we mapped broad areas similar to the sites where the species was found (based on interpretation of aerial images in a Geographical Information System (GIS)). Inspection of the imagery revealed areas that may contain additional habitat in the surrounding area, so these were mapped as well (Figure 6). There was some indication in the field that some habitat classified as degraded habitat may now be classified as potential habitat and some patches of habitat may have been missed in the original mapping done by Osborne and Wong (2013) (Figure 6).

Rosenberg's Goanna *Varanus rosenbergi*

Rosenberg's Goanna was recorded at two of the camera trap sites. In addition, a larger adult as well as a sub-adult or juvenile emerging from a burrow in a termite mound, were sighted opportunistically at separate locations in the study area. Using maximum home range values for available studies on Rosenberg's Goanna, we generated buffers of records from our survey as well as historical records (Will Osborne, pers. comm. 2015) in GIS.

¹ Geophytes are species with an underground storage organ such as lilies and orchids

Pale Pomaderris *Pomaderris Pallida*

We mapped patches of Pale Pomaderris in the field using GPS and estimated the number of individuals for each patch. A total of 0.3 ha of patches of Pale Pomaderris was mapped with individual patches varying between 21m² and 0.1ha within a greater area of approximately 1.5 ha (Figure 8).

Other species and communities of interest or conservation concern

A number of rare plants and disturbance-sensitive species were recorded during the survey. Much of the area is Black Cypress Pine *Callitris endlicheri* / Eucalypt woodland and forest. This is a regionally significant community as Black Cypress Pine is a fire-sensitive species and there do not appear to be many examples of large stands of this fire-sensitive community in the ACT region. Areas of forest and woodland that contained Black Cypress Pine were mapped using orthophoto interpretation in GIS. There was approximately 80ha of the land in and around the Ginninderra Falls area containing Black Cypress Pine. Sixty hectares occur on the eastern side of the Murrumbidgee River (Figure 9). These figures are based on a two dimensional image, so the actual figure would be higher.

Small Crowea *Crowea exalata* subsp. *exalata* was recorded incidentally and during the plant survey. Locations of plants of areas where plants occurred were mapped (Figure 9) but no systematic search was undertaken for this species.

Red-necked Wallaby *Macropus rufogriseus* was recorded at the site. This species is sensitive to the effects of urbanisation.

One species from the genus of Peacock Spiders (*Maratus plumosus*), *Maratus plumosus* was recorded incidentally during the surveys. There are very few records of species from this genus known from the ACT region.

Tree Skink *Egernia striolata* was recorded at a camera trap site. The Ginninderra Falls area represents the extreme south-eastern edge of its known distribution.

Table 1: List of reptiles and frogs recorded in the Ginninderra Falls area (GF 1 – GF8 = active search sites; MS1 = Meandering search site). Dark grey shading indicates threatened species. Light grey shading indicates locally uncommon or rare species.

FAMILY and Species	Common Name	GF1	GF2	GF3	GF4	GF5	GF6	GF7	GF8	MS1	Camera traps	Incidental	Frog survey	Total
MYOBATRACHIDAE - Frogs														
<i>Crinia signifera</i>	Common Eastern Froglet												1	1
<i>Limnodynastes tasmaniensis</i>	Spotted Grass Frog						1							1
<i>Uperoleia laevisgata</i>	Smooth Toadlet	1												1
CHELIDAE - Turtles														
<i>Chelodina longicollis</i>	Eastern Long-necked Turtle											1		1
GEKKONIDAE - Geckos														
<i>Diplodactylus vittatus</i>	Stone Gecko	2	1					1						4
PYGOPODIDAE - Legless Lizards														
<i>Aprasia parapulchella</i>	Pink-tailed Worm-lizard		3					1	1					5
<i>Delma inornata</i>	Olive Legless Lizard											1		1
<i>Lialis burtonis</i>	Burton's Legless Lizard											1		1
AGAMIDAE - Dragons														
<i>Amphibolurus nobbi</i>	Nobbi Dragon											2		2
<i>Amphibolurus sp.</i>	Nobbi Dragon or Jacky Lizard	1		1	1							1		4
<i>Intelligama lesueurii</i>	Gippsland Water Dragon										1	10		11
<i>Pogona barbata</i>	Eastern Bearded Dragon											1		1
VARANIDAE - Goannas and Monitors														
<i>Varanus rosenbergi</i>	Rosenberg's Goanna										2	2		4
SCINCIDAE - Skinks														
<i>Ctenotus robustus</i>	Striped Skink											1		1
<i>Ctenotus taeniolatus</i>	Copper-tailed Skink											1		1
<i>Ctenotus sp.</i>											1			1
<i>Eulamprus heatwolei</i>	Heatwole's Water Skink											1		1
<i>Egernia cunninghami</i>	Cunningham's Skink										2			2
<i>Egernia striolata</i>	Tree Skink										1			1
<i>Hemiergis decresiensis</i>	Three-toed Skink							1						1
<i>Lampropholis delicata</i>	Delicate Skink		1	5	4	2	1		1					14
<i>Lampropholis gutchenoti</i>	Garden Skink				2									2
<i>Morethia boulengeri</i>	Boulenger's Skink			1		1	3		2	2				9
<i>Tiliqua scincoides</i>	Eastern Blue-tongued Lizard										1			1
<i>Unidentified small skink</i>			1			1	1	1						4
ELAPIDAE - Venomous Snakes														
<i>Pseudonaja textilis</i>	Eastern Brown Snake											3		3

Table 2: List of Camera trap results for Ginninderra falls area 09/09/2015-29/10/2015

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14	Site 15	Site 16	Site 17	Total no. camera captures	Total no. Sites Recorded	
Native Mammals																				
Brush-tailed Possum <i>Trichosurus vulpecula</i>	0	5	0	2	4	6	0	1	0	0	0	0	1	0	0	0	0	19	6	
Eastern Grey Kangaroo <i>Macropus giganteus</i>	0	5	7	0	3	8	0	1	11	9	2	2	1	0	0	0	0	49	10	
Echidna <i>Tachyglossus aculeatus</i>	3	4	0	2	0	1	2	0	0	0	1	0	0	0	1	0	0	14	7	
Red-necked Wallaby <i>Macropus rufogriseus</i>	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	
Common Ringtail Possum <i>Pseudocheirus peregrinus</i>	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	
Swamp Wallaby <i>Wallabia bicolor</i>	2	3	10	12	4	26	4	2	8	3	0	0	2	0	3	2	1	82	14	
Wallaroo <i>Macropus robustus</i>	0	1	6	0	3	4	0	0	0	0	1	0	0	0	0	2	0	17	6	
Wombat <i>Vombatus ursinus</i>	3	10	12	0	8	11	11	3	0	7	0	0	3	0	3	0	1	72	11	
Macropod sp.	2	8	6	5	1	0	0	0	0	0	0	0	0	0	1	1	0	24	7	
Reptiles																				
Eastern Blue-tongue Lizard <i>Tiliqua scincoides</i>	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	
Cunningham's Skink <i>Egernia cunninghami</i>	0	0	0	0	0	0	3	0	0	0	0	0	0	1	0	0	0	4	2	
Gippsland Water Dragon <i>Intellagama lesueurii</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	
Rosenberg's Goanna <i>Varanus rosenbergi</i>	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	2	
Tree Skink <i>Egernia striolata</i>	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	
Unconfirmed Skink <i>Ctenotus sp.</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	
Birds																				
Australian Raven <i>Corvus coronoides</i>	17	7	6	0	0	0	14	12	5	13	8	13	10	0	0	0	0	105	10	
Pied Currawong <i>Strepera graculina</i>	2	0	1	0	15	0	0	0	0	0	0	0	0	0	0	0	0	18	3	
Superb Fairy Wren <i>Malurus cyaneus</i>	0	1	0	0	0	0	16	0	0	0	0	0	0	2	0	0	0	19	3	
Pest Animals																				
Cat <i>Felis catus</i>	0	2	1	0	0	1	0	0	0	1	0	0	1	0	0	0	0	6	5	
Sambar Deer <i>Rusa unicolor</i>	0	1	3	0	3	0	0	0	2	0	0	0	0	0	0	0	0	9	4	
Red Fox <i>Vulpes vulpes</i>	8	11	1	9	0	2	3	0	0	0	0	0	0	0	2	1	0	37	8	
European Hare <i>Lepus europeus</i>	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	
Black Rat <i>Rattus rattus</i>	14	40	3	42	10	43	32	6	0	0	0	0	0	21	21	3	0	235	11	
Unidentified	0	4	1	2	3	3	2	0	2	2	0	0	0	1	4	0	0	24	10	
No. Species identified	8	17	12	7	10	11	11	7	5	6	4	2	6	6	7	5	2	22		
Total no. Camera captures	51	105	57	74	54	106	89	26	28	35	12	15	18	27	35	9	2	743		
Camera nights (cameras active 24 hr per day)	27	49	27	49	27	49	27	27	49	27	22	22	22	22	22	22	1	491		

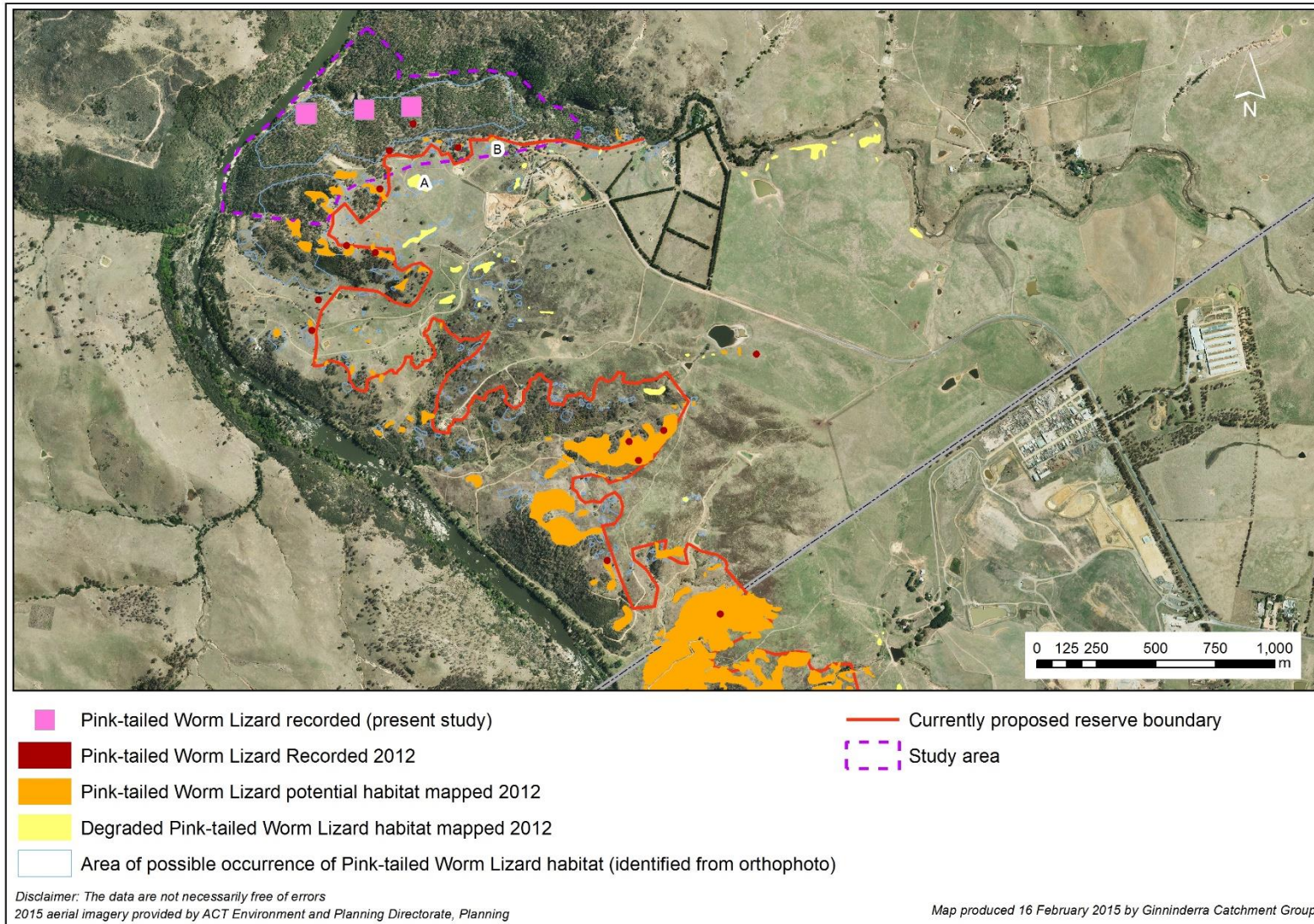
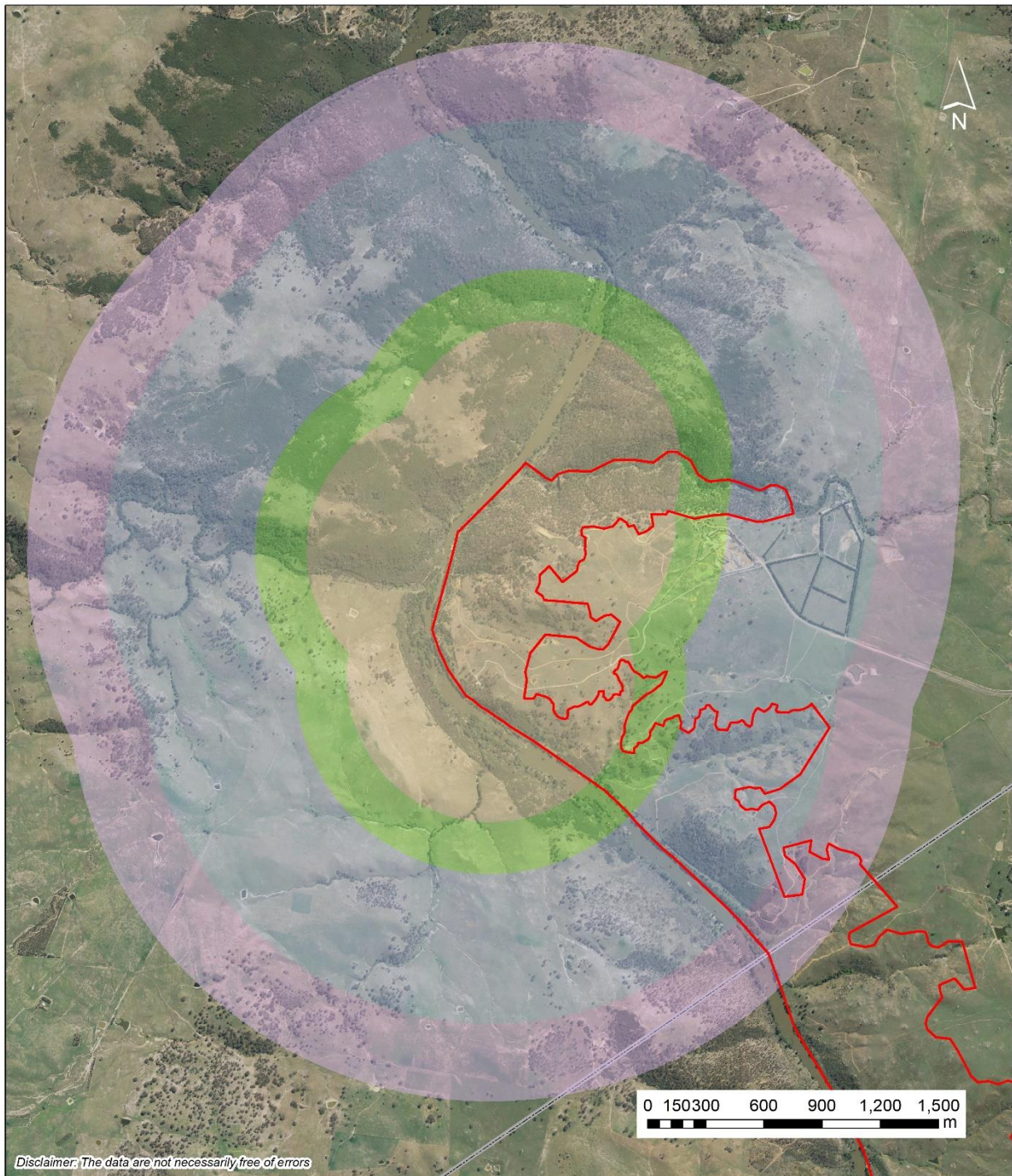


