



**REPORT ON FIELD-SURVEYS FOR THE
PINK-TAILED WORM-LIZARD
(*Aprasia parapulchella*)
IN THE BENDIGO REGION, CENTRAL VICTORIA
DISTRIBUTION, HABITAT ASSOCIATIONS
AND POPULATION ATTRIBUTES**



Prepared by

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Report on field-surveys for the Pink-tailed Worm-Lizard (*Aprasia parapulchella*) in the Bendigo region, central Victoria: Distribution, habitat associations and population attributes.

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Cover Illustration: Pink-tailed Worm-Lizard (*Aprasia parapulchella*), Bendigo, Victoria.
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1. INTRODUCTION

1.1. Background

1.1.1. Ecology of *Aprasia parapulchella*

The genus *Aprasia* is a group of small pygopodid ('legless') lizards that is widespread in the dry-temperate regions of southern Australia (Cogger 2000). While the biology of most species is poorly known, members of the genus are generally fossorial, cryptic species that feed exclusively on ants and termites ('myremecophagus'; Greer 1989, Webb and Shine 1994, Jones 1999). Most species of *Aprasia* have restricted geographic distributions and four are currently recognised as of conservation concern (Jones 1999).

The Pink-tailed Worm-Lizard (*Aprasia parapulchella*) is a medium sized species of worm-lizard that is patchily distributed within the western foothills of the Great Dividing Range in south-eastern Australia (Cogger 2000). Formal descriptions of the species external morphology are provided by Kluge (1974), Jones (1999) and Cogger (2000). Briefly, the species attains a maximum snout-vent length (SVL) of around 140 mm, and total length of some 240 mm. Body colour is grey to grey-brown, becoming salmon pink on the terminal 20 mm of tail. A longitudinal bar on the middle of each scale gives the appearance of faint longitudinal lines on the dorsal surface. As with all pygopodid lizards, limbs are completely absent apart from the presence of vestigial limb-flaps located on either side of the cloaca. The species is illustrated on the front cover of this report.

The occurrence of *A. parapulchella* has been only recently recognised in many areas across its range, stimulating several studies upon the distribution and conservation status of the species in NSW, ACT and Victoria (Osborne *et al.* 1991, Osborne and McKergow 1993, Osborne and Jones 1994, Robertson and Holmes 2000, P. Robertson unpubl. data). These studies have identified significant populations of the species in the Bathurst, Tarcutta and West Wyalong areas of NSW, Canberra and environs in the ACT, and the low foothills around Bendigo in central Victoria. However, intervening areas of land have been poorly surveyed and, therefore, the distribution of the species may extend in a broad arc between these localities. The recent discovery of a population of *A. parapulchella* in the Albury area of NSW (Michael and Herring 2005) is suggestive of this pattern.

Habitat requirements of the species have been studied most thoroughly in the ACT (Osborne *et al.* 1991, Jones 1992, Osborne & McKergow 1993, Jones 1999), however, information is also available from NSW localities. In all areas, the species appears to be associated with abundant surface rock, including granite, basalt and sandstone outcrops. These lizards are typically located sheltering beneath loose or lightly embedded surface rock in these localities, often in association with ants of the genus *Iridomyrmex*. These ants form a major proportion of the diet of *A. parapulchella* in the Canberra area, and rocks supporting colonies of this species are preferred home-sites for the lizard (Jones 1999).

Vegetation at occupied sites in the ACT and NSW is typically described as secondary grassland or grassy woodland, and early surveys concluded the species did not occur in heavily treed areas (e.g. Osborne & McKergow 1993). However, subsequent research has indicated the species has a wide tolerance for floristic attributes, and suggests that microhabitat characteristics, particularly rock structure, are more important determinants of the species occurrence (Jones 1999). In southern NSW and Victoria, the species has been recorded from woodland communities including open mallee and box-ironbark (Jones 1999, Robertson & Holmes 2000, P. Robertson unpubl. data; see below).

Despite intensive research on the ecology of *A. parapulchella* in the ACT (e.g. Jones 1992, 1999), little is known of characteristics such as daily activity patterns, thermoregulation and movements. The species appears to be largely fossorial, remaining sequestered beneath surface rocks and within ant-galleries for extensive periods. However, above ground movements do occur periodically, and the species has been captured (all-be-it infrequently) within pitfall traps (Rauhala 1993, Jones 1999, P. Robertson unpubl. data). Active individuals have been recorded during daylight hours (Osborne & McKergow 1993, P. Robertson pers. obs.).

The population biology of *A. parapulchella* has only recently been examined (Jones 1999). Estimates of population size for several sites examined by Jones in the ACT range from 145 – 599, although actual population sizes are more likely to be between 150-300 lizards. Age at sexual maturity reveals that the species is relatively long-lived and may not reach maturity until their third or fourth year (at >96 mm SVL). Resulting analysis of the composition of the ACT populations indicates that they were composed largely of adult animals (mean, 80%). All populations studied by Jones (1999) displayed equal sex ratios. Demographic attributes such as rate of reproduction and mortality are unknown. Mating probably occurs during the spring months, and gravid females have been recorded in late November and December (Jones 1999; G. Heard, P. Robertson pers. obs). Like all pygopodids, *A. parapulchella* lays a maximum clutch of two eggs.

The apparently fragmented distribution of *A. parapulchella*, and limited extent of occupied habitat has resulted in the species being recognised as VULNERABLE nationally (ANZECC 2000). A National Recovery Plan for the conservation of this species has been prepared (Osborne & Jones 1994).

1.1.2 Conservation status of *Aprasia parapulchella* in Victoria

The occurrence of *A. parapulchella* in Victoria was first recognised in 1988, after which time surveys were undertaken to attempt to determine its broad distribution and habitat requirements. Despite extensive survey throughout the Box-Ironbark region, the species was found only in the vicinity of Bendigo - to the north in the Whipstick public lands, to the south-east in the One Tree Hill area, and with isolated records in the Mandurang/Maiden Gully area. Less than forty individuals were recorded between 1988 and 1994. Most individuals were located in association with rock outcrops or scattered surface rock. Pitfall trapping in other areas has also shown that the species may also occupy areas without rocks, although it is difficult to locate in such areas.

Since that time, some targeted survey work has been conducted in the One Tree Hill area of Bendigo (Robertson & Holmes 2000). That study aimed to determine the significance of the One Tree Hill area of Greater Bendigo National Park for the conservation of *A. parapulchella*, and to provide information on the potential effect on these lizards of nearby urban development. The study located 62 individual *A. parapulchella*, and concluded that the One Tree Hill area (and adjacent private land) should be considered of national significance for the species. Ongoing urban development on land surrounding the park continues to compromise the viability of this population.

The distribution and conservation status of Victorian populations of *A. parapulchella* remain poorly understood. At present, the species appears to be restricted to remnant woodland habitats in the vicinity of Bendigo, much of which is variously degraded by recreational and forestry activities, and is increasingly threatened by urban development. The species has subsequently been recognised as ENDANGERED in Victoria (DSE 2003).

1.2. Study objectives

This study was initiated in August 2001, with the objective of gathering further information on the distribution and conservation status of *A. parapulchella* in the Bendigo region. Additionally, the study provided the opportunity to examine the habitat associations of the species within these woodland environments and subsequently provide guidelines for appropriate regional habitat management; an action identified as of high priority within the National Recovery Plan for the species (Osborne & Jones 1994).

This study operated with four specific aims:

- To increase our understanding of the distribution of *A. parapulchella* within the Bendigo region by undertaking survey work within areas of public land where the occurrence of the species has not yet been determined;
- Explore habitat attributes at those sites examined to determine habitat use and requirements across the region, including associations with specific floristic, topographic and structural variables;
- Explore shelter site use by the species, particularly rock characteristics and invertebrate associations;
- Gather information on other biological attributes of the species, particularly demographic and morphological parameters.

This report details current knowledge of the distribution, habitat associations and population attributes of *A. parapulchella* in the Bendigo region.

2. METHODOLOGY

2.1. Study area

This study was undertaken within an area broadly defined as the Bendigo Box-Ironbark region in central Victoria. Study area boundaries are approximated by the Sugarloaf Range Nature Conservation Reserve in the east, the Big Hill/Coliban Range in the south, Marong in the west and the Whipstick area of Greater Bendigo National Park in the north. However, field-work was concentrated in the southern half of this area, as extensive surveys for *A. parapulchella* have previously been conducted in the Whipstick region (P. Robertson unpubl. data).

2.2. Historical records

All known records of *A. parapulchella* from the Bendigo region were compiled to supplement field-survey data. Records held within the *Atlas of Victorian Wildlife* were accessed. These records included all those obtained previously from studies within the Whipstick area (P. Robertson unpubl. data). All information gathered during surveys for the species within the One Tree Hill area during October 2000 (Robertson & Holmes 2000) was collated for the purposes of this report. The location of all sites examined during that study is presented in Figure 1.

2.3. Field survey

Surveys for *A. parapulchella* were conducted during October and November 2001, and during November 2002. In total, 23 sites were examined across the region (Figure 2, Appendix 1). The majority of these were in Box-Ironbark woodland, although one was predominantly within Whipstick Mallee vegetation (gravelly-sediment mallee of Muir *et al.* 1995).

2.3.1. Site selection

As the primary aim of this study was to expand our knowledge of the distribution of *A. parapulchella* within the Bendigo region, broad selection of survey areas was guided by previous survey effort, with preference for areas that had been poorly examined in the past. One site was surveyed at both the Sugarloaf Range Nature Conservation Reserve and Marong State Forest on the eastern and western extremities of the study area respectively. As discussed above, the majority of survey effort was expended examining areas to the south of Bendigo, including the Big Hill/Coliban Range (2 sites), Mandurang area of Greater Bendigo National Park (5 sites), Sedgewick State Forest (3 sites) and poorly surveyed areas of the One Tree Hill area (11 sites) (Figure 2).

Specific site selection was guided primarily by vehicle access and by the level of surface rock present within the site. All work conducted during the 2001-2002 period employed rock-rolling as the primary survey technique (see below) requiring that sites examined contained at least scattered rock. However, surface rock is abundant in the region, and sites selected encompassed much of the habitat variability evident within the study area.

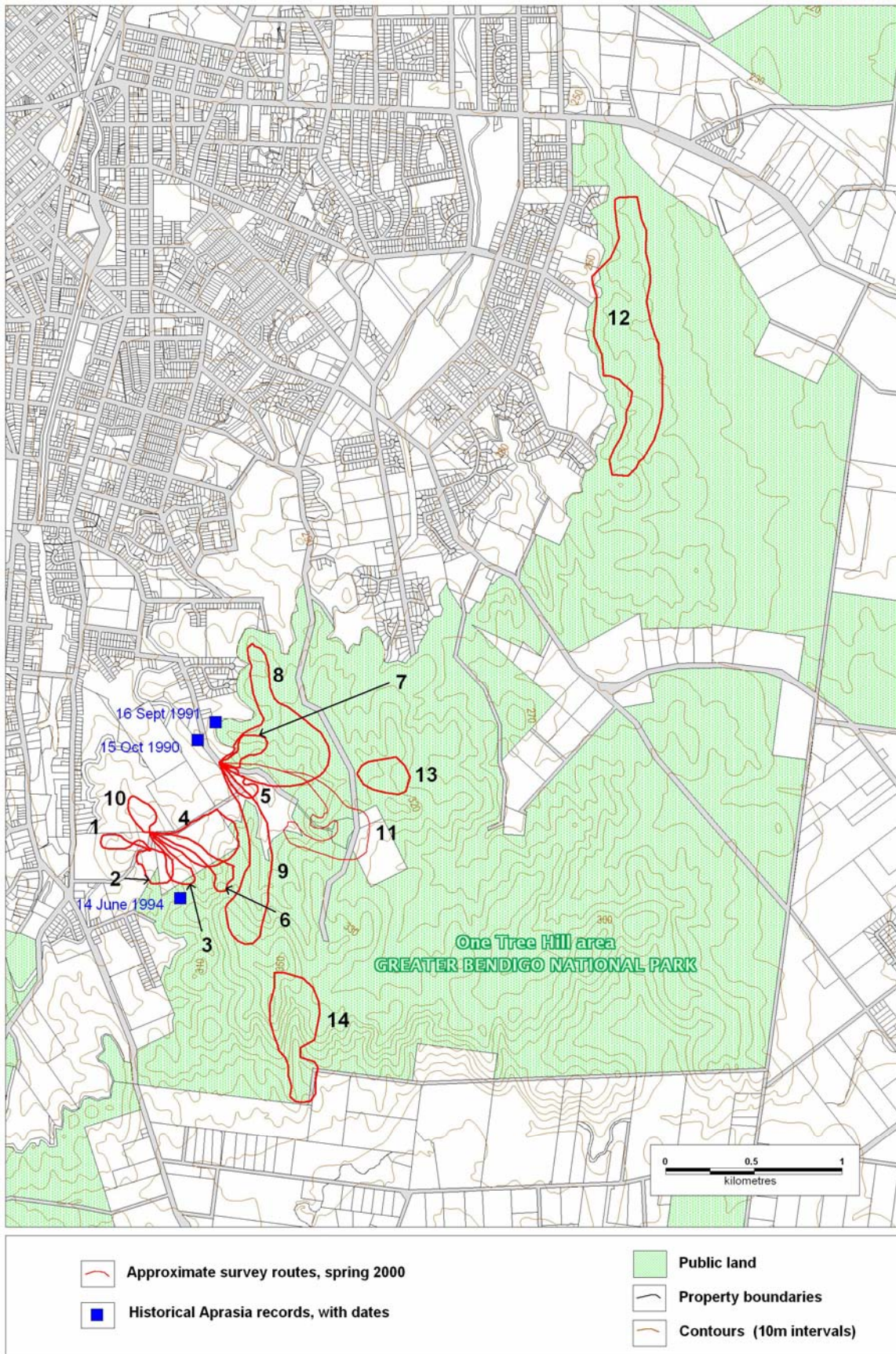


Figure 1. Areas surveyed for the Pink-tailed Worm-Lizard (*Aprasia parapulchella*) within the One Tree Hill area of Greater Bendigo National Park, October 2000 (after Robertson & Holmes 2000).