Figure 6: Pink-tailed Worm Lizard *Aprasia parapulchella* records and previously mapped habitat and records from 2012 (Osborne and Wong 2013 - data provided by Riverview Group) as well as other areas of habitat identified from orthophoto interpretation. The area marked “A” indicates an area classified at low quality habitat that now appears to be moderate quality habitat. The area marked “B” indicates an area of habitat that was not previously mapped.



Rosenberg's Goanna *Varanus rosenbergi* home range (indicative)

- Currently proposed conservation reserve boundary
- Warwick Smith, unpublished data, max. male home range - based on tracking data from a single year (173 ha)
- Rismiller *et al.* 2010 max. male home range based on multi-year tracking data 1991-2007 - Kangaroo Island (320 ha)
- Pelican Lagoon Research and Wildlife Centre 2013 (Rismiller, Green, Kelvey data) - max. home range based on multi-year tracking data (1000 ha)
- Rismiller and Green pers. comm. 2016 max male home range, Kangaroo Island based on tracking data 1991-present (1500 ha)
- NSW/ACT Border

Aerial imagery provided by ACT Environment and Planning Directorate - Planning

Map produced 27 May 2016 by Ginninderra Catchment Group

Figure 7: Rosenberg's Goanna *Varanus rosenbergi* records in the area buffered to a distance of available home range estimates. N.B. Buffers in this figure are only shown for known records. It is almost certain that the species would occur in adjacent areas and any decisions relevant to the conservation of the species should take this to account and extrapolate as appropriate to determine likely home range.

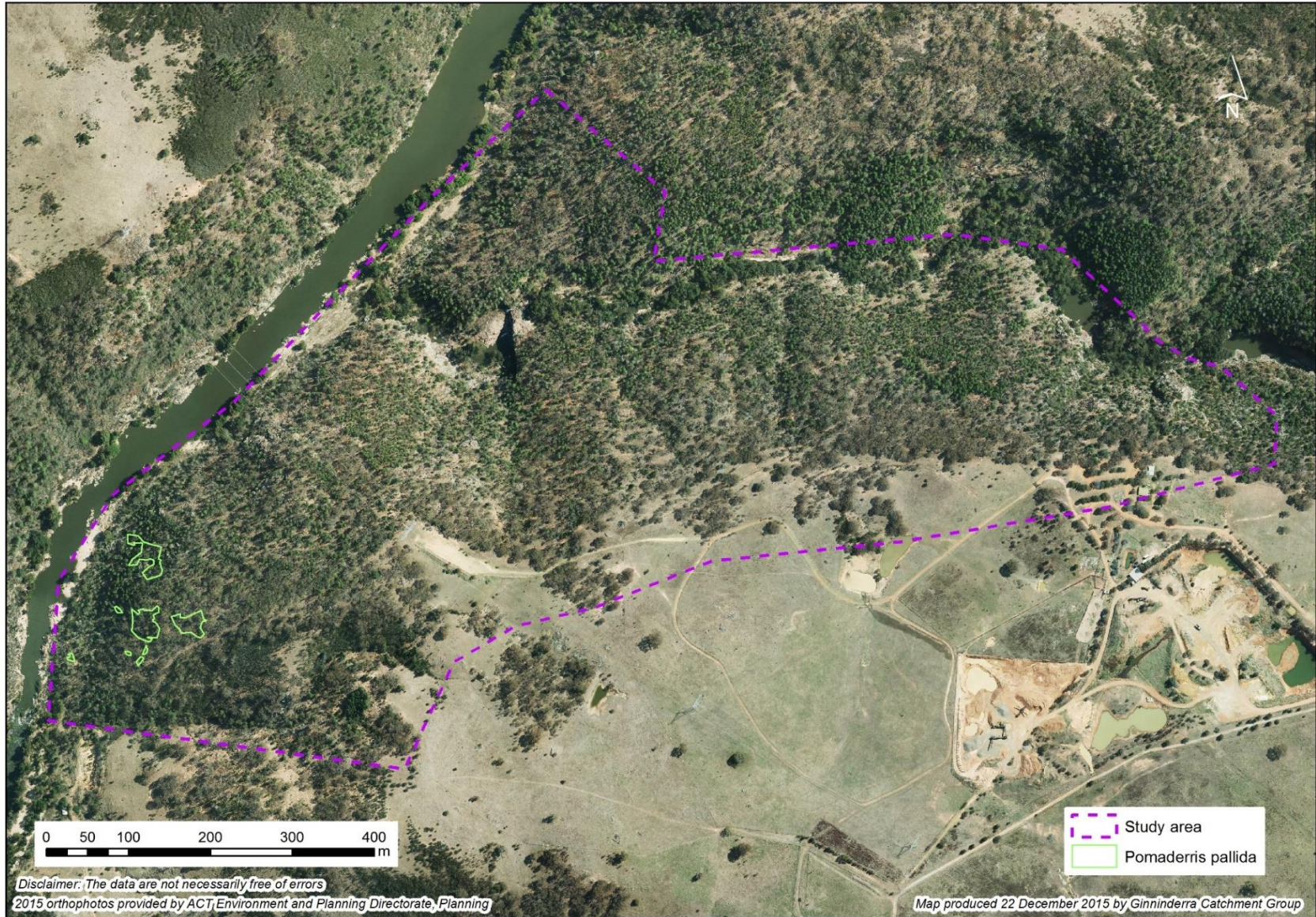


Figure 8: Areas of Pale Pomaderris *Pomaderris pallida* mapped in the field

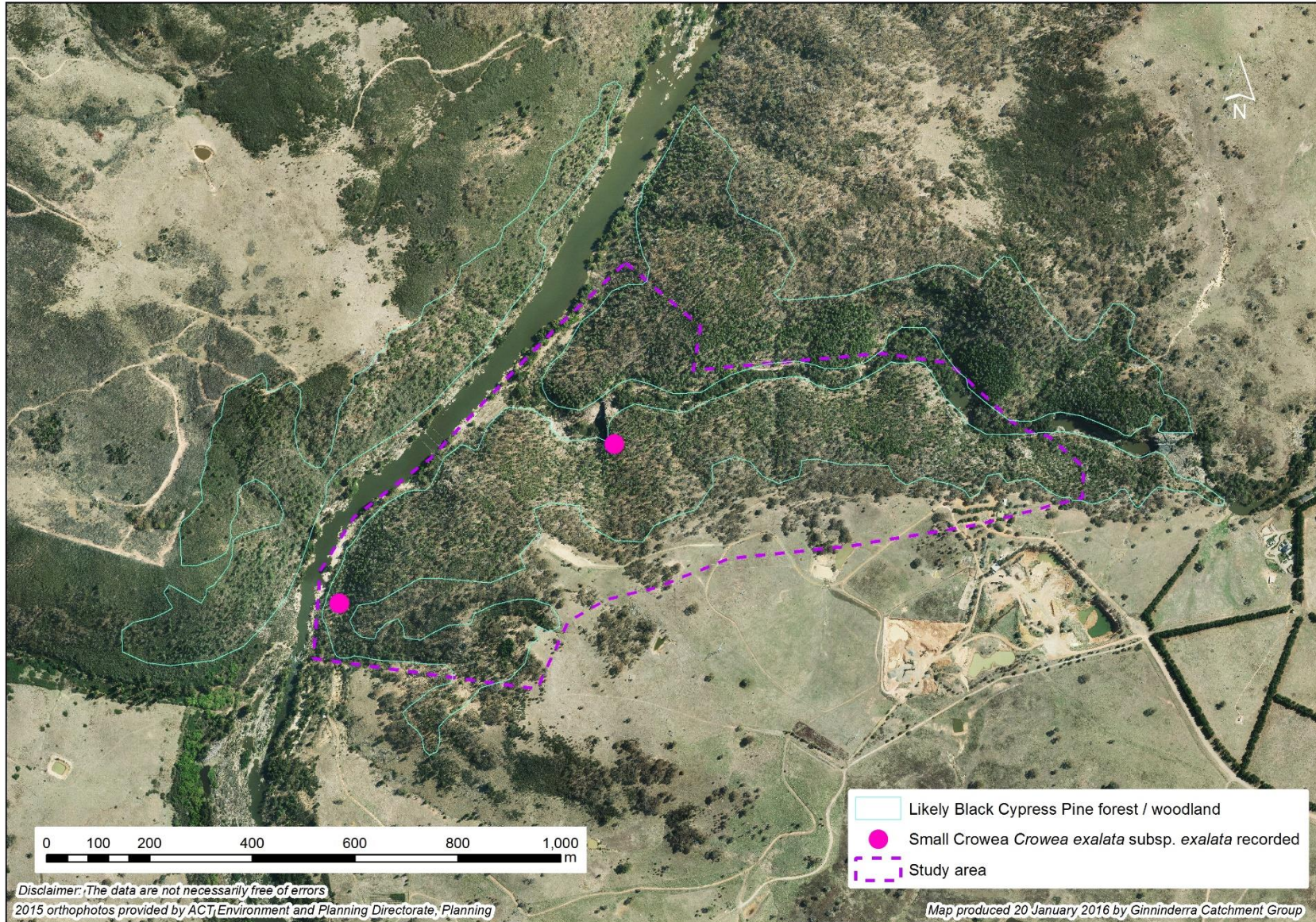


Figure 9: Likely Black Cypress Pine *Callitris endlicheri* / Eucalypt and forest and woodland identified using orthophoto interpretation. Incidental records of occurrence of Small Crowea *Crowea exalata* subsp. *exalata* are shown.

Discussion

Reptiles and Frogs

The 20 reptiles found during the survey is comparable with other surveys of reserves in the region. Barrer (1992) found 20 species of reptile in the Lower Molonglo River Gorge. Rauhala (1993b; 1995) found 24 and 23 species at Stony Creek Nature Reserve and Gigerline Nature Reserve respectively. Kukolic (1990) recorded 20 species at Mount Ainslie and Osborne and McKergow (1993) found 19 species across 12 reserves in Canberra Nature Park. However, survey effort for all of these surveys was much more intensive than that of our surveys and covered much larger geographical areas (e.g. Rauhala (1993b) used pitfall traps as well as active searches over two survey periods of 1 month and 6 weeks). It is therefore highly likely that more intensive surveys and the inclusion of pitfall trapping would result in more species being detected and that the list of reptile species at this reasonably small site would likely be amongst the highest in the region, of sites at a similar altitude (based on the number of species detected in the studies outlined above).

A number of species that were not recorded in the present study were recorded in land to the south of the study area (Kevin Mills and Associates 2013a). These included: Four-fingered Skink *Carlia tetradactyla*, Eastern Three-lined Skink *Bassiana duperreyi*, Red-throated Skink *Pseudemoia platynota* and Red-bellied Black Snake *Pseudechis porphyriacus*. Given the close proximity to the study area, it is likely that some or all of these species also occur in the study area. Other species of reptile that may be expected to occur at the site include: Marbled Gecko *Christinus marmoratus*, Spotted-back Skink *Ctenotus orientalis*, Common Dwarf Skink *Menetia greyi*, Shingleback *Tiliqua rugosa*, Jacky Lizard *Amphibolurus muricatus*, Blind Snake *Ramphotyphlops nigrescens*, and Dwyer's Snake *Suta dwyeri*. Some of these species were recorded by Barrer (1992) in the Lower Molonglo River Corridor. Barrer's survey was conducted within a much bigger study area over a long period of time (around 1 year) (W. Osborne, University of Canberra, pers. comm. 2016).



Figure 10: Male Nobbi Dragon *Amphibolurus nobbi* found near the Murrumbidgee River in the Ginninderra Falls area. Photo: David Wong, Ginninderra Catchment Group.

The richness of reptile species present in the Ginninderra Falls area is likely to be a result of a combination of factors. The area has undergone low levels of human-induced disturbance when compared with surrounding farmland. There is also a diverse range of habitats in the area (e.g. forest, woodland, riparian areas and secondary grassland) and an abundance of complex rocky habitat in many areas. The distinct geology and geomorphology of the area is likely to be an important underlying factor influencing the rich biological diversity observed in the area.