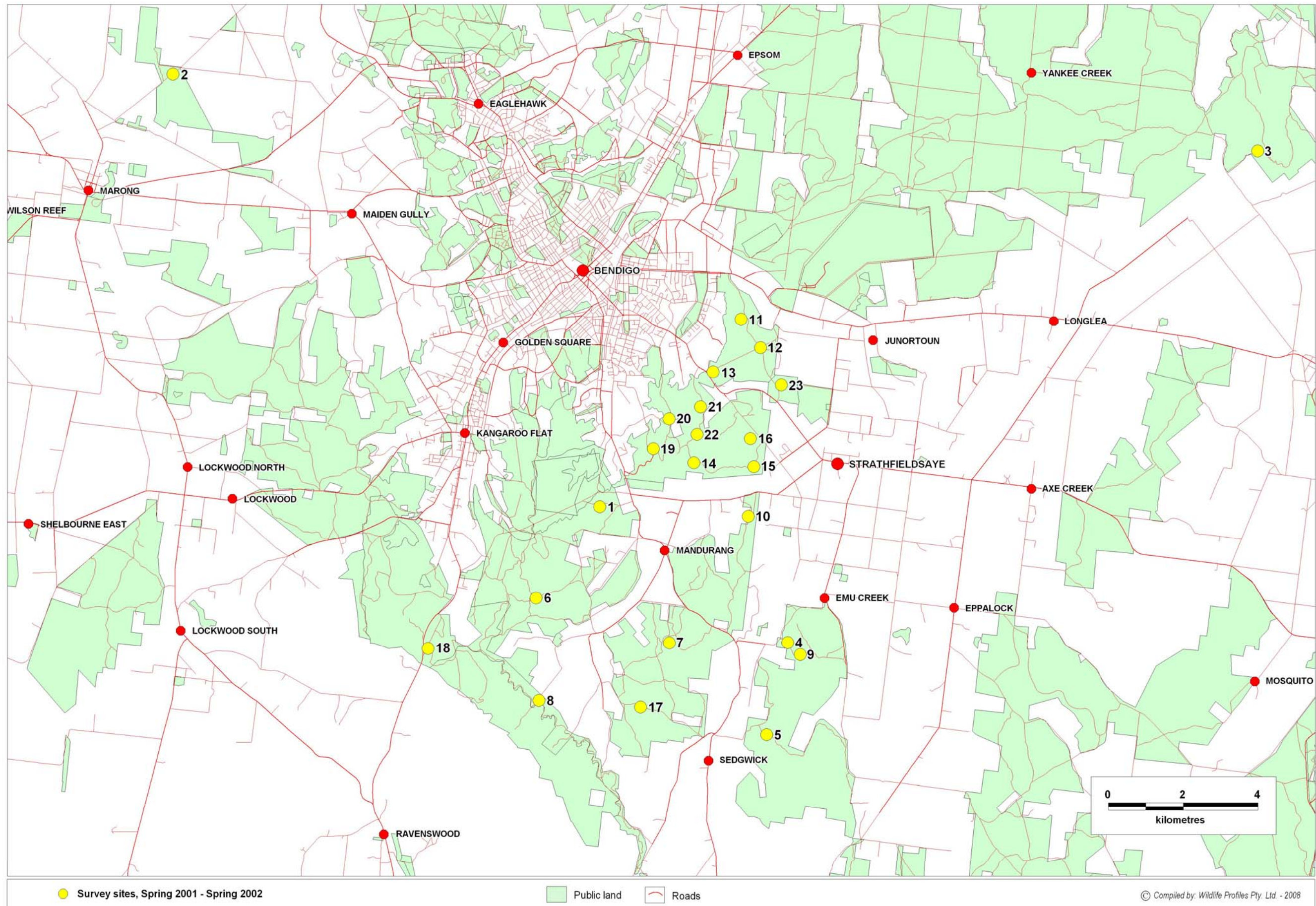


Figure 2. The distribution of field sites surveyed for the Pink-tailed Worm-Lizard (*Aprasia parapulchella*) within the Bendigo region, October 2001 to November 2002 (see also Appendices 1 & 4).

2.3.2. Survey techniques

Surveys for *A. parapulchella* were conducted during daylight hours (between 09:30 and 17:30) generally during mild, sunny conditions. As with many temperate reptile species, the likelihood of detecting *A. parapulchella* beneath surface cover is maximised by these conditions – these microhabitats heat rapidly during sunny periods, allowing lizards to increase body temperatures markedly whilst remaining under cover (see Jones 1999).

Each site was surveyed using a constrained area method following Robertson & Holmes (2000), and similar to that of Osborne *et al.* (1991), Osborne and McKergow (1993) and Jones (1999). Teams of one to thirteen people (mean 4) progressed systematically across a site, turning all rocks greater than 2 cm³. During this period, each field-worker maintained a count of rocks turned during the survey. Tallied results for the entire survey period were used as a measure of survey effort, supplementing records on survey effort as a function of time (person minutes). The area surveyed, and direction of travel, were recorded using the tracking function of a global positioning system ('Garmin 12XL' 12 channel GPS unit - UTM coordinates, AGD'66 Map Datum). The time of day, observers and prevailing weather conditions were also noted during each survey.

Records were maintained of all herpetofauna encountered during the survey period, including time of discovery and AMG co-ordinates. The presence *A. parapulchella* was determined either by sightings of live specimens, or by discovery of the distinctive shed skins of the species (which can also be located under rocks). We attempted to capture all *A. parapulchella* discovered during the survey period. Captured specimens were measured (snout-vent length and tail length to the nearest millimetre) using a 30 cm plastic rule and weighed (total mass to the nearest 0.1 g) using a Pesola spring balance. All individuals were sexed using the presence or absence of spurs beneath the hind-limb flaps, following Robertson and Edwards (1994). These spurs are readily identified on adult males using a 10× eyepiece, but are absent in females and juveniles. Female specimens were subsequently inspected for abdominal swellings indicating egg development. Upon location, notes on prevailing weather conditions were recorded, including shaded air temperature.

2.3.3 Habitat assessments

Habitat assessments were conducted over three spatial scales during the survey period to examine the habitat associations of *A. parapulchella* within the Bendigo region. Broad scale habitat assessments focussed upon describing variation in topographic, floristic and geomorphic attributes amongst the 23 sites examined. Local ('within site') habitat associations were investigated by measuring biophysical attributes within quadrats surrounding locations at which individual *A. parapulchella* were discovered. Finally, attributes of shelter sites (rocks) were measured to examine microhabitat associations of the species. Note that sightings of individual lizards or shed skins were used to designate locations as occupied by *A. parapulchella* at each spatial scale. For the lower two spatial scales, identical data were gathered from random locations to allow statistical comparison of these data. All habitat sampling was conducted by one field-worker (GH) to eliminate observer bias.

(i) Site level

Habitat characteristics at each site were recorded at the conclusion of all field inspections. Notes were maintained on topographic, floristic and geomorphic attributes, along with brief descriptions of habitat disturbance levels (rock displacement etc). Mean projected foliage cover (percent of ground surface that would be obscured by vegetation if viewed from directly above) was estimated visually for each vegetation type (over-storey, under-storey and ground-layer) whilst traversing the site during the survey period. As no detailed measurements were undertaken, and vegetation characteristics often varied significantly within each site, these measures should be treated with some caution. Species composition of the over-storey and under-storey levels was recorded. Table 1 provides definitions for all variables measured during site assessments.

(ii) Quadrat level

Local or 'within site' habitat associations were investigated using a quadrat-based sampling regime. Following the discovery of each *A. parapulchella*, ten biophysical variables (Table 2) were measured within a five square metre quadrat surrounding the lizard's exact location. Quadrat size was based upon the apparently sedentary nature of the species, and probable sensitivity to small-scale variation in habitat structure. Visual estimates were again used to measure projected foliage cover of each vegetation class, and, additionally, substrate variables such as rock, litter and bare-ground cover.

In order to compare the habitat attributes of sites occupied by *A. parapulchella* to those randomly available, a comparative data-set was compiled using a series of random sites sampled within the One Tree Hill area. Ideally, random sites would have been conducted at each area in which *A. parapulchella* was recorded, however, time-constraints limited this sampling to the One Tree Hill area. We justify comparing habitat attributes of sites located outside the One Tree Hill area with these random sites, as all lizard sites used were located within a 4 km radius of the One Tree Hill summit (three lizard sites from the Sugarloaf Range were excluded from these comparisons).

A total of 66 random sites were sampled in the One Tree Hill area during November 2002. Random sites were distributed evenly within the park and were based upon reference points located at 100 m intervals along each of the two main vehicle tracks running through the park (Edward's Rd, Kairn's Rd). Random sites were subsequently located by following a random compass bearing for a random number of paces from each of these reference points (after locating them using a vehicle odometer), with the location of the last foot-step becoming the centre of a random quadrat. To ensure compatibility with the lizard sites, all random sites were located within 200 m of a vehicle track and were required to contain surface rock greater than 2 cm³. Sampling of biophysical attributes at random quadrats was identical to that described above.

Table 1. Definitions for habitat attributes measured at each site surveyed for the Pink-tailed Worm-Lizard (*Aprasia parapulchella*) within the Bendigo region, October 2001 to November 2002.

Variable	Definition
Topography	
Land-form	
Undulating	Low lying country with weak topographic relief.
Low hill	Hilly terrain at generally low altitude (<350 m asl). Numerous low ridges and shallow gullies
Low slope	Lower slopes of a major range, rising to >350 m asl
Upper slope	Upper slope of a major range, above 350 m asl
Slope	
Lower	Base of slope
Middle	Mid-slope
Upper	Upper limits of slope
Aspect	Aspect of slope expressed as major compass bearings
Vegetation	
Vegetation type	
Box-Ironbark	Over-storey dominated by Grey/Red Box and Red Ironbark
Box	Over-storey dominated by Grey/Red Box only
Box-Stringybark	Over-storey dominated by Grey/Red Box and Red Stringybark
Whipstick Mallee	Over-storey dominated by Green Mallee
Over-storey composition	
Dominant over-storey species	List predominant over-storey species
Vegetation cover estimates	
Over-storey	Mean projected foliage cover of over-storey species (trees >3 m in height)
Under-storey cover	Mean projected foliage cover of under-storey species (shrubs and juvenile <i>Eucalpyts</i> <3 m in height)
Ground vegetation cover	Mean project foliage cover of ground layer vegetation species (grasses, herbs etc.)
Rock characteristics	
Dominant structure	
Scattered	Loose surface rock only
Small outcrop	Outcrops less than 5 m ² , with embedded and scattered surface rock
Large outcrop	Outcrops greater than 5 m ² , with large, deeply embedded rock surrounded by scattered surface rock
Disturbance	
Disturbance level	
Low	Vegetation and rock structure display little obvious human disturbance
Moderate	Some structural disturbance to vegetation and rocks
High	Widespread disturbance to vegetation and rock structure

Table 2. Biophysical variables sampled within five square metre quadrats surrounding each location site of the Pink-tailed Worm-Lizard (*Aprasia parapulchella*) within the Bendigo region, October 2001 to November 2002.

Variable	Definition
Topography	
Slope	
Lower	Base of slope
Middle	Mid-slope
Upper	Upper limits of slope
Aspect	Aspect of slope expressed as major compass bearings
Vegetation	
Canopy composition	Over-storey species present within quadrat
Canopy cover	Mean projected foliage cover of over-storey species (trees >3 m in height)
Shrub cover	Mean projected foliage cover of under-storey species (shrubs and juvenile <i>Eucalypts</i> <3 m in height)
Ground vegetation cover	Mean project foliage cover of grasses, herbs and forbs
Rock characteristics	
Dominant structure	
Scattered	Loose surface rock only
Small outcrop	Outcrop less than 5 m ² , with embedded and scattered surface rock
Large outcrop	Outcrop greater than 5 m ² , with large, deeply embedded rock surrounded by scattered surface rock
Substrate	
Rock cover	Mean cover of scattered or outcropping rock (size >2 cm ²)
Litter cover	Mean cover of vegetation litter
Bare-ground cover	Mean cover of bare-soil

(iii) Microhabitat level

Shelter site characteristics were recorded upon locating each *A. parapulchella*, according to definitions provided in Table 3. Physical measurements of each rock (maximum length and depth to the nearest millimetre) were recorded with a standard measuring tape.

At each site in which *A. parapulchella* was recorded, we measured the same set of microhabitat characteristics from a random set of 50 rocks to provide a comparative data-set for statistical analysis. Random rock measurements were conducted by walking randomly through the site and measuring the closest rock to every fifth foot-step (>2 cm³).

Table 3. Microhabitat characteristics recorded during surveys for the Pink-tailed Worm-Lizard (*Aprasia parapulchella*) in the Bendigo region, October 2001 to November 2002.

Variable	Definition
Rock measurements	
Length	Maximum length to the nearest millimetre
Depth	Maximum depth to the nearest millimetre
Substrate	
Under rock on soil	Rock resting or embedded in soil
Under rock on litter	Rock resting on grass-litter or leaf-litter
Under rock on rock	Exfoliated rock resting on rock
Invertebrate associations	
Small ants	Ants < 4 mm TL present/absent
Large ants	Ants > 4mm TL present/absent

2.4 Data analysis

2.4.1 Habitat associations

Statistical analyses of associations between habitat attributes and the occurrence of *A. parapulchella* amongst sites, quadrats and microhabitats were not undertaken for the purposes of this report. Such analyses will be presented elsewhere. These data are summarised here, and allow qualitative assessment of these relationships. As discussed above, quadrats sampled at discovery points of *A. parapulchella* in the Sugarloaf Range during the current study were excluded from comparisons with random sites, to ensure that these comparisons only included quadrats sampled within a 4 km radius of the One Tree Hill summit. Further, as Robertson and Holmes (2000) recorded the same microhabitat data for most of the *A. parapulchella* located by them in the One Tree Hill area, these data were added to that collected here for comparison with randomly sampled rocks.

2.4.2 Population attributes

Count data are often poor indicators of abundance for many wildlife species because they rest on the assumption of proportionality between the numbers of animals observed and the numbers of animals present (White 2005). For this assumption to hold, detection rates of individuals must display little variation through time or space; an unlikely scenario for a fossorial, ectothermic lizard like *A. parapulchella*. Whilst techniques are available to estimate abundances from count data (e.g. Royle and Nichols 2003), they require extensive temporal and spatial replication of counts. Collection of such data was beyond the scope of this study. Thus, no attempt is made here to estimate the abundance of *A. parapulchella* at each of the survey sites. Count data are provided for comparative purposes, but we stress that they simply represent the minimum number of animals known to be present at each site at the time of survey.

For further reference in this regard, we estimated the detection rate of *A. parapulchella* at each site as a function of the number of rocks turned (a measure of survey effort). Note that this analysis was restricted to observations of lizards – records of shed skins were excluded. Following the techniques of Jones (1999), we also estimated the number of rocks required to be 95% confident of observing these lizards at a survey site given these detection rates.

Calculations were as follows:

$$P_i = N(AP)_i / N(R)_i \quad (1)$$

where P_i equals the probability of detecting *A. parapulchella* at site i , $N(AP)_i$ is the number of *A. parapulchella* observed at site i , and $N(R)_i$ is the number of rocks turned at site i .

$$N_{0i} = \ln(0.05) / \ln(1-P_i) \quad (2)$$

where N_{0i} equals the number of rocks turned to be 95% confident of detecting *A. parapulchella* at site i .

The mean figure of N_{0i} from all occupied sites represents an estimate of the search effort (number of rocks turned) required to reliably determine the presence or absence of the species at sites within the Bendigo region.

As data recorded for individual lizards were identical between the current study and Robertson and Holmes (2000), we combined these data-sets to explore population and morphological parameters for *A. parapulchella* in the Bendigo region. Sex ratios were tested for departure from parity using a standard Chi-square test. The statistical significance of variation in body size between male and female lizards was assessed using non-parametric Mann-Whitney U tests. The relationship between snout-vent length and mass for each sex, and for all lizards captured, was assessed using linear regression.

Data were analysed using *JMP version 5.0* (SAS Institute, North Carolina, USA).

3. RESULTS

3.1 Distribution

3.1.1 Historical records

Individual records extracted from the *Atlas of Victorian Wildlife* are included within Appendix 2. All records of *A. parapulchella* from the One Tree Hill area detailed by Robertson and Holmes (2000) are provided in Appendix 3. Locations of all of these records are shown in Figures 3 and 4.

3.1.2 Current survey

Surveys undertaken between October 2001 and November 2002 confirmed the presence of *A. parapulchella* at nine of the 23 sites examined. All records of herpetofauna detected at sites during the current study are summarised in Appendix 5.

Most records of *A. parapulchella* from the current survey are derived from areas of public land immediately south-east of Bendigo, in the One Tree Hill and northern sections of the Mandurang areas of the Greater Bendigo National Park (Davie's Rd, Connelly's Lane) (Figure 3). The lizard was not recorded from sites examined in the north-east of the One Tree Hill area (sites 11, 12 & 13 in the vicinity of Wildflower Dr; see Appendix 4 and Figure 2), although it had been recorded in this area previously (see Figure 3). Likewise, no *A. parapulchella* were encountered in southern sections of the study area, including sites within the Mandurang area (sites 6, 7 & 17), Sedgewick State Forest (sites 4, 5 & 9) and the Big Hill/Coliban Range (sites 8 & 18 – see Figure 2). Three records of *A. parapulchella* were made within a steep, rocky site at the base of the Sugarloaf Range on the eastern boundary of the study area (site 3; see Appendix 4 and Figure 3). The location of these specimens represents a significant easterly range extension for the species within the Bendigo region.

3.1.3 Overall distribution in the Bendigo region

Combined records of the distribution of *A. parapulchella* within the Bendigo region reveal two distinct aggregations of sites at which the species has been recorded (Figure 3), immediately north and south of the city.

Sites within the Whipstick area of Greater Bendigo National Park are distributed in a roughly north-south line, with records from the extreme south and north of the block, in both Box-Ironbark woodland and Mallee areas. It is probable that the species is distributed widely within this area. In the south however, records of *A. parapulchella* are restricted entirely to Box-Ironbark woodland within a 5 km radius of the One Tree Hill summit. Surveys to the south, and west of this area have failed to detect the species. Finally, two widely isolated records of the species occur within the study area, deriving from the Sugarloaf Range Nature Conservation Reserve in the far east, and the Marong area to the west.

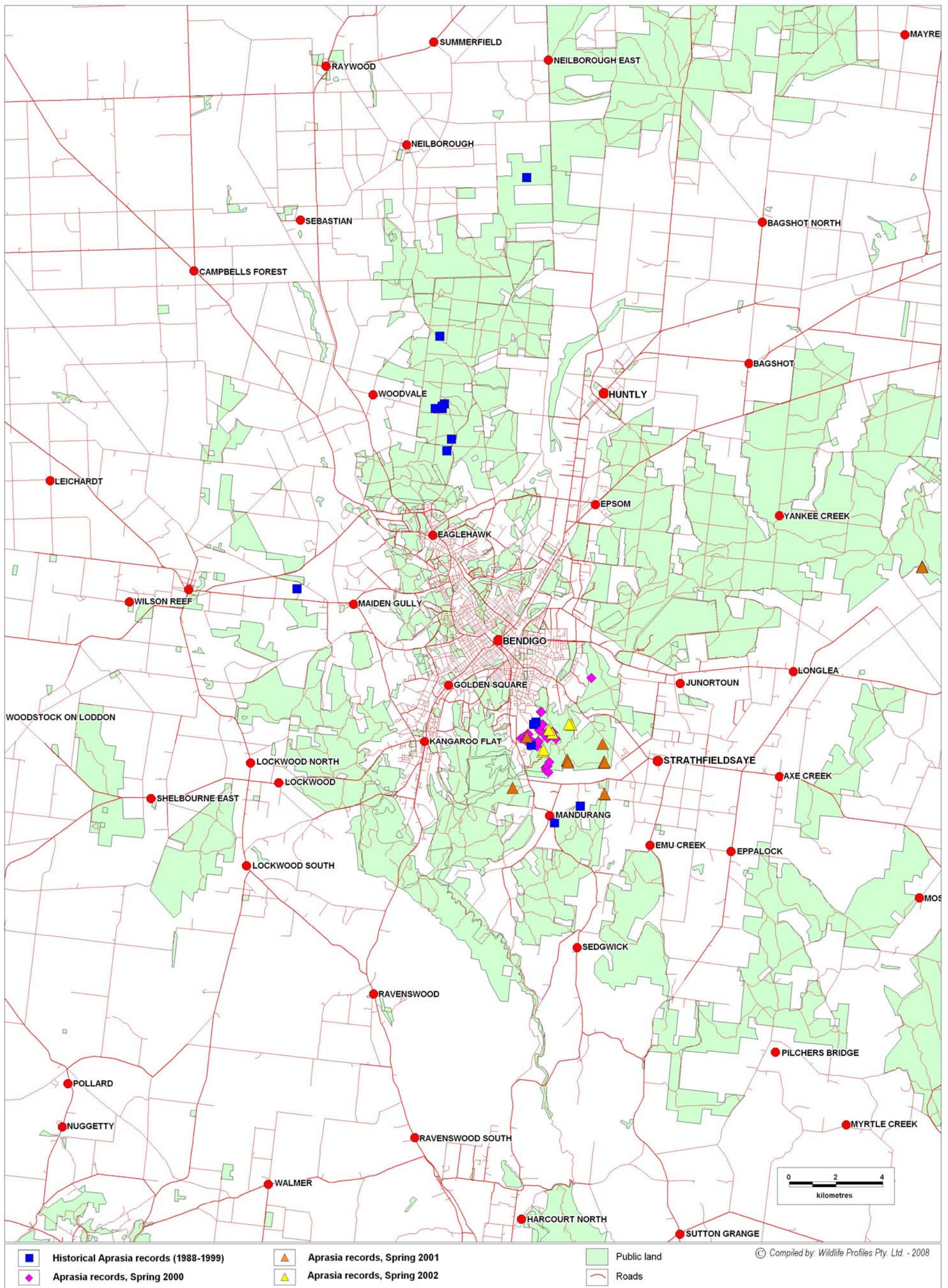


Figure 3. All records of the Pink-tailed Worm-Lizard (*Aprasia parapulchella*) known within the Bendigo region, as recorded from the Atlas of Victorian Wildlife, by Robertson & Holmes (2000), and from the current study.

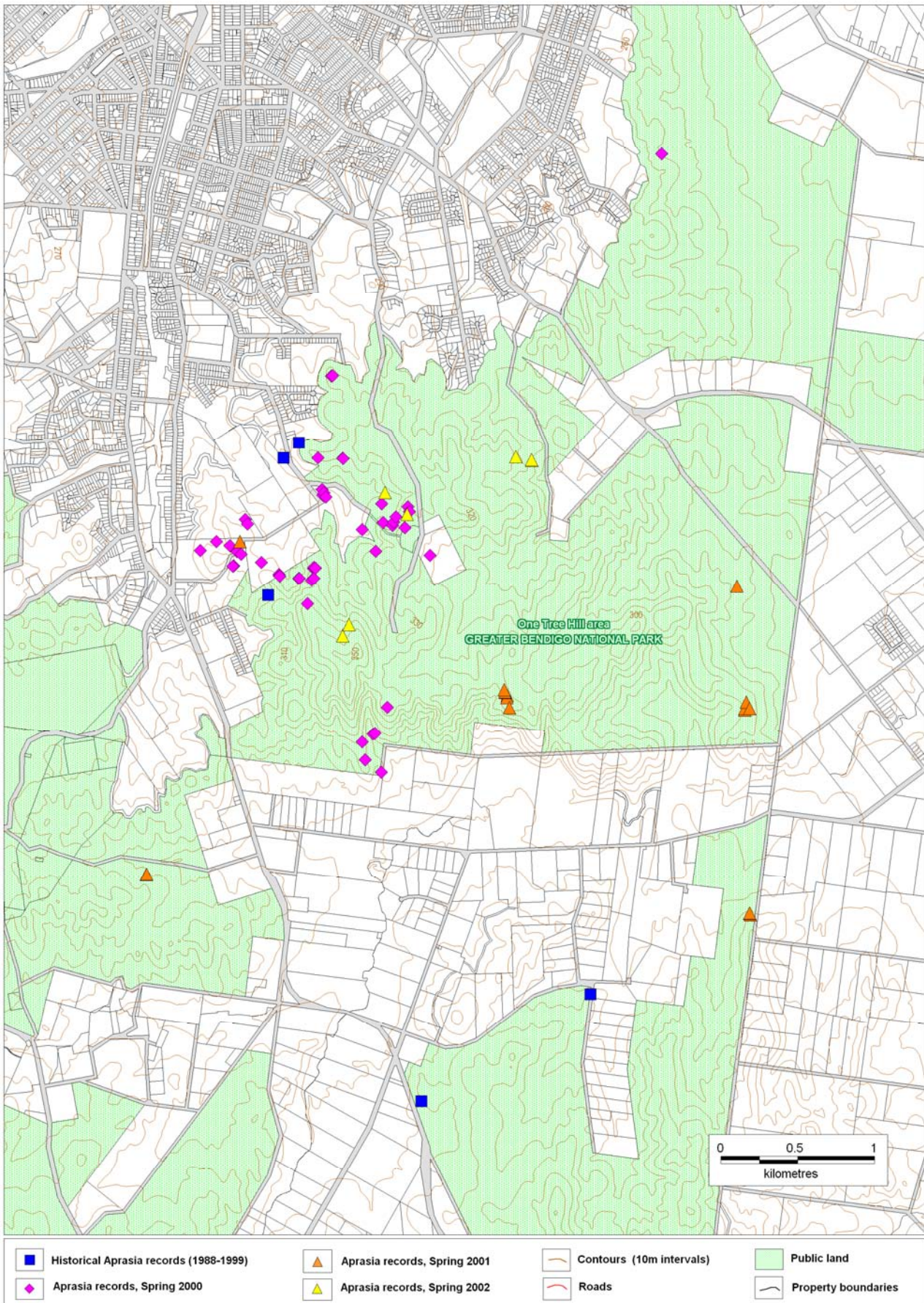


Figure 4. All records of the Pink-tailed Worm-Lizard (*Aprasia parapulchella*) within the vicinity of the One Tree Hill area of Greater Bendigo National Park (AVW, Robertson & Holmes 2000, current study).