Camera trapping was a useful method for supplementing active searches. In particular, larger species and cryptic species, unlikely to be encountered during active searches were detected using camera traps. Four species, Eastern Blue-tongued Lizard *Tiliqua scincoides*, Cunningham's Skink *Egernia cunninghami*, Tree Skink *Egernia striolata* and, importantly, Rosenberg's Goanna *Varanus rosenbergi* were detected by camera traps.

A number of the reptile species recorded are threatened, rare or uncommon (Hogg 1990; Rauhala 1993a) and are generally only found in areas that have not undergone high levels of modification. These include: the Pink-tailed Worm-lizard *Aprasia parapulchella* (listed as vulnerable in ACT, NSW and nationally and as endangered in Victoria); Rosenberg's Goanna *Varanus rosenbergi* (listed as vulnerable in NSW and SA and threatened in Victoria); Burton's Legless Lizard *Lialis burtonis*; Nobby Dragon *Amphibolurus nobbi*, Eastern Stone Gecko *Diplodactylus vittatus* and Tree Skink *Egernia striolata*. This indicates that ecological integrity and habitat values in the area are high.



Figure 11: Spotted Grass Frog *Limnodynastes tasmaniensis* found under a rock in grassland. Photo: David Wong, Ginninderra Catchment Group.

Only three species of frog were recorded during the survey. However, the results should be interpreted with caution as there was only one targeted survey undertaken for frogs. Future surveys should undertake repeated visit surveys in order to better assess the frog fauna in the area. Frog call surveys along the creek may also not pick up all the species present in the area as the nature of the gorge and falls may provide barriers that may reduce the likelihood of frogs occupying pools. It is expected that a range of other species may occur in the area (e.g. Peron's Tree Frog *Litoria peroni*, Eastern Banjo Frog *Limnodynastes dumerilii* etc.). Of particular interest would be determining whether the Broad-palmed Frog *Litoria latopalmata* is present at the site as the species has been

recorded on the Murrumbidgee River approximately 5km upstream of the study area(ALA 2016d). Further work is recommended to establish the status of the frog fauna in the area.

Camera trapping

Camera trapping was a quick and cost effective method to detect the presence of fauna within the survey area and proved critical in detecting Rosenberg’s Goanna and a number of other species which are rarely encountered (e.g. Red-necked Wallaby, Tree Skink and Common Ring-tail Possum). The lack of public access to the area meant that the security of equipment was maintained with only one occurrence of human intervention. Although limited by time, every effort was taken to sample as broad a range of habitats as possible within the survey area.

The generalised approach of this camera trapping survey has proved successful for the purposes of a pilot survey to gauge the general diversity of fauna in the area. However, the fact that some species recorded were represented by just a single camera capture highlights the potential to miss species that are not readily recorded using camera traps. These species could have easily been missed and therefore not recorded for this area. It is almost certain that more targeted camera trapping and/or additional survey techniques would allow for further species to be detected.

Vegetation

The vegetation survey demonstrated that the Ginninderra Falls area has a rich plant community which includes a number of highly significant species. It should be noted that the majority of the survey was conducted along a single transect (and supplemented with incidental observations). It is highly likely that a much more comprehensive survey would yield many more species. The number of native species added to the existing list (76, including 11 rare or uncommon species) highlights the importance of timing of survey and repeat visits to capture species that flower at different times and may otherwise be inconspicuous in the landscape.



Figure 12: Thin-clubbed Mantis Orchid *Caladenia atrovespa* in the Ginninderra Falls area. Photo: David Wong, Ginninderra Catchment Group.

Many of the species identified were disturbance-sensitive species, indicating that the area has a high level of ecological integrity and has been spared from much of the degradation that surrounding agricultural land has undergone. Geophytes (plants with an underground storage organ such as orchids and lilies), ferns and shrubs are particularly sensitive to grazing and fertiliser addition, with geophytes being the most sensitive (Dorrrough and Scroggie 2008). There were nine species of orchid recorded during the survey and orchids were abundant across the area (particularly Dusky Fingers *Caladenia fuscata* and, in parts, Needle-point Rustyhood *Pterostylis aciculiformis* and Tiger Orchid *Diurus sulphurea*). It is likely that further species of orchid will be recorded in the study area in the future as orchids are often inconspicuous unless flowering and different species flower at different times of the year. Twining Fringe Lily *Thysanotus patersonii* was abundant across much of the study area and Vanilla Lily *Arthropodium minus* was abundant in some areas. A range of fern species occur across the site including the rare Bristly Cloak fern *Cheilanthes distans*. A diverse range of shrubs occur at the site including a number of Pomaderris species, one threatened (Pale Pomaderris *Pomaderris pallida*) and one rare, uncommon or significant (Tree Pomaderris *Pomaderris intermedia*). A range of other rare, uncommon or significant shrub or small tree species occur in the study area including: Currawang *Acacia doratoxylon*; Mountain Hickory *Acacia penninervis*, Varnish Wattle *Acacia verniciflua*, *Bertya rosemarinifolia*, Common Fringe Myrtle *Calytrix tetragona* and Small Crowea *Crowea exalata* subsp. *exalata*. The ACT region is the extreme south-eastern edge of the range of *Acacia doratoxylon* (ALA 2016a). Other shrub species that occur at the site, are characteristic of rocky sites in the riverine environment, similar to those described by Barrer (1992) in the Lower Molonglo River Corridor (e.g. Slender Westringia *Westringia eremicola*, Common Correa *Correa reflexa* and Small Crowea *Crowea exalata* subsp. *exalata*, though Small Crowea is only known from a handful of locations in the ACT and surrounding area (ALA 2016b)).

Threatened species

Pink-tailed Worm Lizard *Aprasia parapulchella*



Figure 13: Adult Pink-tailed Worm Lizard *Aprasia parapulchella*. Photo: David Wong, Ginninderra Catchment Group.

The Pink-tailed Worm Lizard is listed as vulnerable nationally (*Environment Protection and Biodiversity Conservation Act 1999*), in the ACT (*Nature Conservation Act 2014*) and in NSW (*Threatened Species Conservation Act 1995*) and as endangered in Victoria (*Flora and Fauna Guarantee Act 1988*). A number of new occurrences of the species were recorded in the course of the surveys. The fact that these individuals were found in woodland and forest is significant as there are very few records in the ACT region known from forested sites (Wong *et al.* 2011).

The presence of Pink-tailed Worm Lizard in the Ginninderra Falls area has implications for conservation strategies in the greater proposed reserve area as maintaining connectivity for the species between this area and other occupied areas south of the study area is crucial for maintaining gene flow. This is important in ensuring that the population in the Ginninderra Falls area does not become unviable and go locally extinct.

Between the ACT border and the Ginninderra Falls area, there is significantly less Pink-tailed Worm Lizard habitat when compared to the ACT. This makes the role of existing habitat all the more important in facilitating movement through the landscape. Conservation strategies that aim to conserve Rosenberg's Goanna will also allow for the protection of Pink-tailed Worm Lizard (e.g. maintaining within reserve additional open areas to cater for home range needs of Rosenberg's Goanna will allow for more patches of Pink-tailed Worm Lizard habitat to be protected and facilitate movement of the species as open areas are likely to be more permeable than wooded areas with respect to movement of Pink-tailed Worm Lizards).

Our visits to the field suggest that there may be habitat that was not identified in earlier surveys (Osborne and Wong 2013) (possibly due to lower quality aerial imagery available at the time for identifying rocky areas or high vegetation obscuring visibility of rocks in the field). There was also at least one area assessed as low quality in the field previously (Osborne and Wong 2013) that appeared to be potential habitat on inspection in the field during this study. This highlights the challenge of assessing habitat based on a single visit as vegetation may change over time and other factors such as overgrazing can make assessment of habitat challenging. Repeated survey of habitat would clarify the status of habitat previously mapped in the area.



Figure 14: Pink-tailed Worm Lizard *Aprasia parapulchella* habitat in the study area. This habitat is different to the typical rocky grassland or grassy open woodland /woodland habitat with which Pink-tailed Worm Lizards are most often associated. There is a sparse cover of grass and it is under tree canopy (albeit quite open at this site). Photo: David Wong, Ginninderra Catchment Group.

Rosenberg's Goanna *Varanus rosenbergi*

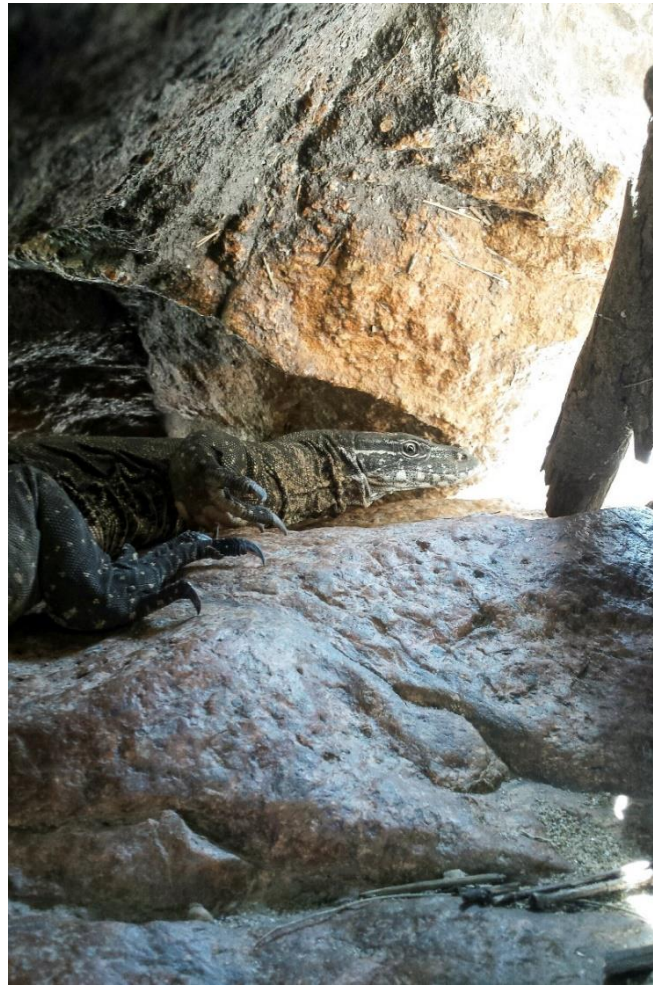


Figure 15: Adult Rosenberg's Monitor *Varanus rosenbergi*. Photo: Damon Cusack, Ginninderra Catchment Group.

The Rosenberg's Goanna is listed as Vulnerable in NSW (*Threatened Species Conservation Act 1995*) and SA (*National Parks and Wildlife Act 1972*) and Threatened in Victoria (*Flora and Fauna Guarantee Act 1988*). It has declined markedly across its natural range on mainland Australia. It is the largest native terrestrial vertebrate predator in the Ginninderra Falls area and is therefore likely to play a crucial role in ecosystem regulation.

A number of studies have illustrated the importance of goannas in an ecosystem by documenting the impact of their loss from that ecosystem or of their increase as a result of the removal of another predator (see Dickman *et al.* 2014 for a review of these studies). It has been suggested (Dickman *et al.* 2014) that the Sand Goanna *Varanus gouldii* acts as a keystone species in semi-arid shrub land in western New South Wales. Increased abundance of Sand Goannas in this ecosystem, as a result of fox baiting, led to increases in the abundance of small lizards (Olsson *et al.* 2005). Whilst Gecko abundance decreased where Sand Goannas were more abundant, gecko diversity was higher in these areas (Olsson *et al.* 2005). Doody *et al.* (2006) found that Yellow-spotted Monitor Dragon *Varanus panoptes* on the Daley River, Northern Territory, declined markedly as a result of consuming toxic Cane Toads *Bufo marinus*. This meant that the monitor was no longer a significant predator of Pig-nosed Turtle *Carettochelys insculpta* eggs. Increase in survival of Pig-nosed Turtles as well as other species of sea turtle (Blamires 2004) could in turn lead to reductions in the animal and plants that the turtles consume and result in trophic cascades (Dickman *et al.* 2014). A decrease in Yellow-spotted Monitor on the Adelaide River, Northern Territory, coincided with increases in the Frog-eating Keelback *Tropidonophis mairii* snakes (Brown *et al.* 2011; Brown *et al.*

2013), posing a threat to native frog populations (Dickman *et al.* 2014). Kangaroo Island is the last remaining stronghold of Rosenberg's Goanna. The species is a key part of the ecosystem here and their role as predators has been linked with the failure of rabbits to establish on the island (Rismiller *et al.* 2010). They also play an important role in the cultivation of ecosystems (Pelican Lagoon Research and Wildlife Centre 2013). Turning over of the soil by animals has a range of benefits for ecosystem functioning such as aiding decomposition, increasing infiltration of water and facilitating seed germination (Eldridge and James 2009).

The results of our survey, combined with analysis of the existing species occurrence records, suggest that the Ginninderra Falls area is highly likely to support a significant population of Rosenberg's Goanna. The species was sighted twice in different locations and recorded at two camera trap locations. The sighting of a juvenile or sub-adult Rosenberg's Goanna emerging from a burrow in a termite mound suggests a breeding population. There have also been historical sightings of the species in the area (Will Osborne, pers. comm. 2015). Rosenberg's Goanna is a cryptic species which is rarely sighted, with only 36 records existing in the ACT and surrounding NSW (ACT Conservation Research Fauna Atlas, December 2015). The vast majority of these records are in the upland areas of the ACT in Namadgi National Park and the Cotter Catchment as well as in the Googong area. The closest existing record to the study area is from 12km away (as the crow flies) in the Stony Creek Nature Reserve. Therefore, the frequency of encounter of the species during the survey period is significant. The records in the Ginninderra Falls area are the only ones known within the Ginninderra Catchment (excluding a roadkill specimen subsequently found by one of the authors on the Barton Highway near Hall. Damon Cusack, pers obs. 2015. Fig 16.). Based on the habitat quality of the area, it is highly likely that the Ginninderra Falls area supports a regionally significant breeding population of the species. Ensuring that this meta-population persists in the Ginninderra Falls area is important not only for the intrinsic value that the species holds as a long-standing part of the local landscape but also for facilitating gene flow between this population and other significant populations, thus buffering the regional population against extinction.