3.2 Habitat associations

3.2.1 Site level

All sites at which *A. parapulchella* was recorded during the 2001-2002 survey period were low, hilly environments (less than 350 m asl) with numerous gullies and associated ridges. Many sites at which *A. parapulchella* was not recorded were located in similar hilly terrain. However, the species was not recorded from undulating country, or from either the lower or upper slopes of the major range examined (Big Hill/Coliban Range south of Bendigo) (Table 4).

Topographic features were often highly variable in the areas surveyed, and therefore categorising slope and aspect proved difficult. Broadly, however, sites in which the species was observed were primarily on mid- to upper-slopes. The two surveys conducted in areas of uniformly low slope (sites 12 & 23) did not yield any lizards. No relationships with aspect are evident at this scale; *A. parapulchella* were observed at sites with north, south and westerly aspects (the lack of records from sites displaying a primarily easterly aspect probably result from low survey effort in these areas). The geological stratum at each site examined during this study is derived from Ordovician sediments. Heavily weathered outcrops were characteristic of most sites inhabited by *A. parapulchella*, and provided abundant shelter sites in the form of lightly embedded surface rocks. Soils are primarily friable clay on shale substrates.

With the exception of Site 2 (located in primarily Whipstick Mallee vegetation), all sites examined during the 2001-2002 survey period were in areas of relatively open dry sclerophyll forest. Over-storey was composed at least partially of box eucalypts at all sites in which *A. parapulchella* was recorded, primarily Grey Box (*Eucalyptus microcarpa*) and Red Box (*E. polyanthemos*), interspersed with either Red Stringybark (*E. macrorhyncha*), Red Ironbark (*E. tricarpa*) or Yellow Gum (*E. leucoxylon*). No obvious differences in over-storey composition are apparent between sites in which the species was recorded or not recorded. Shrub and ground-layer vegetation was often diverse at sites occupied by *A. parapulchella*. Shrubs such as *Cassinia arcuata*, *Calytrix tetragona*, *Acacia pycnantha*, *A. acinaceae*, *A. paradoxa* and *Grevillea alpina* were commonly observed at *Aprasia* sites. Stands of *Brachyloma daphnoides* often occur on the rock outcrops inhabited by the lizard. An intact, diverse ground-layer also appears important. Native grasses (*Themeda triandra*, *Chionochloa* sp. and particularly *Stipa* spp.), lilies (*Dianella* spp.) and sedges (*Lomandra* spp.) were evident at all sites inhabited by *A. parapulchella*. Our survey records indicate that sites inhabited by *A. parapulchella* within the Bendigo region display a relatively open canopy structure with high cover of ground-layer vegetation (Table 4).

All sites surveyed were subject to various forms of human disturbance, including changes in hydrology from drainage schemes, small scale fragmentation from roads and walking paths, and disturbance to vegetation and rock structure from recreational users (walkers, trail bike riders, fossickers). While most sites at which *A. parapulchella* was observed displayed relatively low levels of disturbance (at least in their immediate past), the species was found in areas with significant structural habitat damage, particularly in the One Tree Hill area

Table 4. Summary of habitat characteristics recorded at sites surveyed for the Pink-tailed Worm-Lizard (*Aprasia parapulchella*) in the Bendigo region, October 2001 to November 2002.

Abbreviations: Topography, LS – low slope, US – upper slope, LH – low hill, U – undulating; Slope, L – low, M – mid, U – upper; Vegetation type, B – box, B/I – box-ironbark, B/S – box-stringybark, I/S – ironbark-stringybark, WM – whipstick mallee; Over-storey species, GB – Grey Box, GM – Green Mallee, RB – Red Box, RI – Red Ironbark, RS – Red Stringybark; Rock characteristics, LO – large outcrop, SO – small outcrop, SC – scattered; Disturbance level, L – low, M – moderate, H – high.

Site number	Topography	Slope	Aspect	Vegetation Type	Over-storey species	Over-storey cover (mean %)	Under-storey cover (mean %)	Ground cover (mean %)	Rock characteristics	Disturbance level
<i>Aprasia recorded</i>										
1	LH	M	N-NE	B/I	RI,GB	5	20	30	SO	M
3	LH	M	N	B/S	RS,GB	15	25	15	LO	L
10	LH	M	NE	B	GB,RS	20	10	20	LO	L
14	LH	U	S	B/S	RB,RS	15	35	20	SC	L
15	LH	M	SW	B/S	RB,RS	10	25	10	SO	M
16	LH	M	SW	B/I	RI,GB	35	10	50	SO	L
19	LH	U	W-NW	B/S	RS,GB	15	5	10	LO	L
20	LH	M	S-SW	B/S	RB,RS	15	15	25	SO	M
21	LH	M	NE	B/S	RB,RS	10	5	25	SO	H
					Mean	15.5	16.6	22.7		
					SE	2.8	3.4	4.1		
					Range	5-35	5-35	5-50		
<i>Aprasia not recorded</i>										
2	U	L	-	WM	GM	10	5	10	SC	L
4	LH	U	NE-SE	B	GB,RB	40	10	15	LO	M
5	LH	U	W	B/I	RB,RI	35	15	10	SO	L
6	LH	U	N	B/I	RI,RB	15	20	30	SO	L
7	LH	U	N-S	I/S	RI,RS	10	10	15	LO	M
8	LS	M	N-NE	B/S	RS,RB	20	20	15	SC	L
9	LH	U	W-NW	B/I	RI,RB	25	20	10	LO	H
11	LH	M	E	B/I	RB,RI	25	15	10	SO	M
12	U	L	NE	B/I	RI	?	?	?	SC	L
13	LH	M	E	B/I	RI	?	?	?	SO	L
17	LH	U	N-S	B/I	RB,RI	20	15	15	SO	L
18	US	U	W	B/S	GB,RS	20	30	30	SC	L
22	LH	M	NW	B/I	RI,RB	15	20	15	LO	M
23	U	M	SW	B/I [†]	RI,RB	15	10	15	SO	M
					Mean	20.8	15.8	15.8		
					SE	2.7	1.9	2.0		
					Range	10-40	5-30	10-30		

3.2.2 Quadrat level

As with site-level data, quadrats in which *A. parapulchella* were located within the vicinity of the One Tree Hill area were almost exclusively on mid- and upper-slopes (44% and 48% respectively). Random quadrats also frequently occurred on mid-slopes (47%), but were spread evenly between lower- and upper-slopes (27.3% and 25.7% respectively). Some differences were also apparent in the characteristics of surface rock between lizard and random quadrats. The former primarily displayed small outcropping of rock (56%), whereas the latter displayed primarily scattered rock away from outcrops (59%).

Quantitative habitat data recorded at these quadrats are summarised in Table 5. Quadrats at which *A. parapulchella* were located displayed variable aspect, and differed little in this regard from those sited randomly. Similarly, diversity of canopy species did not appear to differ consistently between quadrat types, although lizard quadrats, on average, displayed slightly higher species counts. However, some clear differences were apparent with regard to the cover of structural habitat attributes. Quadrats occupied by *A. parapulchella* displayed higher rock and bare-ground cover, and substantially lower leaf-litter cover. Shrub and ground-vegetation cover were also higher in lizard quadrats, but not substantially so. Canopy cover differed little between quadrat types.

Table 5. Comparison of habitat attributes between quadrats occupied by the Pink-tailed Worm-Lizard (*Aprasia parapulchella*) and random quadrats within the vicinity of the One Tree Hill area of Greater Bendigo National Park, October 2001 to November 2002.

Abbreviations are as follows: C – canopy, S – shrub, G – ground-vegetation, R – rocks, L – leaf-litter, BG – bare-ground.

Quadrat type	Compass bearing	Canopy diversity (species count)	Cover of structural attributes (%)					
			C	S	G	R	L	BG
<i>Aprasia</i> present (n = 25)								
Mean	136.8	2.12	8.8	15.2	18.3	24.6	27.5	26
SE	21.5	0.1	1.2	2.1	2	2.4	2.3	1.9
Range	45-315	1-3	1-25	1-35	5-40	1-50	10-60	5-45
Random (n = 66)								
Mean	149.3	1.8	12.1	11.3	15.8	14.4	52.9	17.3
SE	13.5	0.1	0.9	1.1	1.6	1.5	1.3	1.1
Range	0-315	1-3	1-35	0-35	0-40	1-60	25-75	1-45

3.2.3 Microhabitat level

Rocks under which *A. parapulchella* were located differed from random rocks in all aspects measured. They were predominantly resting on soil substrates (81%), with few situated on vegetation such as the foliage of grasses or leaf-litter (19%), and none on rock. By contrast, random rocks were evenly categorised as being situated on soil or vegetation (49% and 47% respectively), and several rested atop other rocks (4%). Rocks occupied by *A. parapulchella* were also occupied by small and large ants much more frequently than random rocks (54% and 13% versus 11% and 6% respectively), and were, on average, larger and deeper (Table 6).

Table 6. Comparison of microhabitat (rock) size between those occupied by the Pink-tailed Worm-Lizard (*Aprasia parapulchella*) and those sampled randomly within the Bendigo region, October 2001 to November 2002.

Microhabitat type	Rock length (mm)	Rock depth (mm)
<i>Aprasia</i> present (n = 67)		
Mean	232.0	64.9
SE	11.2	4.2
Range	80-450	6-160
Random (n = 450)		
Mean	160.2	54.5
SE	3.6	1.6
Range	35-490	10-250

3.3 Population attributes

A total of 23 lizards and five shed-skins were located during this study – their details are presented in Appendix 6. The number of lizards observed at each occupied site was typically low, averaging three (range 1-7). Detection rates of *A. parapulchella* were highly variable between sites (one lizard per 81–683 rocks turned; Table 7). Average survey effort required to locate one lizard was 278 minutes, or 438 rocks turned. The estimated mean probability of sighting a lizard (by turning one rock) was 0.0037, with the mean survey effort required to be 95% confident of detecting the species being 1307 rocks turned per site (Table 7).

Lizards captured ranged between 52–154 mm SVL (mean, 120.3 ± 2.8 SE) and 0.1–4 grams in weight (mean, 1.77 ± 0.69 SE). However, the majority of individuals were between 100–130 mm SVL and 1–2.5 grams in weight (Figure 5). Juvenile animals (<96 mm SVL & <1 g total weight) were recorded infrequently (4 individuals). In the sample of 53 adult lizards for which sex was confidently determined, the sex ratio did not differ from parity (25 males, 28 females; $\chi^2 = 0.26$, d.f. = 1, $P > 0.5$).

Comparison of length and mass between sexes revealed that adult females were significantly longer and heavier than their male counterparts (mean SVL: males, 119.7 mm ± 1.54 SE; females, 129.9 mm ± 3.11 SE; $Z = -2.69$, $P < 0.01$; mean weight: males, 1.7 g ± 0.05 SE; females, 2.1 g ± 0.14 SE; $Z = -2.25$, $P < 0.05$). No difference in tail-length was evident between sexes (mean tail-length: males, 73.9 mm ± 3.13 SE; females, 74.4 mm ± 4.07 SE; $Z = -0.30$, $P = 0.76$). Relationships between length and mass for each sex, and the overall sample of lizards measured, are displayed in Figure 6. All relationships are statistically significant (males: $R^2 = 0.49$, $F_{1,23} = 22.84$, $P < 0.0001$, $N = 25$; females: $R^2 = 0.36$, $F_{1,23} = 13.39$, $P < 0.01$, $N = 25$; all individuals: $R^2 = 0.66$, $F_{1,54} = 105.08$, $P < 0.0001$, $N = 56$).

Table 7. Survey results for the Pink-tailed Worm-Lizard (*Aprasia parapulchella*) within the Bendigo region, October 2001 to November 2002, displaying calculations of survey effort required to detect the species (see Methodology).