Inspection of aerial imagery in GIS suggested that similar habitat may extend for approximately 1km north of Ginninderra Creek. Beyond 1km north of Ginninderra Creek, the vegetation appears to change markedly, with dense understorey shrubs (likely to be Burgan *Kunzea ericoides*) becoming a dominant feature of the landscape and fewer habitat features are apparent (e.g. large complex rocky areas and large areas of forest that provide habitat such as fallen logs). It is therefore likely that the best habitat for Rosenberg's Goanna in the Ginninderra Falls area is contained within an area as small as 100 – 150 ha.² As such, it will be important to create a reserve that includes not only the best habitat but incorporates adequate measures to protect that habitat and account for home range size (e.g. including additional areas adjacent to key habitat within reserve to protect that habitat from direct and indirect impacts of urbanisation and to increase reserve size). Such a reserve would also benefit a range of species (e.g. see Ikin *et al.* 2015 and Rayner *et al.* 2015).

Home range and movements

The large home range of Rosenberg's Goanna means that it requires large protected areas for it to persist. Of 47 islands in the Archipelago of the Recherche, off the south coast of Western Australia, Rosenberg's Goanna only persisted on the largest, Middle Island (1080 ha) (Smith and Johnstone 1996; Short and Parsons 2004). It is likely that the population at Ginninderra Falls has persisted as a result of having a high quality habitat resource in the Ginninderra Falls area and adjacent land uses (agricultural – E3 Environmental Management) that, although not optimal habitat, allow free ranging movements and a very large buffer from many of the impacts associated with urban development (e.g. roadkill, predation from cats and dogs, disturbance to habitat and increased encounters with humans).

Home range and movement of the Rosenberg's Goanna has been studied extensively on Kangaroo Island (Rismiller *et al.* 2010; P. Rismiller, Pelican Lagoon Research Centre and B. Green, University of

Canberra, pers. comm. 2016) and to a much lesser degree in the Googong Nature Reserve area (W. Smith, unpublished data).

On the Dudley Peninsula, Kangaroo Island (SA), long-term monitoring of Rosenberg's Goanna population is ongoing with some known individuals having been monitored for 28 years. Radio-tracking data on this population, spanning from 1991 to present, has revealed that male Rosenberg's Goannas have a home range of 140-1,500 ha and females have a home range of 60-100Ha (Rismiller, Pelican Lagoon Research Centre and B. Green, University of Canberra, pers. comm. 2016). One individual that has been tracked for 20 years has used the entire 15km² peninsula (P. Rismiller, University of Adelaide and B. Green University of Canberra, pers. comm. 2016). In one published study (Rismiller *et al.* 2010), based on data spanning from 1991 – 2007 (a total of 205 individuals were tracked on Kangaroo Island (71 Males, 77 Females and 57 sub-adult or gender indeterminate). Average home range for males was 257.5 ± 21 ha (range, 178–320 ha). Average female home range was 96 ± 3.7-ha (range, 85–110 ha) (Rismiller *et al.* 2010).

A small sample of six Rosenberg's Goannas (3 males, 2 females, 1 sub-adult or gender indeterminate) were tracked in the Googong Nature Reserve area (W. Smith, unpublished data). These results should be treated with caution due to the small sample size and associated large margin of error, as well as the fact that they were based on a short period of radio-tracking when compared with other studies on the species. Smith (unpublished data) found that adult males had an average home range of 134.7 ha (range, 103-173 ha). Adult females had an average home range of 142 ha (range 119 – 165 ha). The sub-adult had a home range of 39 ha. Average daily movement for adults was 102.2m and the maximum daily movement recorded was 1,950m. This figure was “as the crow flies” and the actual distance travelled would have been much greater (W. Smith, pers. comm. 2015). In addition, some animals went out of tracking range during tracking and could have made larger movements (W. Smith, pers. comm. 2015). The Kangaroo Island experience suggests that home range of tracked individuals increases over time as a given population is tracked and it has taken almost 30 years to arrive at the current home range estimates. Therefore, it is likely that the Googong data significantly underestimates true home range in that area. In addition, the terrain in the Googong area is highly dissected compared with the Ginninderra Falls area which has both steep and undulating topography; the Dudley Peninsular on Kangaroo Island has similar topography to the Ginninderra Falls area so home ranges of individuals in the Ginninderra Falls area may more closely approximate those observed on Kangaroo Island (P. Rismiller Pelican Lagoon Research Centre and B. Green, University of Canberra, pers. comm. 2016).

One Rosenberg's Goanna has been recorded in a West Belconnen suburb (Hayes, pers. comm., cited in Barrer 1992). The individual was released in the Lower Molonglo River Corridor as this is where it was suspected to have come from, but based on the location, the individual could also have come from the Ginninderra Falls or Riverview area. Whatever the case, this illustrates the fact that Rosenberg's Goannas travel through agricultural landscapes and open areas and underscores the importance of taking into consideration the wide ranging nature of the species into planning of reserves where the species is present if it is to be successfully protected. A roadkill specimen was also recently found by one of the authors on the Barton Highway (approximately 11 km from Ginninderra Falls).

Threats and conservation considerations

This study suggests that the resident population of Rosenberg's Goanna at the Ginninderra Falls is highly significant from a conservation perspective at both a local and regional scale. The population is on the edge of the range of the species (ALA 2016f; ACT Conservation Research Fauna Atlas 2016) and is disjunct from other known populations in the ACT region (i.e. Namadgi National Park; Cotter Dam / Stony Creek Nature Reserve area; Namadgi National Park; Lower Cotter Catchment; Googong area, Bywong area and; Mount Ainslie Nature Reserve) (ALA 2016 f; ACT Government Conservation Research Fauna Atlas 2016). It the only population in the Ginninderra catchment. The Ginninderra Falls area features large areas of high quality habitat for the species necessary for supporting a

breeding population of the species (e.g. complex rocky habitat; termite mounds and fallen trees). The area is therefore critical when considering maintaining gene flow of populations of Rosenberg's Goanna in the region. It is likely that the resident population in the Ginninderra Falls area is relatively small when compared with other populations (e.g. Namadgi National Park). This makes the conservation planning of the area even more important as small populations are prone to extinction particularly in fragmented habitats (Henle *et al.* 2004; Foufopoulos and Ives 1999). Habitat specialisation (relying on specific habitat features) puts species further at risk of extinction (Foufopoulos and Ives 1999). Rosenberg's Goanna falls under this category, particularly in relation to its breeding biology and reliance on termite mounds (Rismiller *et al.* 2010).

Rosenberg's Goannas are particularly at risk in urban areas (White and Burgin 2004). Pressure on habitat (including the termite mounds they rely on for breeding), increased road traffic leading to increases in roadkill and predation by feral animals (particularly foxes and cats) are cited as major causes for their decline in Southern Australia (Rismiller *et al.* 2007). Of 10 known females monitored on Kangaroo Island that had bred for more than three breeding cycles, three were killed by cats and one died as a result of roadkill (Rismiller 2010). There are at least two records of Rosenberg's Goanna road-kills that were reported in 2015 (one on the Barton Highway and one on Mount Ainslie) (ACT Conservation Research Fauna Atlas). Even single losses from populations are significant when the populations are likely to be relatively small. Dogs are another threat that is likely to increase with urbanisation (Will Osborne, University of Canberra, pers. comm. 2015). A range of other direct and indirect impacts of development threaten the species. These include: reduction in prey availability as a result of increased predation of small lizards associated with the urban edge (Anderson and Burgin 2008), increase in (negative) encounters with roads, paths or people as a result of their large home range and wide ranging foraging habits and; illegal collection of the species (White and Burgin 2004).



Figure 16: Roadkill Rosenberg's Goanna *Varanus rosenbergi* found approximately 11km from the study area on the Barton Highway. Rosenberg's Goanna are particularly susceptible to roadkill as they are attracted to carrion. *Photo: Damon Cusack, Ginninderra Catchment Group December 2015.*

Rosenberg's Goanna has only been recorded in one nature reserve which is adjacent to urban development in the ACT region (Mt Ainslie Nature Reserve) and is likely to have gone locally extinct from most of the urban reserves in the ACT area, as has occurred with goannas in urban reserves in Sydney (White and Burgin 2004). Therefore, we calculated corrected perimeter-area ratio (Farina

2008) for Mt Ainslie Nature Reserve and the proposed reserve in West Belconnen. The below figure illustrates the difference between the corrected perimeter-area ratio of the only urban reserve that supports Rosenberg’s Goanna and the proposed reserve (and NSW section of the reserve). This is largely a result of the convoluted nature of the proposed reserve boundary, which does not take into account a principle of reserve design that has been well established in ecological theory (i.e. minimizing ratio of perimeter to interior of reserves in order to reduce the impacts of edge effects such as increases in invasive species and predation and to cater for larger animals with large home ranges) (Anderson and Burgin 2008; Piper and Catterall 2004; Soule and Simberloff 1986).

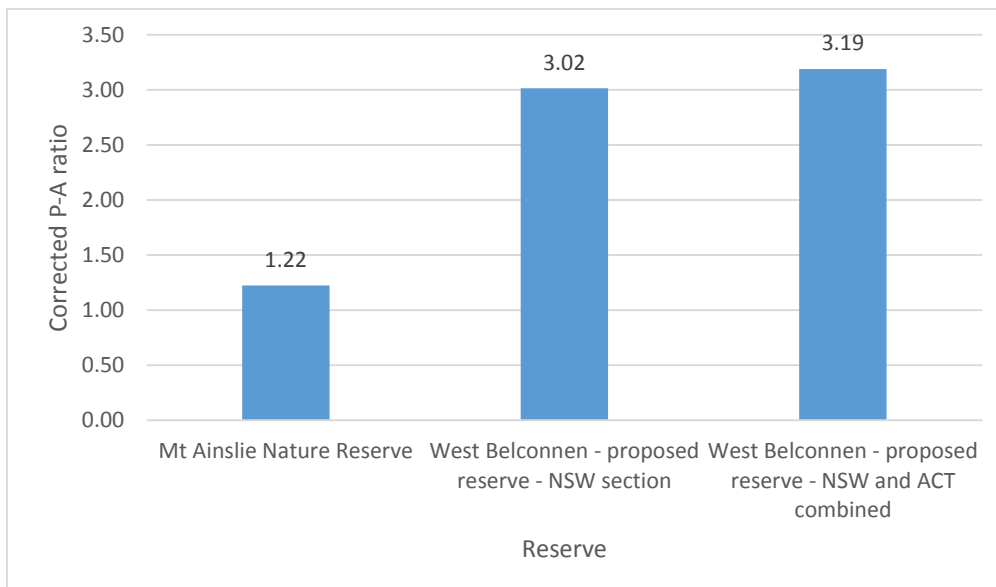


Figure 17: Corrected perimeter-area ratio (Farina 2008) for Mt Ainslie Nature Reserve and proposed reserve in the West Belconnen area (NSW section and whole reserve).

Key ways of protecting Rosenberg’s Goanna would include:

- Incorporating home range of Rosenberg’s Goanna into reserves (P. Rismiller, Pelican Lagoon Research Centre and B. Green, University of Canberra, pers. comm. 2016)
- Redesigning the proposed reserve to reduce corrected perimeter-area ratio to a much smaller figure (incorporating home range of Rosenberg’s Goanna would help to achieve this).
- Restrict construction of roads to outside reserved areas (as Rosenberg’s Goanna is very susceptible to death by roadkill)
- Slowing traffic speeds on roads adjacent to reserves (e.g. using speed humps, reduced speed limits etc.).
- Managing feral predator populations
- Prevention of dogs and cats from establishing in reserves or from roaming free in reserves
- Protecting termite mounds as key breeding resources (Sass 2008).
- Protecting shelter sites rocky outcrops, rocks, fallen timber and burrows (Rosenberg’s Goanna may also occupy rabbit burrows (Sass 2008, W. Smith, unpublished data).

These management actions will also increase the likelihood that Spotted-tailed Quolls *Dasyurus maculatus maculatus* (Endangered: Cwlth, SA, Qld; Vulnerable: ACT, NSW) which are likely to occur in the area based on historical records in nearby suburbs, and which have an even bigger home range than Rosenberg’s Goanna, may be able to persist in the area if present. The Ginninderra Falls area has large areas of complex rocky habitat that are suitable for Spotted-tailed Quolls. The Rosenberg’s Goanna and Spotted-tailed Quoll could be considered umbrella species in the context of

the West Belconnen area. Designing reserves that appropriately protect these species will allow other important species such as the Pink-tailed Worm Lizard as well as the range of significant plants found in the Ginninderra Falls area to also be protected.

Pale Pomaderris Pomaderris pallida

A large area of Pale Pomaderris *Pomaderris pallida* was recorded during our surveys. Pale Pomaderris is listed as Vulnerable nationally (*Environment Protection and Biodiversity Conservation Act 1999*) and in NSW (*Threatened Species Conservation Act 1995*). It is known from around 15 populations in south-eastern Australia and most of the populations are found along the Murrumbidgee, Cotter and Paddy's Rivers (Department of Environment 2008).



Figure 18: Pale Pomaderris *Pomaderris pallida* in bud. Photo: David Wong, Ginninderra Catchment Group.

In the areas that the species is conserved (Namadgi National Park, Bullen Range Nature Reserve and Stony Creek Nature Reserve in the ACT), populations of less than 1000 individuals occur (Briggs and Leigh 1995).

We estimated that the area we mapped contained 800-1000 Pale Pomaderris plants and a more comprehensive search is likely to identify further areas where the species occurs. Therefore, this population is likely to be a highly significant one and could become the largest population of Pale Pomaderris in the country under formal protection if the area becomes a nature reserve.

The main threats to Pale Pomaderris include residential development, weed competition (particularly Blackberry *Rubus sp.*); browsing by Feral Goats (*Capra hircus*); inappropriate fire regimes; increased fragmentation; and loss of remnants (Moore 2005; ANRA 2007a; ANRA, 2007b - cited in: Australian Department of Environment 2008; OEH 2013). The species should not be burnt more than once in 20 years (NSW RFS, 2004).