Site number	Date surveyed	Total person minutes	Total rocks turned	<i>Aprasia</i> recorded	Average survey effort per lizard		Estimated probability of sighting (P_i)	95% probability of detection (N_{0i})
					Minutes	Rocks		
1	17/10/01	380	1085	3	127	362	0.0028	No. of rocks required 1068
2	17/10/01	102	245	0				
3	18/10/01	195	1317	2	98	659	0.0015	1996
4	18/10/01	304	1878	0				
5	18/10/01	88	757	0				
6	19/10/01	128	645	0				
7	19/10/01	223	905	0				
8	20/10/01	230	982	0				
9	6/11/01	246	1600	0				
10	6/11/01	360	960	2	180	480	0.0021	1425
11	7/11/01	280	798	0				
12	7/11/01	325	976	0				
13	7/11/01	300	1000	0				
14	7/11/01	465	566	7	66	81	0.0124	240
15	7/11/01	300	1199	4	75	300	0.0034	879
16	7/11/01	450	500	1	450	500	0.0020	1496
17	7/11/01	325	1302	0				
18	7/11/01	135	806	0				
19	13/11/02	826	?	2	413			
20	13/11/02	895	?	1	895			
21	20/11/02	200	683	1	200	683	0.0014	2044
22	28/11/02	60	570	0				
23	28/11/02	170	1249	0				
			Total	23				
				Mean	278	438	0.0037	1307
				SE	90.18	79.69	0.0014	241.34
				Range	828	602	0.0109	1804

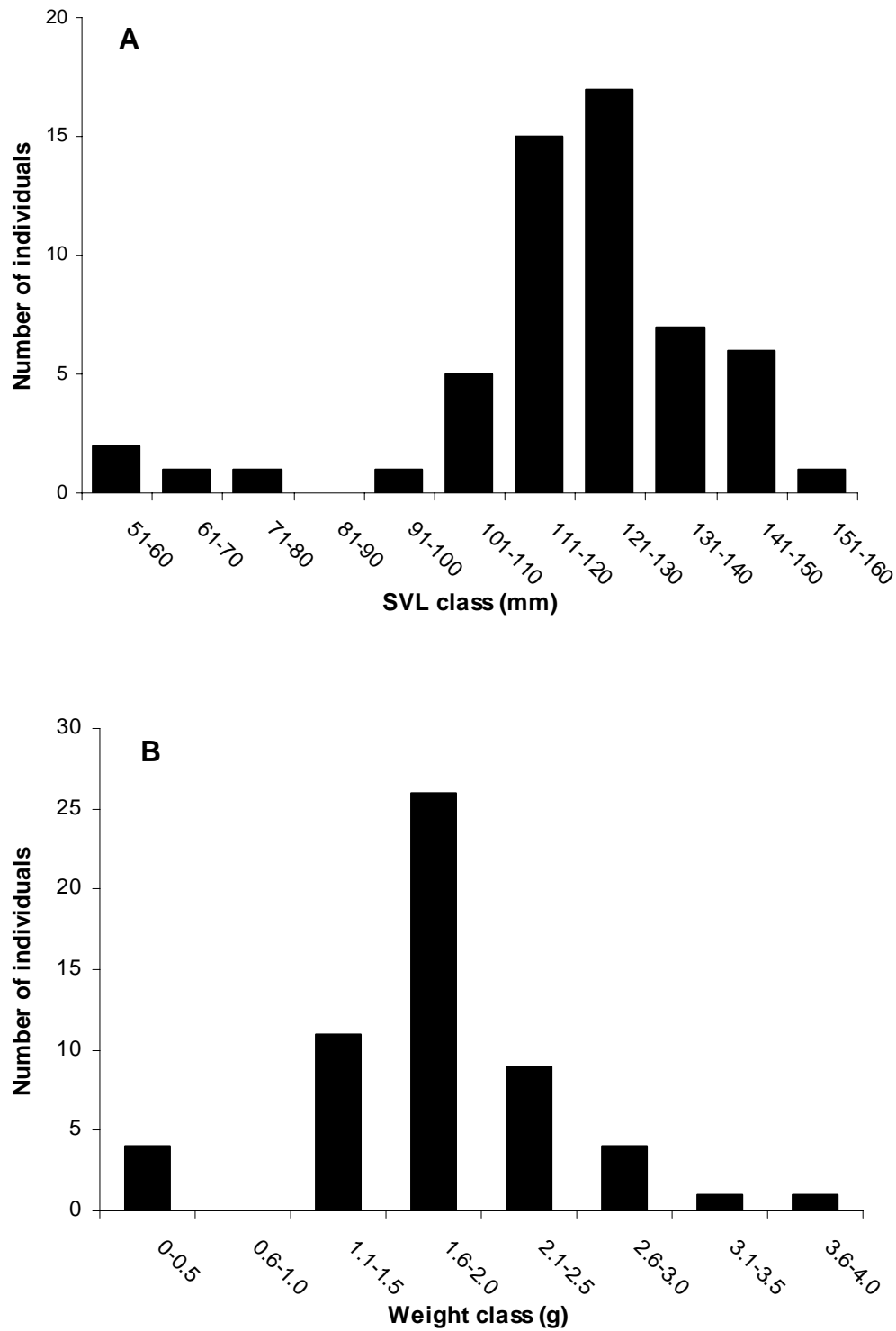


Figure 5. Frequency distribution of snout-vent length (svl) (A) and weight (B) for all Pink-tailed Worm-Lizards (*Aprasia parapulchella*) captured in the Bendigo region, 2000 to 2002.

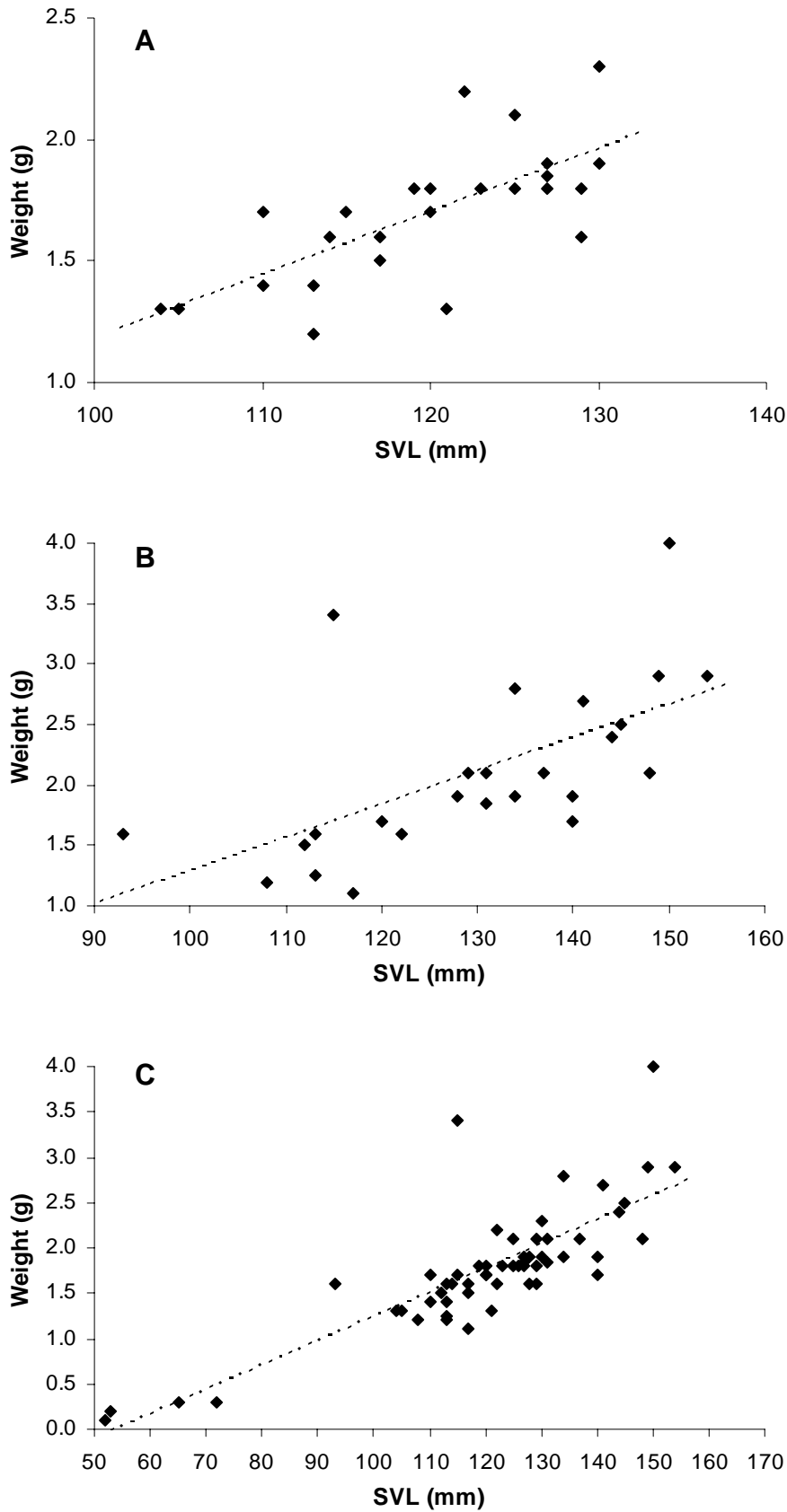


Figure 6. Length and weight relationships of the Pink-tailed Worm-Lizard (*Aprasia parapulchella*) captured within the Bendigo region, 2000 to 2002. Relationships displayed are for adult males (A), adult females (B) and all individuals (C).

4. DISCUSSION

4.1. Distribution

The currently recognised distribution of *A. parapulchella* in Victoria is confined to the Bendigo region. The species is known from forested areas on the south-eastern outskirts of Bendigo centred upon the One Tree Hill/Mandurang area, where there appears to be a concentration of records in remnant Box-Ironbark vegetation; from the Whipstick area to the north, where records are sparsely distributed in both Box-Ironbark and Mallee vegetation, and from isolated records in the west at Maiden Gully and the east in the Sugarloaf Range.

Targeted surveys for *A. parapulchella* have been undertaken further east in the Heathcote area and further south in the Harcourt area, where the species was not found (see section 4.3 below). Similarly, extensive pitfall surveys (a technique known to be useful for the species) elsewhere in central Victoria during the late 1980s, in the Kingower, Inglewood, Wedderburn and Wychitella areas, concentrated within Mallee vegetation, failed to detect the species (Robertson, unpublished; AVW).

It appears, therefore, that *A. parapulchella* may be restricted to the Bendigo region in central Victoria, perhaps not extending south of the Big Hill range, west of Marong, north of Kamarooka or east of the Sugarloaf Range. Even within this broad area, the species appears to be patchily distributed, and likely to be present as a number of small, essentially-isolated populations. A similar pattern of distribution was found by Jones (1999) in NSW and the ACT.

There is some potential for *A. parapulchella* to occur in north-eastern Victoria, where apparently suitable habitat exists east of Wodonga, an area poorly surveyed for reptiles. Also, the species is known from nearby in NSW, and has recently been discovered in the Albury area (Michael & Herring 2005).

Within the known distribution of *A. parapulchella* in the Bendigo region, many areas of potentially suitable habitat remain poorly surveyed. Similarly, even in surveyed areas, an apparent absence of records may not be a realistic indication of the absence of the species, given the difficulty of surveying and the effort required. Furthermore, the survey methodology has relied upon the lizard's utilisation of rocks as shelter sites – while *A. parapulchella* undoubtedly uses rocky areas, it does occur in areas lacking rocks, as found in the Whipstick area when pitfall traps were employed as a survey technique (Robertson, pers. obs.). Therefore, the species may be present in areas that have not been surveyed due to lack of rocks.

Consequently, the distribution of *A. parapulchella* in the Bendigo region may be more continuous than currently recognised due to these factors. Areas that remain poorly surveyed within this region include forested areas of the Big Hill Range and east of Kangaroo Flat, vegetation remnants in the Maiden Gully/Marong/Lockwood area, the Junortoun/Yankee Creek area east of Bendigo towards the Sugarloaf Range, forest blocks south-east of the Mandurang area, and the Kamarooka area. Recognition of potential habitat by GIS analyses should allow targeting of more likely habitat patches within these areas. Similarly, survey methodology should include the facility for pitfall trapping in non-rocky areas.

4.2. Conservation status

4.2.1. Habitat requirements

Factors determining the distribution of *A. parapulchella* in the Bendigo region remain unclear – the lizard was not found at several sites with apparently suitable habitat. However, as mentioned above, the species may remain undetected at some sites surveyed because of sampling difficulties. Conversely, apparently suitable habitat may be unoccupied due to a number of factors: we do not clearly understand the range of attributes the species requires; there may have been historical periods when the habitat was unsuitable leading to past local extinctions; and other ecological interactions (such as with predators) may preclude the species presence. Life history attributes of *A. parapulchella*, particularly low vagility and low intrinsic potential rate of population increase (Jones 1999), may both make local extinctions of small restricted populations likely, and restrict opportunities for dispersal and re-colonisation.

It does appear likely that in the Bendigo region the species occurs as a number of small, restricted and isolated populations, with little opportunity for interchange between occupied sites. It should be reiterated here though that we currently have no definitive information on population sizes. Jones (1999) surmised that the likely size of populations in the ACT (where capture rates far exceed those in Victoria) was less than 500 individuals.

Between sites surveyed in this study, rock structure appears important for *A. parapulchella* – outcrops on mid- and upper slopes were apparently preferred over lower slopes with few or scattered rock. However, to the north of Bendigo in the Whipstick area, while low rocky reefs were utilised, the species was also found in areas without rocks, and all sites were in gently undulating areas rather than mid- and upper slopes. Jones (1999) contends that the species is restricted to rocky areas in the ACT and southern NSW by thermoregulatory requirements, but that in warmer regions, such as at West Wyalong in NSW and the Bendigo region, the presence of rocks may not be an essential habitat requirement for *A. parapulchella*. In the current study south of Bendigo, we found that rock characteristics were clearly important within sites – the species prefers larger rocks on soil substrate with ant galleries present, a situation also found by Jones (1999) in the ACT.

During the current study, vegetation affiliations were less clear. At a site level, it appeared that occupied sites had a lower canopy cover, and a higher shrub and ground-layer vegetation cover and diversity. The latter two were supported somewhat by the quadrat data, but canopy openness did not differ greatly between occupied and random sites. However, occupied sites did display a much lower leaf-litter cover. It did appear that sites with a greater diversity at the shrub and ground level were more likely to be inhabited by *A. parapulchella*. Jones (1999) found that in the ACT, where most sites were in secondary grasslands, a greater density of grasses was a characteristic of occupied sites.

Aprasia parapulchella, like its congeners, is known to be a specialist feeder, preying upon a few species of small ants and their larvae (Jones 1999). Many of the rocks under which individuals were found also had ants present, and the lizards readily utilised the ant galleries. The interactions between the lizard and its prey are poorly understood, as

are the relationships between the ants and their habitat. Investigations of the habitat requirements of the ant prey of *A. parapulchella* may provide important insights into factors affecting micro-distribution of the species.

It would appear, therefore that rock characteristics are important for the species, and that relationships with vegetation are less obvious. Rock structure is likely to enhance thermoregulatory possibilities, particularly in southern areas and/or where canopy cover may limit available insolation. The species may utilise areas, however, where rocks are absent. Reduced canopy cover may be an advantage for the species, as may increased vegetation cover at ground level. Interactions of *A. parapulchella* with the distribution of its ant prey (and their habitat requirements) may also be important determinants of habitat suitability influencing lizard distribution.

These factors, along with historical events, have combined to produce the apparently patchy distribution of the species in the Bendigo region, and indeed across most of the species' range.

4.2.2. Perceived threats and their potential management

The patchy distribution of *A. parapulchella*, together with the likely small and highly-isolated status of most populations, place them at heightened risk due to environmental and demographic stochastic events. In addition, anthropogenic disturbances may further endanger remaining populations. Threats to *A. parapulchella* in the Bendigo region are centred around processes which 1) reduce the extent of available habitat, 2) reduce the quality of remaining habitat, and 3) further fragment and isolate existing populations. Some of these perceived threats are outlined below:

- Considerable habitat on private land has been and continues to be lost on the outskirts of Bendigo by urban encroachment (such as recent residential development around One Tree Hill). The presence of potential habitat for the species should be a major factor to be considered when planning any such developments. It should be noted here also that the potential effects of urban development extend well beyond the development boundaries into surrounding remnant vegetation.
- Within remnant habitat, collection of rock for suburban gardens has in many areas been shown to have severe impacts upon reptile populations. Such is likely to be the case with *A. parapulchella* in the Bendigo region, and appears to be particularly problematic close to new housing estates. Any rock disturbance in potential habitat should be precluded by regulation, and management implemented to ensure that rock collection does not occur.
- Recreational pressure, often involving a plethora of tracks, widespread rock disturbance (e.g. by fossicking in particular), and reduction/simplification of vegetation at ground level, is high in most areas of remnant habitat surrounding Bendigo. These changes affect just those attributes of the habitat important to *A. parapulchella*. These activities must be regulated and restricted to low conservation priority areas if the species is to survive in the region.
- The effects of exotic predators on *A. parapulchella* are unknown. However, introduced cats, for example, have been shown to exert particularly high predation upon terrestrial reptiles. It is likely that *A. parapulchella* in the

Bendigo region is subject to just such elevated predator pressure, and measures should be taken to implement ongoing and effective predator suppression in habitat areas as a priority. Domestic pets from adjacent residential developments are similarly likely to affect *A. parapulchella*, and should be controlled to prevent access to remnant vegetation.

- There is some potential for exotic ants to affect populations of *A. parapulchella*. Monitoring of ants at a selection of *A. parapulchella* sites on the outskirts of urban areas should be implemented to detect any such species, to investigate their effects on the lizard, and to control if necessary.
- The effects of fire on populations of *A. parapulchella* in the Bendigo region, on the quality of its habitat, and on the habitat relationships of its ant prey are unknown. However, ant faunas are known to display profound responses to fire. As such, it is likely that *A. parapulchella* would also be affected. Until such time as these interactions are better understood, and the responses to fire in the habitat can be predicted, it would be prudent to exclude fire from habitat areas, unless other evidence suggests that fire may be desirable to maintain and/or improve habitat attributes.
- The potential for greenhouse induced climate change to affect populations of *A. parapulchella* is high. Increased temperature and aridity are likely to reduce opportunities for activity of the species, as well as affecting the vegetation and the ant fauna. To attempt to buffer the species against these effects, it will be important to aim to maintain the habitat at optimum quality, to enhance habitat continuity, and to reduce other factors potentially suppressing populations.

4.3. Addendum – subsequent surveys

Two major surveys targeting *A. parapulchella*, utilising the methodologies reported herein, have been undertaken since the completion of the current survey. Although reported elsewhere (Robertson & Heard 2003, Robertson & Heard 2004), summaries of their findings are reproduced here to assist planning for any future studies of the species.

A) Heathcote area, 2003. (see Robertson and Heard 2004)

Surveys for *A. parapulchella* were conducted between 18th November and 3rd December, 2003. Fifteen separate sites were examined, according to a standardised methodology. This study was undertaken within areas of Box-Ironbark forest north-east, north-west and south of Heathcote in central Victoria. In addition, two sites in the One Tree Hill area of Greater Bendigo National Park, at one of which the species had previously been recorded, were examined. The surveys failed to detect the presence of *A. parapulchella* at any of the 13 sites examined in the Heathcote area, but two individuals were located at one of the two sites examined in One Tree Hill area. Details of these surveys and of the two individuals observed are presented in Appendix 7.

B) Harcourt area, 2003. (see Robertson and Heard 2003)

Potential woodland habitat for *A. parapulchella* had been identified within remnant woodland patches predominantly on private land along the proposed alignment of the Calder Freeway in the Harcourt area. Targeted survey for the species was undertaken at

seven sites to the south and west of Harcourt, approximately between Gaaschs Road and Specimen Gully Road, on the 25th, 26th and 30th of October, 2003. The sites supported variable quality Heathy Dry Forest vegetation and plentiful surface rock of Ordovician sediment origin. Their locations and the survey effort employed are presented in Appendix 8.

No Pink-tailed Worm-Lizards, nor signs of their presence, were recorded during the survey. Given the survey effort expended, it was concluded that it is unlikely that *A. parapulchella* is extant in this study area. Further, the authors noted that the population of this species known to the north in the Marong area appears to be isolated from the study area by a band of unsuitable habitat – open woodlands and pasture on granitic soils – in the Ravenswood area. Consequently, they contended that the Marong area may represent the southern limit of the distribution of the species, and that the remnant woodlands on Ordovician sediments in the Harcourt are beyond this limit.

4.4. Directions for further work

To assist with future management planning and the implementation of conservation measures, improved knowledge of several areas is desirable. Recommendations for further work include:

- Completion of habitat analyses of existing data, to be supplemented with broader GIS based habitat modelling to predict range and location of potential habitat areas within the Bendigo region, enabling targeted survey and management.
- Targeted surveys in locations highlighted by the modelling as having potential habitat, but which have been poorly surveyed to date. Surveys to include a range of methodologies, not dependent solely on rock presence.
- Dietary studies and examination of the relationships between ant and lizard distribution, and ant habitat requirements.
- Genetic studies to clarify the relationship of Bendigo populations to those in the ACT and NSW, and to investigate the degree of isolation of known populations around Bendigo. Genetic studies could also prove instructive in determining other population attributes, and the need for any assisted manipulation.
- Population monitoring is an essential management tool. We must know the status of populations and how they are responding to external factors so that management can be implemented or altered in an effective and timely manner. A subset of populations of *A. parapulchella* within the Bendigo region should be selected for regular monitoring according to a standardised methodology. Such monitoring should include investigation of particular ecological interactions (such as with ants and habitat as mentioned above) to make best use of resources. Note that monitoring of ants at these selected sites should be an integral part of the program.

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Appendix 1. Locations of sites surveyed during the current study.

Site number	Location	AGD66 Easting	AGD66 Northing	Date of survey
1	Connelly's Lane, Mandurang	257554	5921980	17/10/2001
2	Sheldon's Rd, Marong	246130	5933582	17/10/2001
3	Sugarloaf Track, Sugarloaf Range	275163	5931521	18/10/2001
4	Sedgewick State Forest	262583	5918325	18/10/2001
5	Sedgewick State Forest (2km S of Site 4)	262019	5915857	18/10/2001
6	Munro Rd, Mandurang	255847	5919519	19/10/2001
7	Diggers Track, Mandurang	259412	5918313	19/10/2001
8	Hunters Gap Rd, Big Hill Range	255926	5916774	20/10/2001
9	Sedgewick State Forest	262917	5918002	6/11/2001
10	Davies Rd, Mandurang	261525	5921720	6/11/2001
11	Wildflower Dr, Kennington/One Tree Hill	261331	5927004	7/11/2001
12	Wildflower Dr, Kennington/One Tree Hill	261857	5926244	7/11/2001
13	Wildflower Dr, Kennington/One Tree Hill	260585	5925592	7/11/2001
14	Pioneer Rd, Kennington/One Tree Hill	260073	5923151	7/11/2001
15	Pioneer Rd, Kennington/One Tree Hill	261676	5923050	7/11/2001, 28/11/2002
16	Guys Hill Rd, Kennington/One Tree Hill	261581	5923805	7/11/2001
17	Hogan's Rd, Mandurang	258646	5916597	7/11/2001
18	Calder Hwy, Big Hill Range	252955	5918164	7/11/2001
19	Tower Car-park, One Tree Hill	258987	5923535	13/11/2002
20	Edwards Rd, One Tree Hill	259405	5924332	13/11/2002
21	Kairn's Rd, One Tree Hill	260247	5924655	20/11/2002
22	Pioneer Rd, One Tree Hill	260154	5923920	28/11/2002
23	Wildflower Dr, Kennington/One Tree Hill	262414	5925239	28/11/2002

Appendix 2. Previous records of the Pink-tailed Worm-Lizard (*Aprasia parapulchella*) in Victoria available from the Atlas of Victorian Wildlife (AVW).

Date	Record type	Number of individuals	AGD66 Easting	AGD66 Northing	Latitude	Longitude	Altitude	Ref. No.	Nearest place name	Locality	Observer	Notes
27/10/1988	M	1J	254700	5938200	3640	14415		6961529/11		Whipstick Trapsite A	PR	
28/10/1988	M	1	254700	5938200	3640	14415		6961530/11		Whipstick Trapsite A	PR	
30/10/1988	M	1	254700	5938200	3640	14415		6961531/11		Whipstick near Trapsite A	PR	
31/10/1988	M	1	254700	5938200	3640	14415		6961534/11		Whipstick Trapsite A	PR	
31/10/1988	M	1	254900	5936400	3641	14415		6961535/11		Whipstick Trapsite 3	PR	
2/11/1988	M	1	254800	5938400	3640	14415		6961537/11	Bendigo	Whipstick Trapsite 6	PR	
18/10/1989	M	1	254700	5938200	3640	14415		18014/12	MV61646	Whipstick Trapsite A near bucket 2		Duplicate
19/10/1989	M		254700	5938200	3640	14415	220	6961646/11		Whipstick site A near bucket 2		
29/10/1989	M	1M	254400	5938200	3640	14415		6966587/11		300 M W of Whipstick Trapsite A	PR	
29/10/1989	M	1F	254400	5938200	3640	14415		6966588/11		300 M W of Whipstick Trapsite A		
13/11/1989	M	1F	254600	5941300	3640	14415		6966572/11		Whipstick Trapsite 10 Pitfall 9	PR	Check details
13/11/1989	M	1F	255100	5936900	3638	14415		6966573/11		Whipstick Trapsite 4 Pitfall 1	PR	Check details
16/11/1989	T	1	254800	5938400	3639	14351		1685144/31	ROUGHLY 6 KM NNW OF ARNOLD		NS	
15/10/1990	M	1	258600	5924700	3647	14417		6961712/11	Bendigo	One Tree Hill State Park		
15/10/1990	M	1	258600	5924700	3647	14417		6961713/11		One Tree Hill Park		
15/10/1990	M	1	258600	5924700	3647	14417		6961714/11		One Tree Hill State Park		
15/10/1990	M	1	258600	5924700	3647	14417		6961715/11		One Tree Hill State Park		
15/10/1990	T	6	258600	5924700	3647	14417	300	102701/12	WITHIN 2 KM OF QUARRY HILL			
16/09/1991	M	1F	258300	5948100	3634	14417	180	6966544/11		5.6 M E of Black Rock Whipstick		
16/09/1991	M	1M	258300	5948100	3634	14417	180	6966545/11		5.6 M E of Black Rock Whipstick		
16/09/1991	M	2	258300	5948100	3634	14417	180	104784/12	ROUGHLY 2 KM W OF NEILBOROUGH EAST			
16/09/1991	T	1	258700	5924800	3647	14417	280	104785/12		Off Osborne Street Spring Gully Bendigo		
23/09/1991	M	1	260600	5921200	3649	14418		6965988/11		Dysone Road corner Mandurang State Forest	PR	
23/09/1991	M	1	260600	5921200	3649	14418		6965989/11		Dysone Road corner Mandurang State Forest	PR	
23/09/1991	M	2	260600	5921200	3649	14418	250	104782/12		Dysons Road Corner Mandurang State Forest		
29/09/1991	X	2	259500	5920500	3649	14418	330	105395/12		Mandurang State Forest off Mandurang Road		
6/10/1991	M	1	248500	5930500	3644	14410	230	6965990/11		Maiden Gully between Hermitage Rd & Calder Hwy		
6/10/1991	X		248500	5930500	3644	14410	230	105398/12		Between Hermitage Rd & Calder Hwy Maiden Gully		Duplicate
9/08/1992	T	1			3642	14414		113717/12		Riflerange Road Whipstick Forest		Check details
14/06/1994	X	1	258500	5923800	3648	14417	300	114239/12	WITHIN 2 KM OF SPRING GULLY (computer)			
14/09/1994	S	4	260600	5921200	3649	14418	250	114399/12		Dysons Road Mandurang State Forest		
0/0/1989	M				3647	14417		6964867/11	Bendigo			Check details
0/10/1990	M	1	258600	5924700	3647	14417		6961716/11		One Tree Hill State Park		
0/10/1990	M	1	258600	5924700	3647	14417		6961717/11		One Tree Hill State Park		
0/10/1990	M	1	258600	5924700	3647	14417		6961718/11		One Tree Hill State Park		
0/11/1989	M	1F	254700	5938300	3640	14415		6966569/11		200 M N of Whipstick Trapsite A	PR	
0/11/1989	M	1F	254700	5938300	3640	14415		6966570/11		200 M N of Whipstick Trapsite A		
0/11/1989	M	1M	254700	5938300	3640	14415		6966571/11		200 M N of Whipstick Trapsite A	PR	

Note: All AVW records need checking and verification.