The main potential threat to *P. pallida* is extinction through stochastic processes (random environmental and demographic events that are a significant threat to small populations) (Australian Department of Environment 2008). Therefore, ensuring that the current population does not decline (and hopefully expands) is extremely important as small populations are more susceptible to stochastic processes (Soule and Simberloff 1986; Reed and Bryant).

We observed in the field that a few smaller plants were dead or in poor condition. Establishing whether this is due to natural plant death or another potential threat (e.g. disease) should be addressed as a matter of priority.

Conservation actions that will be important for the species include:

- Conducting a detailed survey for the species to identify other plants or populations in the area
- Monitoring plant survival and investigating possibility of disease
- Avoiding fire or prescribed burning in the area as unplanned fire on top of prescribed burning could threaten the population
- Monitoring browsing of the species by herbivores and controlling pest herbivores such as deer as appropriate.

Gang-gang Cockatoo *Callocephalon fimbriatum*

The Gang-gang Cockatoo *Callocephalon fimbriatum* is listed as Vulnerable in NSW (*Threatened Species Conservation Act 1995*). Gang-Gang Cockatoos are commonly seen in the Ginninderra Falls area and there has been a sighting by one of the authors of up to 50 of the species in a single tree located near the study area. Loss or degradation of hollow bearing trees (nest resources) and loss of foraging and roosting resources as a result of clearing of native vegetation or changed fire regime are key threatening processes for the species.

Other species and communities of interest or conservation concern

Black Cypress Pine / Eucalypt woodland and forest



Figure 19: Black Cypress Pine *Callitris endlicheri* dominated forest and woodland occur throughout most of the study area.
Photo: David Wong, Ginninderra Catchment Group.

Black Cypress Pine *Callitris endlicheri* communities are fire-sensitive (Zimmer *et al.* 2009) and there is at least one example of a population, in the Woronora Plateau in the local government area of Wollongong, NSW that has been listed as endangered (Mackenzie and Keith 2008; OEH 2004). It is likely that the Ginninderra Falls area is one of the largest and best examples of this community in the region and may, therefore, be a highly significant population.

The recommended fire prescription for the species is that it not be burnt more than once in 20 years. This suggests that any fire in the area may be inappropriate as the community has evolved with infrequent fire and unplanned fire in addition to prescribed burning is likely to have detrimental effect on the community, especially when considering the likelihood of more frequent wildfire with climate change.

Research has shown that post-fire survival of seedlings within an endangered population of the community has been impacted upon by deer browsing and that interventions such as control of deer populations and use of woody debris to protect seedlings may be necessary interventions to protect seedlings (Mackenzie and Keith 2008).

Small Crowea *Crowea exalata* subsp. *Exalata*



Figure 20: Small Crowea *Crowea exalata* subsp. *exalata* plant near lower Ginninderra Falls. Photo: David Wong, Ginninderra Catchment Group.

The Ginninderra Falls area is the only recorded location for the Small Crowea *Crowea exalata* subsp. *exalata* in the area immediately surrounding the ACT. It is from this population from that the nursery cultivar *Crowea exalata* ‘Ginninderra Falls’ was sourced. As such, Small Crowea is a species that has a ‘special place’ in the area. There are only two known location of occurrence in the ACT (Woodstock Nature Reserve at Shepherds Lookout and the Lower Molonglo River Corridor). The next closest known population is located in the Burrinjuck Dam area approximately 40km to the northwest (ALA 2016b). There is at least one area with a large number of plants. As we did not undertake a targeted search for the species, it is likely that there are quite a few more sites where the species occurs in the Ginninderra Falls area. More detailed survey and mapping of species of particular interest such as Small Crowea is warranted.

Red-necked Wallaby *Macropus rufogiseus*

The Red-necked Wallaby *Macropus rufogiseus* is a species that is thought to have declined as a result of urbanisation. This species appears to have disappeared from many areas close to suburbia around Sydney and the ACT as a result of urbanisation (Zusi 2010; D. Fletcher, ACT Government, pers. comm. 2016). Unlike the Swamp Wallaby *Wallabia bicolor*, a species with which Red-necked Wallabies ordinarily co-occur, Red-necked Wallabies are habitat specialists and appear to prefer open and flat areas and to avoid urban environments (Zusi 2010). Red-necked Wallabies are ecotone specialists (D. Fletcher, ACT Government, pers. comm. 2016); that is they specialise in the transition zone between two biomes (such as forest and grassland or woodland). Maintaining a range of habitats within reserve (e.g. grasslands, woodlands and forests) and adequate areas of these

habitats is therefore important for this species in order to avoid the loss of the species from the Ginninderra Falls area (D. Fletcher, pers. comm. 2016).

Maratus plumosus

There are only a handful of records of this species in the ACT region (ALA 2016e). Further survey is recommended in the area in order to gain more information about the population as well as to identify other species that may occur at the site. This genus of spiders has recently captured the attention of the public and there has recently been a film, *Maratus, made* about the discovery of a new species from the genus in the ACT.



Figure 21: *Maratus plumosus*, Members of this genus are referred to as Peacock Spiders due to their bright colouration. The species is much more brightly coloured at a certain time of the year than it appears in this photo. Photo: David Wong, Ginninderra Catchment Group.

Tree Skink *Egernia striolata*

The Tree Skink record is significant as the Ginninderra Falls area appears to be the extreme south-eastern edge of its geographical range with the next closest record occurring in the Tantangara Dam / Wee Jasper area approximately 40 km to the north-west (ALA 2016c). The species had been recorded approximately 20 years ago (W. Osborne pers. comm. 2015). The fact that it was recorded in this survey confirms that the species is still persisting at the site. Further survey for the species in the area is warranted.

Threatened species likely to occur in the Ginninderra Falls area

Whilst no systematic survey of the Ginninderra Falls area has been undertaken, a number of threatened species (Vulnerable in NSW *Threatened Species Conservation Act 1995*) that have been identified as present in surveys mainly conducted in the river corridor to the south of the Ginninderra Falls area and on adjacent farmland (Kevin Mills and Associates 2013a; 2013b). It is, therefore highly likely that some or all of these species occur in the Ginninderra Falls area. The threatened species recorded:

- Flame Robin *Petoica phoenicea* (Vulnerable NSW)
- Gang-Gang Cockatoo *Callocephalon fimbriatum* (Vulnerable NSW)
- Scarlet Robin *Petroica boodang* (Vulnerable NSW and ACT)
- Speckled Warbler *Chthonicola sagittata* (Vulnerable NSW)
- Spotted Harrier *Circus assimilis* (Vulnerable NSW)
- Superb Parrot *Polytelis swainsonii* (Vulnerable: Cwlth, NSW and ACT)
- Eastern Bent-wing Bat *Miniopterus schreibersii* (confirmation needed as to exact species)

The report noted that Flame Robin, Scarlet Robin and Spotted harrier were all recorded on open farming land in winter (Kevin Mills and Associates 2013). Recent research indicates that many species, including many species that have been recorded in the development area (Kevin Mills and Associates 2013b) (e.g. Scarlet Robin, Striated Thornbill, Rufous Whistler, Sacred Kingfisher, Dusky Woodswallow and others) avoid urban areas and the effects of urbanisation can extend far into reserve areas (Rayner *et al.* 2015; Ikin *et al.* 2015). These findings suggest that it is important to include additional areas into reserves if biodiversity is to be effectively protected.

Other threatened species that were identified (Kevin Mills and Associates 2013a) as having been previously recorded in the area were:

- Koala *Phascolarctos cinereus* (Vulnerable, NSW)
- Spotted-tailed Quoll *Dasyurus maculatus maculatus* (Vulnerable NSW; Endangered Cwlth)
- Brown Treecreeper *Climacteris picumnus* (Vulnerable NSW)
- Diamond Firetail *Stagonopleura guttata* (Vulnerable NSW)
- Flame Robin *Petroica phoenicea* (Vulnerable NSW)
- Hooded Robin *Melanodryas cucullata* (Vulnerable NSW)
- Little Eagle *Hieraaetus morphnoides* (Vulnerable NSW)
- Painted Honeyeater *Grantiella picta* (Vulnerable NSW)
- Regent Honeyeater *Xanthomyza phrygia* (Endangered NSW and Cwlth)
- Varied Sittella *Daphoenositta chrysoptera* (Vulnerable NSW)
- Green and Golden Bell Frog *Litoria aurea* (Vulnerable: Cwlth; Endangered: NSW)
- Golden Sun Moth *Synemon plana* (Critically Endangered: Cwlth; Endangered: NSW and ACT)

Of these species, some are no longer likely to occur in the study area (e.g. Koala, Green and Golden Bell Frog) but others could occur.

A preliminary assessment of the Ginninderra Falls area, associated with a proposal to create a National Park in the area, has been conducted by NSW National Parks and Wildlife (M. Boak, NSW Office of Environment and Heritage, pers. comm. 2015). The internal report concluded that the Ginninderra Falls area contains significant scenic as well as natural and heritage values and identified a number of species that are highly likely to occur in the area. These include:

- Glossy black Cockatoo *Calyptorhynchus lathamii* (Vulnerable NSW and ACT)
- Gang-gang Cockatoo *Callocephalon fimbriatum* (Vulnerable NSW)
- Spotted-tailed Quoll *Dasyurus maculatus* (Endangered Cwlth; Vulnerable: NSW and ACT)
- Sooty Owl *Tyto tenebricos* (Vulnerable NSW)
- Masked Owl *Tyto novaehollandiae* (Vulnerable NSW)

Other threatened fauna listed as possibly occurring in the area include:

- Booralong Frog *Litoria booroolongensis* (Endangered Cwlth and NSW)
- Eastern Pygmy Possum *Cercartetus nanus* (Vulnerable NSW)
- Rosenberg's Goanna *Varanus rosenbergi* (Vulnerable NSW)

Our surveys confirmed the presence of Rosenberg's Goanna and Gang-gang Cockatoo and no systematic, targeted surveys were conducted for the other species, so it is highly likely that further investigation would reveal one or more of the species to be present. It is therefore recommended that targeted surveys be undertaken to determine whether any of the above species or other significant species are present.

The Spotted-tailed Quoll is worthy of special mention. The species has been recorded in Macgregor, in close proximity to the Ginninderra Falls area. The species has very large home range (e.g. males 621 ha to at least 2561 ha; females: 88 ha to at least 653 ha) (Claridge *et al.* 2005). Major threats to the species include: habitat loss and competition; competition from cats and foxes; deliberate killing by humans and roadkill (OEH 2014). High priority should be given to undertaking targeted survey for this species.

Limitations and further research

This survey should be viewed as a preliminary study of a subset of the terrestrial biodiversity of the Ginninderra Falls area. A more detailed study of threatened species found during this survey and those likely to occur should be undertaken to gain a more complete understanding of the likely impacts of development close to the Ginninderra Falls area.

Many sections of the study area were considered too dangerous to safely survey within the scope of this study. Further work on threatened species such as Rosenberg's Goanna and Spotted-tailed Quoll would need to include survey in these more inaccessible areas as they represent some of the best habitat (i.e. complex rocky habitat). A comprehensive Spotted-tailed Quoll survey should be undertaken as a matter of priority. A range of techniques (including less traditional techniques such as the use of detection dogs) may be necessary as Spotted-tailed Quolls are very difficult to detect. Other surveys that could be undertaken include small mammal trapping (Elliott and pitfall trapping), bat surveys, pitfall trapping for reptiles, survey of invertebrates, bird surveys and nesting surveys.

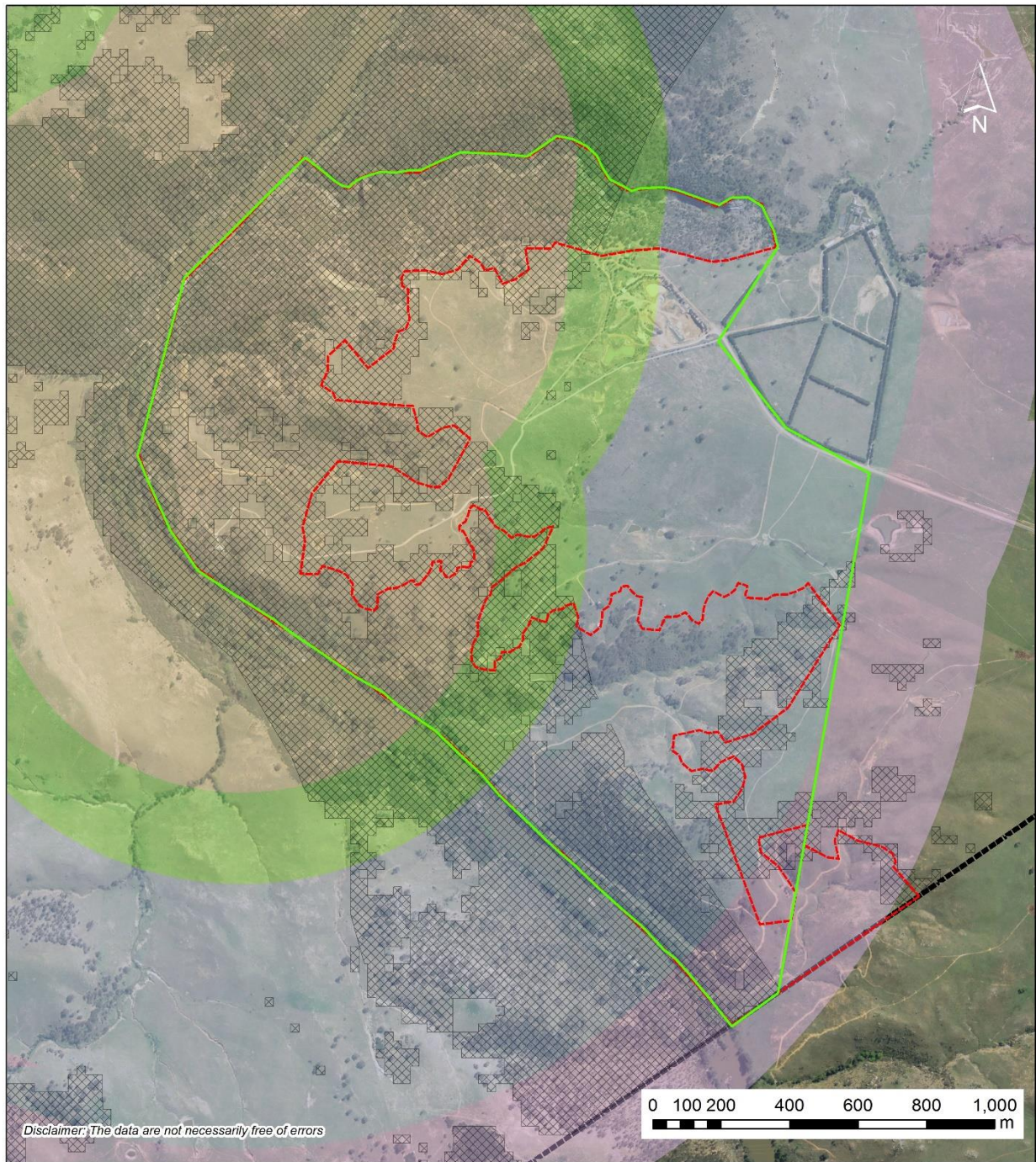
Whilst it is likely that many more species could be found during additional survey it is recognised that applying the precautionary principle by managing for the larger home range species such as Rosenberg's Goanna and Spotted-tailed Quoll would be the most effective way to ensure the protection of the majority of other species. Such an approach would therefore represent best practice.