Appendix 4. Survey details, habitat characteristics and fauna recorded at each site surveyed for the Pink-tailed Worm-Lizard (*Aprasia parapulchella*) in the Bendigo region, October 2001 – November 2002.

Site No: 1

Locality: Connelly's Lane, Mandurang.

Date: 17/10/01

Time: 1012 - 1322

Observers: GH and PR

Weather: 22°C, slight breeze, moderately overcast (sunny breaks), no rain.

GPS track no: 1

WPT range: 001 - 032

Coordinates: 257554 5921980

Search effort.

Time spent (person minutes): 380

Search Method: Active search (rock rolling).

Topography etc: N - NE facing slopes (mid - low) of a small range, head of a small gully.

Vegetation (dominant spp. and cover ranges): Box Ironbark with RI, GB, RS, RB (0-20%) slightly higher along gully lines. Diverse shrub layer (variable cover c. 5-50%, mean = 20%), dominated by *Cassinia*, *Calytrix*, *Acacia* and *Grevillia* sparsely distributed. Variable ground layer with *Stipa* tussocks, *Chionochloa* spp.

Rocks.

Number turned: 1085

Sample size of rocks measured: 50

Notes: Rock structure most complex on the higher slopes were small linear outcrops are found. Remaining areas display scattered rock only.

Habitat notes: *Aprasia* associated with rocky reefs, with open canopy and dense shrubs. Moderate disturbance noted apparently from recreational uses such as trail bike riding, fossicking and rock rolling.

Species Found:

Lerista bouganvillii (35)

Ctenotus robustus (2)

Lampropholis guichenoti (4)

Aprasia parapulchella (3)

Ramphotyphlops nigrescens (1)

Appendix 4 (cont.)**Site No: 2**

Locality: Mallee stand close to Sheldon's Rd, state forest north of Marong.

Date: 17/10/01

Time: 1528 - 1617

Observers: GH and PR

Weather: Cool (approx. 23°C), slight breeze, and moderate cloud cover with sunny breaks.

GPS track no: 1

WPT range: 001 - 004

Coordinates: 246130 5933582

Search effort.

Time spent (person minutes): 102 mins.

Search Method: Active searching (rock rolling).

Topography etc: Gently undulating hills with shallow gullies.

Vegetation (dominant spp. and cover ranges): Begin in small stand of green mallee and travel between green mallee, box-ironbark woodland and ecotonal areas between the two. Green mallee (*Eucalyptus viridis*) patches displayed open understory of *Acacia acinacea*, *Hibbetia spp.* and *Goddenia spp.* Box-Ironbark areas dominated by Red Ironbark (*E. tricarpa*) and Grey Box (*E. microcarpa*) with open, shrubby understory.

Rocks.

Number turned: 245

Sample size of rocks measured: 0

Notes: Scattered quartz, very small stones. Occasional groupings of shale.

Habitat notes: Mix of green mallee with very open box ironbark. Little rock cover and therefore difficult to survey.

Species Found:

Lerista bouganvillii (2).

Appendix 4 (cont.)**Site No: 3****Locality:** Sugarloaf Range, east side, mid latitude (Sugarloaf Track)**Date:** 18/10/01**Time:** 1105 - 1210**Observers:** GH, PR and DG**Weather:** Overcast with sunny breaks (approx. 24°C), slight breeze. Approaching rainsquall arrived at 1205.**GPS track no:** 1**WPT range:** 001 - 012**Coordinates:** 275163 5931521**Search effort.****Time spent (person minutes):** 195 mins.**Search Method:** Active searching (rock rolling).**Topography etc:** Steep sloping country on the base of Sugarloaf Range. Work on lower to mid slope of a foothill (rising to 210m).**Vegetation (dominant spp. and cover ranges):** Woodland/open forest dominated by small Red Stringybark (*E. macrorhyncha*) with occasionally large Grey Box (*E. microcarpa*). Moderately dense understory dominated by *Brachyloma daphnoides* with occasional *Cassinia arcuata* and *Grevillia alpina*. Ground cover dominated by Rock Fern with sparse grasses and herbs.**Rocks.****Number turned:** 1317**Sample size of rocks measured:** 50**Notes:** Dominated by a large outcrop at mid slope. Scattered rock surrounded the larger outcrop.**Habitat notes:** Evidence of rock rolling on the main outcrop. Greater abundance and complexity of rocks on the higher slopes. Moderate shrub cover with little evidence of disturbance from past mining activities etc.**Species Found:***Aprasia parapulchella* (2 + 1 slough)*Lerista bouganvillii* (4)*Lampropholis guichenoti* (2)

Appendix 4 (cont.)

Site No: 4

Locality: Sedgewick State Forest

Date: 18/10/01

Time: 1426 - 1542

Observers: GH, PR, DG, CZ

Weather: Overcast with occasional sunny breaks, slight breeze.

GPS track no: 1

WPT range: 013 - 046

Coordinates: 262583 5918325

Search effort.

Time spent (person minutes): 304 mins.

Search Method: Active searching (rock rolling).

Topography etc: Steeply sloping hills, interspersed with shallow gullies. Rocky outcrops found on the peaks of the hills investigated.

Vegetation (dominant spp. and cover ranges): Thick overstory cover of Grey Box (*Eucalyptus microcarpa*), Yellow Box (*E. melliodora*), Red Stringybark (*E. macrorhyncha*) and Red Box (*E. polyanthemos*). Low shrubs (*Brachyloma daphnoides*, *Cassinia arcuata*) on the NE slopes. Very little shrub cover on the SE facing slopes leading down to gully. Heavy litter cover in areas with high canopy cover.

Rocks.

Number turned: 1878

Sample size of rocks measured: 0

Notes: Large rock outcrops present on the peaks investigated. Both fractured and scattered rock fairly complex. On the mid-lower slopes, predominantly scattered rock occurs. Most small scattered rock resting vegetation.

Habitat notes: Very open habitat at ground level. Disturbance to rock structure noted.

Species Found:

Lerista bouganvillii (31)

Tiliqua rugosa (1)

Lampropholis guichenoti (2)

Appendix 4 (cont.)**Site No: 5**

Locality: Sedgewick State Forest (approx. 2km south of Site 4)

Date: 18/10/01

Time: 1610 - 1632

Observers: GH, PR, DG, CZ

Weather: Sunny with slight breeze, overcast patches, cool. Light rain shower at 1615.

GPS track no: 1

WPT range: 047 - 053

Coordinates: 262019 5915857

Search effort.

Time spent (person minutes): 88 mins.

Search Method: Active searching (rock rolling).

Topography etc: Relatively steep hills; although, relief fairly consistent with few protruding large outcrops etc. Site on hill top with west aspect.

Vegetation (dominant spp. and cover ranges): Relatively high overstory cover of Red Box (*Eucalyptus polyanthomes*), Red Stringybark (*E. macrorhyncha*), Grey Box (*E. microcarpa*) and Red Ironbark (*E. tricarpa*). Open understory with low shrubs including *Brachyloma daphnoides*, *Cassinia arcuata*, *Acacia acinacea*.

Rocks.

Number turned: 757

Sample size of rocks measured: 0

Notes: Small rocky ridge investigated. Mixer of embedded outcropping with surrounding surface rock.

Habitat notes: Peak of large hill (west aspect). Area with wider variety of eucalypts than Site 4.

Species Found:

Lerista bouganvillii (5).

Appendix 4 (cont.)**Site No: 6**

Locality: Mandurang area, western block (Munro Rd).

Date: 19/10/01

Time: 1039 - 1247

Observers: GH

Weather: Fine, sunny with slight easterly breeze (bringing periodic cloud cover).

GPS track no: 1

WPT range: 001 - 022

Coordinates: 255847 5919519

Search effort.

Time spent (person minutes): 128 mins.

Search Method: Active searching (rock rolling).

Topography etc: Site within the upper reaches of a small east-west running gully. Most sampling was carried out on north facing slopes.

Vegetation (dominant spp. and cover ranges): Fairly intact woodland with large specimens of Red Ironbark (*Eucalyptus tricarpa*). Red Stringybark (*E. macrorhyncha*) and Red Box (*E. polyanthemos*) also present in the overstory (mean cover = 15%). Moderately dense shrub layer of *Cassinia*, *Brachyloma daphnoides*, *Acacia pycnantha* (and *acinacea?*) and Holly Grevillia. Ground layer sparse to moderate (mean cover = 25 - 35%), dominated by *Stipa* tussocks and Pampas grass in disturbed gully areas.

Rocks.

Number turned: 645

Sample size of rocks measured: 0

Notes: Rock cover highly variable. Small rock outcrops found on the upper slopes with scattered surface rock surrounding. In the mid-lower slopes surface rocks are generally small and loose (many rocks noted to be resting on veg). Artificial shale deposits were noted in the gully.

Habitat notes: Rock structure similar to sites where *Aprasia* were found on the 17/10/01. Perhaps more ground layer vegetation, particularly tussock grasses. Little disturbance noted.

Species Found:

Lerista bouganvillii (19)

Amphibolurus muricatus (1)

Lampropholis guichenoti (1)

Brown Quail (1)?

Appendix 4 (cont.)**Site No: 7****Locality:** Mandurang area, Diggers Track**Date:** 19/10/01**Time:** 1402 - 1745**Observers:** GH**Weather:** Generally fine with cloudy/overcast breaks, slight westerly breeze.**GPS track no:** 1**WPT range:** 023 - 046**Coordinates:** 259412 5918313**Search effort.****Time spent (person minutes):** 223 mins.**Search Method:** Active searching (rock rolling).**Topography etc:** Search opposing slopes at the head of small north south running gully. Slope on both sides moderate (c. 30°). Rocky ridges occur on the upper slopes in both cases. A small water channel exists at mid slope on both sides of the gully.**Vegetation (dominant spp. and cover ranges):** Variable in all vegetation layers. Gully contains Rushes (*Juncus spp.*), *Cassinia spp.* and occasional Pampas clumps. Red Ironbark (*Eucalyptus tricarpa*) and Red Stringybark (*E. macrorhyncha*) dominates the overstory (cover = 5-20%). Understory variable in cover (1-35%) with *Cassinia spp.*, *Leptospermum ovatum*, *Brachyloma daphnoides*, *Grevillia alpina*, Holly Grevillia and *Acacia pycnantha*. Ground layer dominated by *Stipa* tussocks (cover = 1-45%).**Rocks.****Number turned:** 905**Sample size of rocks measured:** 0**Notes:** Small scattered rock found regularly distributed on mid-lower slopes. Many surface rocks on the lower slopes rest on litter and have been dug out of a water channel present. Rocky outcrops (small and large) found on the upper slopes. Complex in nature and often surrounded by very large numbers of surface rocks, 5-50cm in length.**Habitat notes:** Hill top on the western side very dry with hard soils; devoid of grasses and shrub layer with high canopy cover. Very rocky in these areas.**Species Found:***Lerista bouganvillii* (16)*Egernia whitii* (2)*Ramphotyphlops nigrescens* (2)*Christinus marmoratus* (1)*Ctenotus robustus* (2)

Brown Quail (1)?