Due to the broad methodology used during the camera trapping in order to maximise the range of species camera captured, quantitative analysis should be assessed with caution. The numbers of less cautious or more broadly ranging species may be over-represented as they could possibly visit numerous sites on a single night. Conversely more shy or cryptic species may be under-represented or may not have been detected. Methods that target particular species or groups (e.g. small mammals) should be used in order to provide a more comprehensive picture of the presence or estimated relative abundance of these species.

General discussion and planning considerations

This survey has provided valuable data on the biodiversity of the Ginninderra Falls area. Whilst more study is needed, with respect to specific taxa and groups, there is enough research available in the existing scientific literature to assist in making suitable, precautionary planning decisions with respect to reserve design that take into account the ecological factors of the area. Such planning outcomes would benefit not only Rosenberg's Goanna, but also a range of other species (e.g. threatened species, ecotone specialists and mobile species) and values (e.g. cultural heritage and aesthetic). Whilst the presence of Rosenberg's Goanna was previously suspected in the Ginninderra

Falls area, it has now been confirmed. This population is the only known population of the species in the Ginninderra Creek catchment, and from our analysis, appears to be a highly significant population (appears to be a breeding population; geographically distant from other populations). In light of this, a re-evaluation of the proposed reserve (e.g. size, shape and management) is warranted in order to ensure the long-term survival of the species in the Ginninderra Falls area. A range of other species including the Spotted-tailed Quoll, Pink-tailed Worm Lizard, Red-necked Wallaby and a range of birds of conservation interest should also be considered.



- Area in NSW currently zoned as E3 (Environmental Management) in West Belconnen study area
 - Currently proposed conservation reserve - NSW
 - Areas identified for Biodiversity Conservation in Yass Local Environmental Plan
- Rosenberg's Goanna *Varanus rosenbergi* home range values (indicative)**
- Warwick Smith, unpublished data, max. male home range - based on tracking data from a single year (173 ha)
 - Rismiller *et al.* 2010 max. male home range based on multi-year tracking data 1991-2007 - Kangaroo Island (320 ha)
 - Pelican Lagoon Research and Wildlife Centre 2013 (Rismiller, Green, Kelvey data) - max. home range based on multi-year tracking data (1000 ha)
 - Rismiller and Green pers. comm. 2016 max male home range, Kangaroo Island based on tracking data 1991-present (1500 ha)
- NSW/ACT Border

Aerial imagery provided by ACT Environment and Planning Directorate - Planning

Map produced 27 May 2016 by Ginninderra Catchment Group

Figure 22: Currently proposed conservation reserve and current E3 (Environmental Management) land in the NSW section of the West Belconnen development area

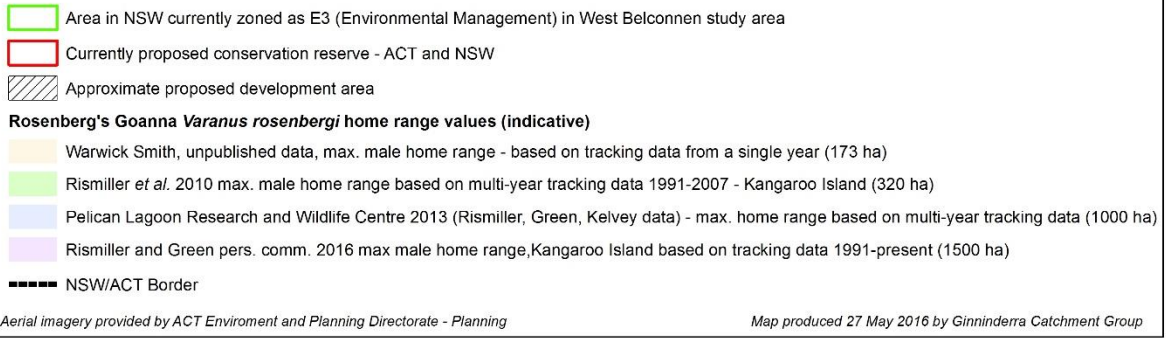
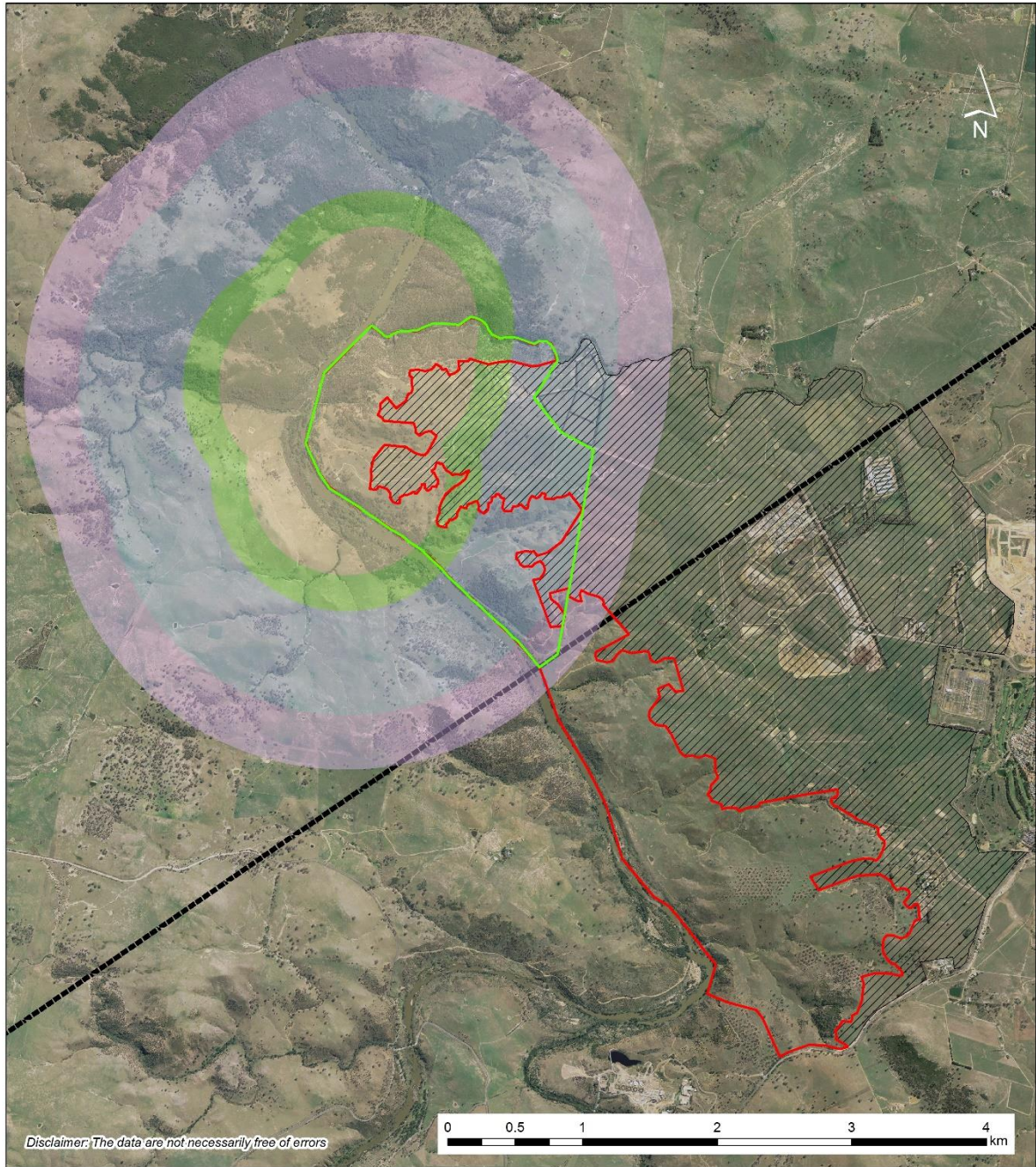


Figure 23: Currently proposed conservation reserve and current E3 (Environmental Management) land in NSW section of West Belconnen development within context of whole development.

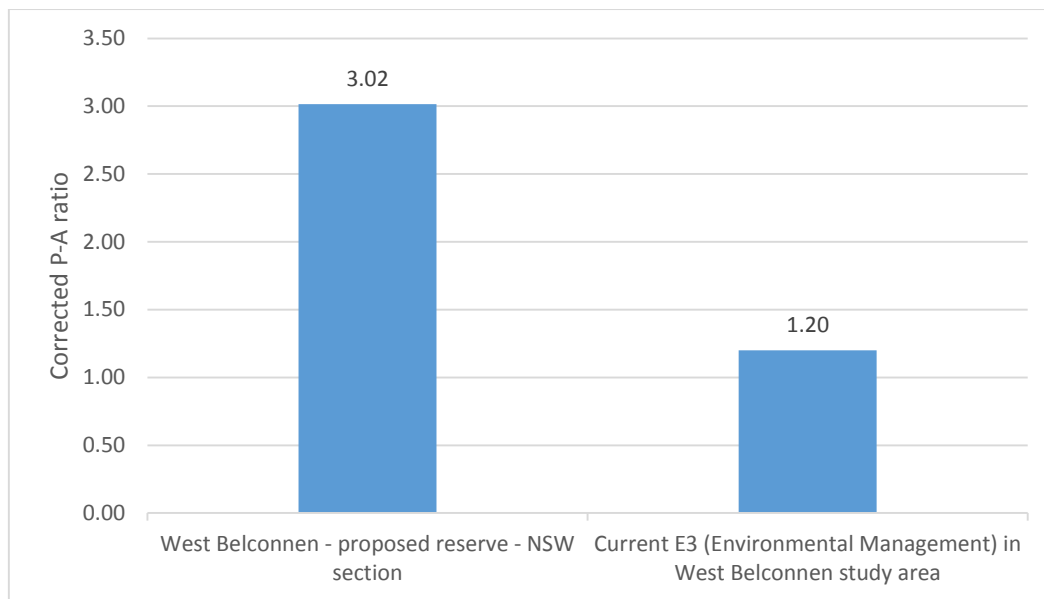


Figure 24: Corrected Perimeter – Area ratios for proposed conservation reserve and existing land zoned as E3 in the NSW section of the West Belconnen development.

The currently proposed approach of protecting within a conservation reserve areas that coincide with matters of national environmental significance (as well as areas that are deemed as of ecological value under a limited set of criteria) does not incorporate well established ecological principles relating to reserve design (e.g. size and configuration) and does not cater for the needs of large-home range threatened species that are sensitive to urbanisation. In addition, this approach does not incorporate relevant scientific knowledge about the sensitivity of species such as Rosenberg’s Goanna and a range of birds to the proximity of urban development (Rayner *et al.* 2015). Much larger areas of land are protected in the south of the development (in the ACT) when compared with the NSW section of the proposed conservation reserve (Figure 23). The southern part of the proposed conservation reserve coincides with large areas of Box Gum Woodland. By contrast, the area near the Ginninderra Falls is underrepresented in the conservation reserve even though the values of the Ginninderra Falls area are high and the species and ecosystem that occur there are more intact ecologically and are more unique in a regional context than those in the ACT section of the reserve. Figure 24 illustrates the difference between the corrected perimeter-area ratio of the proposed conservation reserve in the NSW section and that of the land currently zoned as E3 in the West Belconnen study area. This highlights significant concerns about the proposed reserve boundary in relation to conservation and ongoing management. It is recommended that the proposed conservation reserve boundary be re-assessed with respect to reserve size and configuration and the needs of large home-range species. This assessment should incorporate ecological principles of reserve design and expert opinion of the leading researchers in the fields of the large home-range species concerned.

The current E3-zoned land provides adequate protection for larger home range species such as Rosenberg’s Goanna and Spotted-tailed Quoll. In addition, the rural land between the E3 land and West Macgregor provides an extra buffer between the Ginninderra Falls area and suburbia. It is likely that the urban development in the proposed West Belconnen development area will have impacts on biodiversity in the Ginninderra Falls area, particularly for large home range species and a range of birds.

From a biodiversity conservation perspective, protecting the area currently zoned as E3 within a nature reserve would provide the best protection for Rosenberg’s Goanna, as it would best approximate the outer home range values of Rosenberg’s Goanna. This would represent the most precautionary approach and would be in keeping with advice provided by experts on the species (Dr Peggy Rismiller, Pelican Lagoon Research and Wildlife Centre; Dr Brian. Green, University of

Canberra; Dr Will Osborne, University of Canberra and; Dr Damian Michael, ANU) to incorporate the home range of Rosenberg's Goanna within the conservation reserve. Conserving this area would also be more appropriate for protecting Spotted-tailed Quoll, and would allow for movement of Pink-tailed Worm Lizard and a range of macropods and mammals. It would also protect a range of birds sensitive to urban development (Rayner *et al.* 2015). Whilst there is no guarantee that these species would not be impacted upon, such a precautionary approach would be broadly consistent with the Riverview Group's stated Guiding Principles for Sustainable Results (Eco 1; Eco 2; Eco 7)(The Riverview Group 2016); that is:

- Acknowledging the intrinsic value of all species and the special role and regional significance of the Murrumbidgee river corridor and Ginninderra Creek
- Respecting and supporting the ecosystem functions of air, soil and water, recognising the importance of living and non-living environmental resources
- Fostering a deep sense of respect for and connection to the land, flora and fauna.

The more that urban development encroaches into the E3 land, the greater the impact will be on large home-range species, species sensitive to urbanisation and general biodiversity. Further work that incorporates ecological reserve design principles and the best scientific research is required in order to design a conservation reserve that will be suitable to protect the significant species and biodiversity within the area.

Conclusion

This survey has highlighted the biodiversity values of the Ginninderra Falls and suggests that the area could be considered as an outstanding and unique ecosystem. These values are one aspect of the many features that make Ginninderra Falls the "magnificent place" that John Gale described and Aboriginal people have held, and continue to hold sacred. The rugged terrain and relative isolation has protected this area from many of the impacts associated with agricultural land use and urbanisation. Designing a reserve that adequately protects large home-range species such as Rosenberg's Goanna and Spotted-tailed Quoll would protect other threatened species; maintain connectivity, facilitating movement of fauna through the landscape; protect valuable ecotone resources; conserve cultural heritage and; maintain aesthetic values and sight lines. Such a reserve would be a key feature of a sustainable community in West Belconnen.

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Appendices

Appendix 1: Plant species list for the Ginninderra Falls Area

GENUS	SPECIES	INTRASPECIES	Common Name	Type	Indigenous/ Exotic	Declared	Rare	Threatened	Jessop 2014 1=recorded	GCG 2015 or ANPS 1=recorded 1*=new record	All surveys 1=recorded
AA Exotic or non-indigenous species				Ex							
<i>Acetosella</i>	<i>vulgaris</i>		Sheep Sorrel	Ex	E				1		1
<i>Aira</i>	<i>sp</i>		Hairgrass	Ex	E				1		1
<i>Anagallis</i>	<i>arvensis</i>		Scarlet Pimpernel	Ex	E				1		1
<i>Arctotheca</i>	<i>calendula</i>		Cape Weed	Ex	E					1*	1
<i>Briza</i>	<i>minor</i>		Shivery Grass	Ex	E				1		1
<i>Bromus</i>	<i>dianthus</i>		Great Brome	Ex	E				1		1
<i>Bromus</i>	<i>hordeaceus</i>		Soft Brome	Ex	E				1		1
<i>Bromus</i>	<i>rubens</i>		Red Brome	Ex	E				1		1
<i>Carduus</i>	<i>sp.</i>		Thistle	Ex	E	D			1		1
<i>Centaurium</i>	<i>erythraea</i>		Common Centaury	Ex	E					1	1
<i>Cerastium</i>	<i>glomeratum</i>		Sticky Mouse-ear	Ex	E					1*	1
<i>Cerastium</i>	<i>vulgare</i>		Mouse-ear Chickweed	Ex	E				1		1
<i>Conium</i>	<i>maculatum</i>		Hemlock	Ex	E					1*	1
<i>Conyza</i>	<i>sp</i>		Fleabane	Ex	E				1		1
<i>Conyza</i>	<i>bonariensis</i>		Flaxleaf Fleabane	Ex	E					1*	1
<i>Conyza</i>	<i>canadensis</i>		Canadian Fleabane	Ex	E					1*	1
<i>Echium</i>	<i>plantagineum</i>		Patersons Curse	Ex	E	D				1*	1
<i>Eragrostis</i>	<i>curvula</i>		African Love Grass	Ex	E	D			1	1	1
<i>Eschscholzia</i>	<i>californica</i>		California Poppy	Ex	E					1*	1
<i>Fumaria</i>	<i>muralis</i>		Fumitory	Ex	E					1*	1
<i>Galium</i>	<i>aparine</i>		Sticky Weed	Ex	E					1*	1
<i>Grevillea</i>	<i>rosmarinifolia</i>	subsp. <i>rosmarinifolia</i>	Rosemary Grevillea	Ex	E					1*	1
<i>Holcus</i>	<i>lanatus</i>		Yorkshire Fog	Ex	E				1		1
<i>Hypericum</i>	<i>perforatum</i>	subsp. <i>veronense</i>	St John's Wort	Ex	E	D			1	1	1
<i>Hypochaeris</i>	<i>glabra</i>		Smooth Catsear	Ex	E					1	1
<i>Hypochaeris</i>	<i>radicata</i>		Flatweed	Ex	E				1		1
<i>Linaria</i>	<i>pelisseriana</i>		Pelisser's Toadflax	Ex	E				1	1	1
<i>Lolium</i>	<i>rigidum</i>		Wimmera Ryegrass	Ex	E				1		1

<i>Orobanche</i>	<i>minor</i>		Broomrape	Ex	E				1		1
<i>Oxalis</i>	<i>corniculata</i>		Yellow Woodsorrel	Ex	E					1*	1
<i>Petrorhagia</i>	<i>nantueilii</i>		Proliferous Pink	Ex	E				1		1
<i>Plantago</i>	<i>lanceolata</i>		Ribwort Plantain	Ex	E				1		1
<i>Rosa</i>	<i>rubiginosa</i>		Sweet Briar	Ex	E	D			1	1	1
<i>Rubus</i>	<i>fruticosus complex</i>		A blackberry	Ex	E	D			1		1
<i>Rumex</i>	<i>crispus</i>		Curled Dock	Ex	E					1*	1
<i>Silybum</i>	<i>marianum</i>		Variegated thistle	Ex	E				1		1
<i>Solanum</i>	<i>nigrum</i>		Black nightshade	Ex	E					1*	1
<i>Stellaria</i>	<i>media</i>			Ex	E				1	1	1
<i>Taraxacum</i>	<i>officinale</i>		Dandelion	Ex	E					1*	1
<i>Trifolium</i>	<i>arvense</i>	var. <i>arvense</i>	Haresfoot Clover	Ex	E				1	1	1
<i>Verbascum</i>	<i>thapsus</i>	subsp. <i>thapsus</i>	Great Mullein	Ex	E					1*	1
<i>Verbena</i>	<i>bonariensis</i>		Purpletop	Ex	E					1*	1
<i>Vulpia</i>	<i>sp.</i>		Fescue	Ex	E				1	1	1
AA Native Trees and Tall Shrubs											
<i>Acacia</i>	<i>dealbata</i>	subsp. <i>dealbata</i>	Silver Wattle	TS	N					1*	1
<i>Acacia</i>	<i>doratoxylon</i>		Currawang	TS	N		R			1*	1
<i>Acacia</i>	<i>mearnsii</i>		Black Wattle	TS	N					1*	1
<i>Acacia</i>	<i>melanoxylon</i>		Blackwood	TS	N					1*+	1
<i>Acacia</i>	<i>penninervis</i>		Mountain Hickory	TS	N		R			1*	1
<i>Acacia</i>	<i>rubida</i>		Red Leaved Wattle	TS	N				1	1	1
<i>Acacia</i>	<i>verniciflua</i>		Varnish Wattle	TS	N		R			1*	1
<i>Bertya</i>	<i>rosmarinifolia</i>			TS	N		R			1*	1
<i>Brachychiton</i>	<i>populneus</i>	subsp. <i>populneus</i>	Kurrajong	TS	N					1*	1
<i>Callitris</i>	<i>endlicheri</i>		Black Cyprus Pine	TS	N				1	1	1
<i>Casuarina</i>	<i>cunninghamiana</i>	subsp. <i>cunninghamiana</i>	River She-oak	TS	N					1*	1
<i>Dodonaea</i>	<i>viscosa</i>	subsp. <i>angustissima</i>	Narrow-leaf Hop-bush	TS	N					1*	1
<i>Eucalyptus</i>	<i>blakelyi</i>		Blakely's Red Gum	TS	N				1	1	1
<i>Eucalyptus</i>	<i>bridgesiana</i>		Apple Box	TS	N				1		1
<i>Eucalyptus</i>	<i>macrorhyncha</i>	subsp. <i>macrorhyncha</i>	Red Stringybark	TS	N				1	1	1
<i>Eucalyptus</i>	<i>melliodora</i>		Yellow Box	TS	N				1	1	1
<i>Eucalyptus</i>	<i>nortonii</i>		Large-flowered Bundy	TS	N				1	1	1
<i>Eucalyptus</i>	<i>rossii</i>		Inland Scribbly Gum	TS	N				1	1	1
AA Shrubs 1 - 2 m											

<i>Astroloma</i>	<i>humifusum</i>	var. <i>humifusum</i>	Native Cranberry	S	N				1	1	1
<i>Bossiaea</i>	<i>sp.</i>			S	N					1*	1
<i>Bossiaea</i>	<i>buxifolia</i>		Matted Bossia	S	N				1	1	1
<i>Brachyloma</i>	<i>daphnoides</i>	var. <i>daphnoides</i>	Daphne Heath	S	N				1	1	1
<i>Bursaria</i>	<i>spinosa</i>	subsp. <i>lasiophylla</i>	Native Blackthorn	S	N				1	1	1
<i>Calytrix</i>	<i>tetragona</i>		Common Fringe Myrtle	S	N		R		1	1	1
<i>Callistemon</i>	<i>sieberi</i>		River Bottlebrush	S	N					1*	1
<i>Cassinia</i>	<i>longifolia</i>		Shiny Cassinia	S	N				1	1	1
<i>Cassinia</i>	<i>quinquefaria</i>		Coughbush	S	N				1	1	1
<i>Correa</i>	<i>reflexa</i>		Common Correa	S	N				1	1	1
<i>Crowea</i>	<i>exalata</i>	subsp. <i>exalata</i>	Small Crowea	S	N		R			1*	1
<i>Cryptandra</i>	<i>amara</i>	var. <i>amara</i>	Sweet Cryptandra	S	N				1		1
<i>Cryptandra</i>	<i>propinqua</i>			S	N					1*	1
<i>Daviesia</i>	<i>mimosoides</i>	subsp. <i>mimosoides</i>	Narrow-leaf Bitter Pea	S	N				1	1	1
<i>Dillwynia</i>	<i>sericea</i>	var. <i>sericea</i>	Showy Parrot Pea	S	N					1*	1
<i>Dillwynia</i>	<i>sieberi</i>			S	N					1*	1
<i>Dodonaea</i>	<i>viscosa</i>	subsp. <i>angustissima</i>	Hopbush	S	N				1		1
<i>Grevillea</i>	<i>juniperina</i>	subsp. <i>fortis</i>	Prickly Spiderflower	S	N				1		1
<i>Grevillea</i>	<i>juniperina</i>			S	N					1*	1
<i>Hakea</i>	<i>decurrens</i>		Bushy Needlewood	S	N					1*	1
<i>Hardenbergia</i>	<i>violacea</i>		False Sarsparilla	S	N				1	1	1
<i>Hibbertia</i>	<i>calycina</i>		Lesser Guinea-flower	S	N					1*	1
<i>Hibbertia</i>	<i>obtusifolia</i>		Hoary Guinea-flower	S	N				1	1	1
<i>Hibbertia</i>	<i>riparia</i>		Erect Guinea-flower	S	N				1	1	1
<i>Indigofera</i>	<i>adesmiiifolia</i>		Leafless Indigo	S	N				1	1	1
<i>Kunzea</i>	<i>ericoides</i>		Burgan	S	N				1	1	1
<i>Leptospermum</i>	<i>sp.</i>		Teatree	S	N				1		1
<i>Lissanthe</i>	<i>strigosa</i>	subsp. <i>subulata</i>	Peach Heath	S	N				1	1	1
<i>Phebalium</i>	<i>squamulosum</i>	subsp. <i>ozothamnoides</i>	Alpine Phebalium	S	N					1*	1
<i>Pomaderris</i>	<i>andromedifolia</i>	subsp. <i>confusa</i>		S	N				1	1	1
<i>Pomaderris</i>	<i>angustifolia</i>		Narrow-leaved Pomaderris	S	N				1	1	1
<i>Pomaderris</i>	<i>betulina</i>	subsp. <i>actensis</i>	A pomaderris	S	N					1*	1
<i>Pomaderris</i>	<i>betulina</i>	subsp. <i>betulina</i>	A pomaderris	S	N					1*	1
<i>Pomaderris</i>	<i>eriocephala</i>			S	N					1*	1
<i>Pomaderris</i>	<i>intermedia</i>		Tree Pomaderris	S	N		R			1*	1
<i>Pomaderris</i>	<i>pallida</i>		Pale Pomaderris	S	N		R	T		1*	1

<i>Pomaderris</i>	<i>prunifolia</i>		Plum-leaf Pomaderris	S	N				1		1
<i>Pomaderris</i>	<i>subcapitata</i>			S	N					1*	1
<i>Poranthera</i>	<i>microphylla</i>			S	N				1		1
<i>Pultenaea</i>	<i>spinosa</i>		Spiny Bush Pea	S	N				1	1	1
<i>Solanum</i>	<i>cinereum</i>		Narrawa Burr	S	N					1*	1
<i>Westringia</i>	<i>Eremicola</i>		Slender Westringia	S	N					1*	1
AA Other (native forbs, rushes and sedges, creepers)											
<i>Acaena</i>	<i>novae-zelandiae</i>		Bidgee Widgee	F	N					1*	1
<i>Acaena</i>	<i>ovina</i>		Sheep's Burr	F	N				1		1
<i>Ajuga</i>	<i>australis</i>		Austral Bugloss	F	N				1	1	1
<i>Arthropodium</i>	<i>minus</i>		Small Vanilla Lily	F	N					1*	1
<i>Blechnum</i>	<i>nudum</i>		Fishbone Water Fern	F	N					1*	1
<i>Brachyscome</i>	<i>diversifolia</i>	var. <i>diversifolia</i> ?		F	N					1*	
<i>Brachyscome</i>	<i>rigidula</i>		Cutleaf Daisy	F	N					1*	1
<i>Bulbine</i>	<i>glauca</i>		Rock Lily	F	N					1*	1
<i>Caladenia</i>	<i>atrovespa</i>		Thin-clubbed Mantis Orchid	F	N					1*	1
<i>Caladenia</i>	<i>carnea</i>		Pink Fingers	F	N					1*	1
<i>Caladenia</i>	<i>fuscata</i>		Dusky Fingers	F	N					1*	1
<i>Calandrinia</i>	<i>eremaea</i>			F	N					1*	1
<i>Carex</i>	<i>breviculmis</i>		Short-stem Sedge	F	N				1	1	1
<i>Carex</i>	<i>inversa</i>		Knob Sedge	F	N				1		1
<i>Cassytha</i>	<i>pubescens</i>		Common Devil's Twine	F	N					1*	1
<i>Chamaesyce</i>	<i>drummondii</i>		Caustic Weed	F	N				1		1
<i>Cheilanthes</i>	<i>sp</i>		Rock Fern	F	N				1	1	1
<i>Cheilanthes</i>	<i>austrotenuifolia</i>		Rock Fern	F	N					1	1
<i>Cheilanthes</i>	<i>distans</i>		Bristly Cloak Fern	F	N		R			1*	1
<i>Chrysocephalum</i>	<i>apiculatum</i>		Common Everlasting	F	N					1*	1
<i>Chrysocephalum</i>	<i>semipapposum</i>		Clustered Everlasting	F	N				1	1	1
<i>Clematis</i>	<i>leptophylla</i>			F	N				1		1
<i>Clematis</i>	<i>microphylla</i>		Small-leaved Clematis	F	N					1*	1
<i>Cotula</i>	<i>australis</i>		Bachelor's Button	F	N					1*	1
<i>Convolvulus</i>	<i>angustissimus</i>	subsp. <i>angustissimus</i>	Pink Bindweed	F	N				1		1
<i>Crassula</i>	<i>sieberiana</i>		Austral Stonecrop	F	N				1	1	1

<i>Cyanicula</i>	<i>caerulea</i>		Blue Fingers	F	N					1*	1
<i>Cymbonotus</i>	<i>lawsonianus</i>		Bear's Ear	F	N				1	1	1
<i>Cynoglossum</i>	<i>australe</i>		Australian Forget-me-not	F	N					1*	1
<i>Cynoglossum</i>	<i>suaveolens</i>		Sweet Houndstongue	F	N				1		1
<i>Daucus</i>	<i>glochidiatus</i>		Native Carrot	F	N				1	1	1
<i>Desmodium</i>	<i>varians</i>		Slender Tick-trefoil	F	N				1	1	1
<i>Dianella</i>	<i>revoluta</i>	var. <i>revoluta</i>	Black-anther Flax Lily	F	N				1	1	1
<i>Dichondra</i>	<i>repens</i>		Kidney Weed	F	N				1	1	1
<i>Dichopogon</i>	<i>fimbriatus</i>		Nodding Chocolate Lily	F	N				1		1
<i>Diuris</i>	<i>pardina</i>		Leopard Orchid	F	N					1*	1
<i>Diuris</i>	<i>sulphurea</i>		Tiger Orchid	F	N		R			1*	1
<i>Einadia</i>	<i>hastata</i>		Berry Saltbush	F	N					1*	1
<i>Einadia</i>	<i>nutans</i>	subsp. <i>nutans</i>	Climbing Saltbush	F	N				1	1	1
<i>Euchiton</i>	<i>sp.</i>		Cudweed	F	N				1	1	1
<i>Geranium</i>	<i>solanderi</i>	var. <i>solanderi</i>	Native Geranium	F	N				1	1	1
<i>Geum</i>	<i>urbanum</i>		Herb Bennet	F	N					1*	1
<i>Glycine</i>	<i>clandestina</i>	var. <i>clandestina</i>	Twining Glycine	F	N					1*	1
<i>Glycine</i>	<i>tabacina</i>		Variable Glycine	F	N					1*	1
<i>Gonocarpus</i>	<i>tetragynus</i>		Common Raspwort	F	N				1	1	1
<i>Hydrocotyle</i>	<i>laxiflora</i>		Stinking Pennywort	F	N				1	1	1
<i>Hydrocotyle</i>	<i>sibthorpioides</i>		Shining Pennywort	F	N		R			1	1
<i>Hymenochilus</i>	<i>sp.</i>			F	N					1	1
<i>Hypericum</i>	<i>gramineum</i>		Small St John's Wort	F	N				1	1	1
<i>Juncus</i>	<i>sp.</i>			F	N				1	1	1
<i>Lepidosperma</i>	<i>laterale</i>		Variable Sword Sedge	F	N				1	1	1
<i>Lobelia</i>	<i>sp.</i>			F	N					1*	1
<i>Lomandra</i>	<i>filiformis</i>	subsp. <i>coriacea</i>	Wattle Matrush	F	N				1		1
<i>Lomandra</i>	<i>filiformis</i>	subsp. <i>filiformis</i>	Wattle Matrush	F	N				1	1	1
<i>Lomandra</i>	<i>longifolia</i>		Spiny-headed Matrush	F	N				1	1	1
<i>Lomandra</i>	<i>multiflora</i>	subsp. <i>multiflora</i>	Many-flowered Matrush	F	N					1*	1
<i>Luzula</i>	<i>densiflora</i>		Woodrush	F	N					1*	1
<i>Microseris</i>	<i>lanceolata</i>		Yam Daisy	F	N		R			1*	1
<i>Microtis</i>	<i>sp.</i>			F	N					1*	1
<i>Opercularia</i>	<i>hispida</i>		Hairy Stinkweed	F	N				1	1	1
<i>Oreomyrrhis</i>	<i>eriopoda</i>		Australian Carraway	F	N					1*	1
<i>Oxalis</i>	<i>perennans</i>		Grassland	F	N				1		1

			Woodsorrel								
<i>Poranthera</i>	<i>microphylla</i>			F	N					1*	1
<i>Pterostylis</i>			Greenhood	F	N					1*	1
<i>Pterostylis</i>	<i>aciculiformis</i>		Needle-point Rustyhood	F	N					1*	1
<i>Pterostylis</i>	<i>nutans</i>		Nodding Greenhood	F	N					1*	1
<i>Rumex</i>	<i>brownii</i>		Swamp Dock	F	N			1		1	1
<i>Senecio</i>	<i>hispidulus</i>	var. <i>hispidulus</i>	Rough Fireweed	F	N					1*	1
<i>Senecio</i>	<i>quadridentatus</i>		Cotton Fireweed	F	N					1*	1
<i>Senecio</i>	<i>sp. (native)</i>		Fireweed	F	N			1			1
<i>Stackhousia</i>	<i>monogyna</i>		Creamy Candles	F	N			1			1
<i>Stellaria</i>	<i>pungens</i>		Prickly Starwort	F	N					1*	1
<i>Thelymitra</i>	<i>sp.</i>		Orchid sp.	F	N					1*	1
<i>Thysanotus</i>	<i>Patersonii</i>		Twining Fringe Lily	F	N					1*	1
<i>Tricoryne</i>	<i>elatior</i>		Yellow Rush Lily	F	N			1			1
<i>Triptilodiscus</i>	<i>pygmaeus</i>		Common Sunray	F	N			1		1*	1
<i>Vittadinia</i>	<i>cuneata</i>	var. <i>cuneata</i>	Fuzzy New Holland Daisy	F	N					1*	1
<i>Vittadinia</i>	<i>gracilis</i>		New Holland Daisy	F	N					1*	1
<i>Vittadinia</i>	<i>muelleri</i>		Narrow-leaved New Holland Daisy	F	N			1		1	1
<i>Wahlenbergia</i>	<i>communis</i>		Tufted Bluebell	F	N			1			1
<i>Wahlenbergia</i>	<i>multicaulis</i>		Tadgell's Bluebell	F	N			1			1
<i>Wahlenbergia</i>	<i>stricta</i>	subsp. <i>stricta</i>	Tall Bluebell	F	N			1		1	1
<i>Wurmbea</i>	<i>dioica</i>	subsp. <i>dioica</i>	Early Nancy	F	N					1*	1
AA Grasses				G	N						
<i>Aristida</i>	<i>ramosa</i>		Purple Wire Grass	G	N			1		1	1
<i>Austrostipa</i>	<i>densiflora</i>		Foxtail Speargrass	G	N			1		1	1
<i>Austrostipa</i>	<i>scabra</i>	subsp. <i>falcata</i>	Sickle Speargrass	G	N			1			1
<i>Bothriochloa</i>	<i>macra</i>		Redleg Grass	G	N			1			1
<i>Cymbopogon</i>	<i>refractus</i>		Barbed-Wire Grass	G	N			1		1	1
<i>Dichelachne</i>	<i>sp</i>		Plume Grass	G	N			1		1	1
<i>Digitaria</i>	<i>brownii</i>		Cotton Panic Grass	G	N					1*	1
<i>Elymus</i>	<i>scaber</i>	var. <i>scaber</i>	Common Wheat Grass	G	N			1		1	1
<i>Microlaena</i>	<i>stipoides</i>	var. <i>stipoides</i>	Weeping Grass	G	N			1		1	1
<i>Panicum</i>	<i>effusum</i>		Hairy Panic Grass	G	N			1			1
<i>Phragmites</i>	<i>australis</i>		Southern Reed	G	N					1*	1
<i>Poa</i>	<i>sp.</i>			G	N					1*	1
<i>Poa</i>	<i>meionectes</i>			G	N					1*	1
<i>Poa</i>	<i>sieberiana</i>		A tussock grass	G	N			1		1	1
<i>Rytidosperma</i>	<i>carphoides</i>		Short Wallaby Grass	G	N			1			1

<i>Rytidosperma</i>	<i>laevis</i>		Bare-backed Wallaby Grass	G	N					1*	1
<i>Rytidosperma</i>	<i>pallidum</i>		Redanther Wallaby Grass	G	N				1	1	1
<i>Rytidosperma</i>	<i>sp.</i>		Wallaby Grass	G	N				1	1	1
<i>Sorghum</i>	<i>leiocladum</i>		Wild Sorghum	G	N					1*	1
<i>Themeda</i>	<i>triandra</i>		Kangaroo Grass	G	N				1	1	1
Native species									88	139	164
Native non-grass (forbs) understorey species									39	69	83
Native grass species									14	16	20
Native tall shrubs and trees									10	17	18
Native shrubs									25	36	42
No. important species									21	40	42
Rare species									1	11	11
Threatened species									0	1	1
Declared pest species									5	4	6
Exotic or non-local species									30	25	43
Total species									118	164	207

Appendix 2: Camera trapping examples of each identified species.







Appendix 3: Examples of reptile and frog species recorded in the Ginninderra Falls area



Rosenberg's Goanna *Varanus rosenbergi*



Eastern Stone Gecko *Diplodactylus vittatus*



Pink-tailed Worm Lizard *Aprasia parapulchella*



Burton's Legless Lizard *Lialis burtonis*



Three-toed Skink *Hemiergis decresiensis*



Nobbi Dragon *Amphibolurus nobbi*



Bearded Dragon *Pogona barbata*



Spotted Grass Frog *Limnodynastes tasmaniensis*



Copper-tailed Skink *Ctenotus taeniolatus*

Appendix 4: Examples of trees and shrubs in the Ginninderra Falls area



Black Cypress Pine *Callitris endlicheri*



Pale Pomaderris *Pomaderris pallida*



Bertya rosmarinifolia



Common Fringe Myrtle *Calytrix tetragyna*



Small Crowea
Crowea exalata subsp. *exalata*



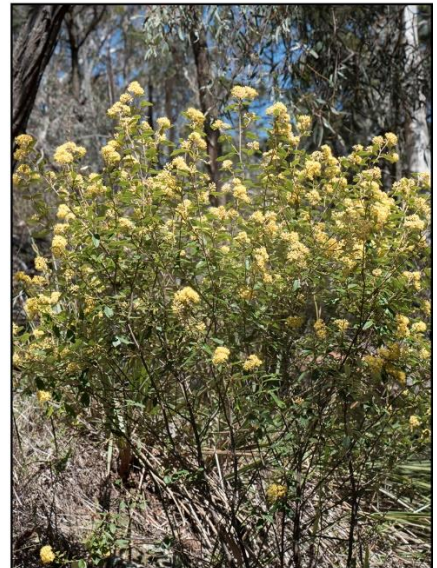
Alpine Phebalium *Phebalium squamulosum*
subsp. *ozothamnoides*



Common Correa *Correa reflexa*



Slender Westringia *Westringia eremicola*



Tree Pomaderris *Pomaderris intermedia*

Appendix 5: Examples of orchid species recorded in the Ginninderra Falls area



Nodding Greenhood *Pterostylis nutans*



Late Leopard Orchid *Diuris Pardina*



Dusky Fingers *Caladenia fuscata*



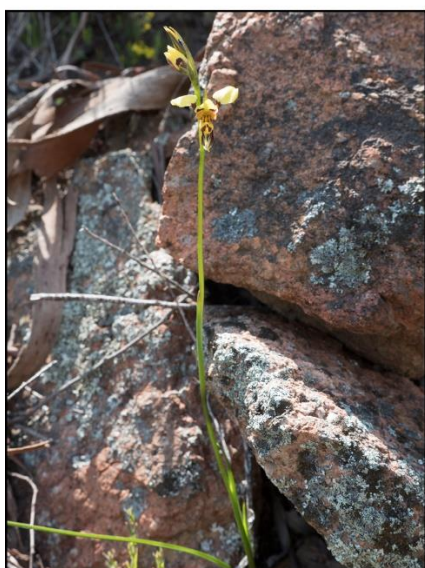
Waxlip Orchid *Glossodia major*



Thin-clubbed Mantis Orchid
Caladenia atrovespa



Needle-point Rustyhood
Pterostylis aciculiformis



Tiger Orchid *Diuris sulphurea*



Blue Fingers *Cyanicula caerulea*



Pink Fingers *Caladenia carnea*

Appendix 6: Examples of lilies, forbs and ferns in the Ginninderra Falls area



Bristly Cloak Fern *Cheilanthes distans*



Yam Daisy *Microseris lanceolata*



Brachyscome diversifolia var. *diversifolia*



Chocolate Lily *Dichopogon fimbriatus*



Early Nancy *Wurmbea dioica*



Small Vanilla Lily *Arthropodium minus*



Twining Fringe Lily *Thysanotus patersonii*



Rock Lily *Bulbine glauca*



Calandrinia eremaea