Appendix 4 (cont.)**Site No: 8****Locality:** Coliban/Big Hill Range, south of Mandurang (Hunts Gap Road).**Date:** 20/10/01**Time:** 1030 - 1420**Observers:** GH**Weather:** Overcast with sunny breaks, fining up as the day progressed. Approx. 23°C**GPS track no:** 1**WPT range:** 048 - 070**Coordinates:** 255926 5916774**Search effort.****Time spent (person minutes):** 230 mins.**Search Method:** Active searching (rock rolling).**Topography etc:** Steeply rising slope (generally NNE aspect). Artificial drainage line cut through the lower-mid slope ('Coliban Main Channel').**Vegetation (dominant spp. and cover ranges):** Mixture of Red Stringybark (*Eucalyptus macrorhyncha*), Yellow Box (*E. melliodora*) and Red Box (*E. polyanthemos*). Older, larger trees apparent on the upper slopes with the lower slopes having a thicker cover of small trees (cover ranges = 15-30%). Understorey layer sparse to moderate (cover ranges = 10-30%). *Cassinia* spp., *Brachyloma daphnoides*, *Grevillia alpina*, *Acacia pycnantha*, *A. acinacea* and *A. paradoxa*. Ground layer variable but dominated by *Stipa* tussocks.**Rocks.****Number turned:** 982**Sample size of rocks measured:** 0**Notes:** The great majority of rocks appear to have arisen from past excavations. Approximately half those turned were apparently dug out during the construction of the channel. Two small outcrops were found at mid slope; however, in other areas only small scattered rocks were found. Almost all scattered rocks were resting on litter. Rock sizes: 5-50cm in length, mean = 20cm.**Habitat notes:** Many areas were open at the understorey level with large amounts of litter. Along the drainage line, rock is plentiful; however, there is little vegetation apart from tussock grasses.**Species Found:***Lerista bouganvillii* (14)*Tiliqua rugosa* (2).*Ctenotus robustus* (3)*Lampropholis guichenoti* (5)*Ctenotus* spp. (2 - no I.D., probably *robustus*)

Appendix 4 (cont.)**Site No: 9****Locality:** Sedgewick State Forest**Date:** 6/11/01**Time:** 1338 - 1500**Observers:** GH, PR and AJC**Weather:** Overcast (complete cloud cover), moderate southerly breeze, 19.8 °C.**GPS track no:** 1**WPT range:** 008 - 034**Coordinates:** 262917 5918002**Search effort.****Time spent (per person):** 246 mins.**Search Method:** Active searching (rock rolling).**Topography etc:** Hill top with steep, W-NW facing slopes. A small amount of time (c. 20mins) was spent on a SW facing slope towards the end of the survey period.**Vegetation (dominant spp. and cover ranges):** Red Ironbark (*Eucalyptus tricarpa*) dominates the overstory with Red Stringybark (*E. macrorhyncha*) and Red Box (*E. polyanthemos*) patchily distributed. Overstory cover moderate and consistent (20-30%). Understory dominated by *Brachyloma daphnoides* (particularly in rocky areas) with *Cassinia arcuata* and *Acacia paradoxa* (25-30% shrub cover in rocky areas, down to 10-15% on the slopes). Ground layer of Paper Daisy (*Helichrysum* spp.), Flax Lily (*Dianella* spp.) and a sedge species.**Rocks.****Number turned:** 1600**Sample size of rocks measured:** 0**Notes:** High rock cover on hill peak and some slope areas. Large rock outcrops in several areas, often with horizontal crevices. Large amounts of surface rocks in the majority of areas, particularly around outcrops. Rock size variable (5-60cm in length, mean = c. 20cm). Rock on surface generally resting on soil; however many disturbed rocks sitting on litter. High rock disturbance.**Habitat notes:** Reasonable shrub layer in some areas; although patchy and associated with rock cover and lower canopy cover.**Species Found:***Lerista bouganvilli* (31)*Suta flagellum* (2)*Lampropholis guichenoti* (5)*Amphibolurus muricatus* (1)

Appendix 4 (cont.)**Site No: 10**

Locality: Mandurang area, north-eastern corner of the eastern block (Davies Rd).

Date: 6/11/01

Time: 1603 - 1803

Observers: GH, PR and AJC

Weather: Overcast, strong southerly breeze, 18.3 °C.

GPS track no: 1

WPT range: 035 - 055.

Coordinates: 261525 5921720

Search effort.

Time spent (person minutes): 360 mins.

Search Method: Active searching (rock rolling).

Topography etc: North east facing slope of a small range. Most work carried out on the mid-upper slope. Steeper on the higher slopes where rocky ridges were found.

Vegetation (dominant spp. and cover ranges): Grey Box (*Eucalyptus microcarpa*) on the lower slopes; however, Red Box (*E. polyanthemos*) and Red Stringybark (*E. macrorhyncha*) dominant on the mid - upper slopes (15-20% cover, slightly higher on lower slopes). Shrub layer dominated by *Acacia acinacea*, *A. paradoxa*, *Grevillia alpina*, *Cassinia arcuata*, *Exocarpus cupressiformis* (shrub cover: 10-15%, lower on rocky areas, c. 5%). Ground layer dominated by *Stipa* tussocks (particularly mid slope) and Flax Lily (*Dianella* spp.) and Red Anther Wallaby Grass (*Chionochloa* sp). Rock Fern on upper slopes.

Rocks.

Number turned: 960

Sample size of rocks measured: 50 (on 7/12/02)

Notes: Few scattered surface rocks present on the lower slope. Many large outcrops encountered on the mid - upper slopes, complex with large amounts of surrounding surface rock. Majority of work carried out on a long rocky ridge.

Habitat notes: Herbaceous ground layer; lots of *Stipa* and *Chionochloa* sp. tussocks. Rock Fern on upper slopes. Pale soil, high litter cover in some areas.

Species Found:

Ctenotus robustus (3)

Lerista bouganvillii (18)

Pseudonaja textilis (1)

Amphibolurus muricatus (1)

Aprasia parapulchella (2 + 1 slough)

Ramphotyphlops nigrescens (1)

Appendix 4 (cont.)**Site No: 11****Locality:** Kennington (One Tree Hill) - Wildflower Drive.**Date:** 7/11/01**Time:** 1039 - 1135**Observers:** GH + 4 TAFE students**Weather:** Fine, no cloud cover, sunny with southerly breeze; 18.3 °C.**GPS track no:** 1**WPT range:** 001 - 010 (NRE Garmin GPS unit)**Coordinates:** 261331 5927004**Search effort.****Time spent (person minutes):** 280 mins.**Search Method:** Active searching (rock rolling).**Topography etc:** Majority of time spent on a gently sloping easterly facing slope. Finishing on hill top and opposing face of hill (westerly facing) with steeper slope and some rocky ridges.**Vegetation (dominant spp. and cover ranges):** Overstory mix of Red Box (*Eucalyptus polyanthemos*), Red Ironbark (*E. tricarpa*) and Red Stringbark (*E. macroryncha*) with c. 25% cover on average. Understory moderate with *Cassinia arcuata*, *Acacia pycnantha*, *A. acinacea*, *Brachyloma daphnoides*, *Exocarpus cupressiformis* and *Grevillia alpina*. Ground layer dominated by *Stipa* tussocks with some Flax Lily (*Dianella spp.*) and Red Anther Wallaby Grass (*Chionochloa sp.*).**Rocks.****Number turned:** 798**Sample size of rocks measured:** 0**Notes:** Little surface rock on the lower slopes; generally small, previously excavated rock present. Small outcrops present on the upper slopes and on the westerly facing slope. Moderate disturbance to the rock structure (fossicking etc) was evident.**Habitat notes:** Open on the lower slopes, with ver little rock and high litter cover. Higher up on the slopes, several small outcrops were surveyed. In these areas greater shrub cover was noted. Disturbance included excavations, rubbish and rock displacement.**Species Found:***Lerista bouganvillii* (7)*Ctenotus robustus* (1)

Appendix 4 (cont.)**Site No: 12****Locality:** Kennington (One Tree Hill) - Wildflower Rd intersection.**Date:** 7/11/01**Time:** 1030 - 1135**Observers:** PR, AJC + 3 TAFE students**Weather:** Sunny, mild, moderate southerly breeze, 18 °C.**GPS track no:** 1**WPT range:** 056 - 065 (PR's GPS)**Coordinates:** 261857 5926244**Search effort.****Time spent (person minutes):** 325 mins.**Search Method:** Active searching (rock rolling).**Topography etc:** Gently undulating country with NE aspect.**Vegetation (dominant spp. and cover ranges):** Red Ironbark (*Eucalyptus tricarpa*) dominant in the overstory. Understory patchy (dominated by *Acacia acinacea*) with diverse ground layer of grasses and sedges.**Rocks.****Number turned:** 976**Sample size of rocks measured:** 0**Notes:** Very few; generally only scattered surface rock.**Habitat notes:****Species Found:***Lerista bouganvillii* (4)*Ctenotus robustus* (1)*Amphibolurus muricatus* (3)*Lampropholis guichenoti* (1)

Appendix 4 (cont.)**Site No: 13**

Locality: Kennington (One Tree Hill) - Pylon access track, west of Wildflower Drive.

Date: 7/11/01

Time: 1030 - 1130

Observers: PJ + 4 TAFE students.

Weather: Sunny, warm breeze.

GPS track no:

WPT range: Co-ordinates recorded.

Coordinates: 260585 5925592

Search effort.

Time spent (person minutes): 300 mins.

Search Method: Active searching (rock rolling).

Topography etc: Moderate slope, with some rocky ridges.

Vegetation (dominant spp. and cover ranges): Dry heathy forest - open structure.
Little grass cover.

Rocks.

Number turned: 1000

Sample size of rocks measured: 0

Notes: Mean size = 10cm*5cm; maximum size = 40cm*15cm. Rocky reefs with apparent suitability for *Aprasia* noted.

Habitat notes: Numerous loose rocks associated with the rocky reef.

Species Found:

Lerista bouganvillii (4)

Amphibolurus muricatus (1)

Lampropholis guichenoti (1)

Appendix 4 (cont.)

Site No: 14

Locality: Southern block of Kennington (One Tree Hill) - Pioneer Rd

Date: 7/11/01

Time: 1227 - 1400

Observers: GH + 4 TAFE students

Weather: Warm (22 - 24 °C), sunny with little cloud and easterly breeze.

GPS track no: 1

WPT range: 011 - 025 (NRE Garmin GPS unit).

Coordinates: 260073 5923151

Search effort.

Time spent (person minutes): 465 mins.

Search Method: Active searching (rock rolling)

Topography etc: Edge of a high and steep south facing slope. Almost all work carried out on the very top of the hill, with little real aspect (ie. *Aprasia* aspect records weak).

Vegetation (dominant spp. and cover ranges): Open, heathy vegetation. Low canopy cover (mean = c. 15%) of Red Box (*Eucalyptus polyanthemos*) and Red Stringybark (*E. macroryncha*). Moderate cover of shrubs (mean = 35%, range = 5-50%); although variable with open patches at the lower end of the scale. *Brachyloma daphnoides* dominant with *Cassinia arcuata*, *Grevillia alpina* and *Acacia acinacea*. Ground layer of *Stipa* and Red Anther Wallaby Grass (*Chionochoa* sp.) tussocks.

Rocks.

Number turned: 566 (note: unreliable due to poor counts by 2 students).

Sample size of rocks measured: 50 (on 8/12/02)

Notes: Mostly scattered surface rock with small outcrops/aggregations. Patches of excavated slate scattered and in piles in several areas.

Habitat notes: Apparently a fairly moist site with good shrub cover and bryophytes present at ground level. This site is a narrow strip between the road and the edge of the south facing slope which drops away sharply.

Species Found:

Ramphotyphlops nigrescens (1)

Aprasia parapulchella (7)

Lerista bouganvillii (9)

Ctenotus robustus (1)

Appendix 4 (cont.)**Site No: 15****Locality:** Southern block of Kennington (One Tree Hill) - Pioneer Rd**Date:** 7/11/01**Time:** 1215 - 1330**Observers:** PR, AJC with 2 TAFE students.**Weather:** Mild and sunny; 22 - 24 °C.**GPS track no:** 1**WPT range:** 066 - 081 (PR's GPS unit)**Coordinates:** 261676 5923050**Search effort.****Time spent (person minutes):** 300 mins.**Search Method:** Active searching (rock rolling).**Topography etc:** Hilly country.**Vegetation (dominant spp. and cover ranges):** Overstory dominated by Red Stringybark (*Eucalyptus macrorhyncha*), Red Box (*E. polyanthemos*) and Grey Box (*E. microcarpa*). Overstory cover 5-25%.**Rocks.****Number turned:** 1199**Sample size of rocks measured:** 50 (28/11/02)**Notes:** Some good rocky reefs and ridges.**Habitat notes:** Diverse shrubby patches with *Ozathamus spp.*, *Brachyloma daphnoides*, *Acacia pycnantha*, *Grevillia alpina* and *Hakea spp.* Shrub cover 10-30% with height up to 1.5m. Ground layer of Flax Lily (*Dianella spp.*) and Red Anther Wallaby Grass (*Chionochloa sp.*). Cover patchy but up to 50% in some areas.**Species Found:***Aprasia parapulchella* (1) (+3 on 28/11/02)*Lampropholis guichenoti* (3)*Lerista bouganvillii* (17)

Appendix 4 (cont.)**Site No: 16****Locality:** Kennington (One Tree Hill) - West of Guys Hills Rd.**Date:** 7/11/01**Time:** 1200 - 1330**Observers:** PJ + 4 TAFE students**Weather:** Sunny, warm breeze**GPS track no:****WPT range:** Co-ordinates recorded**Coordinates:** 261581 5923805**Search effort.****Time spent (person minutes):** 450 mins.**Search Method:** Active searching (rock rolling)**Topography etc:** East slope rising to a SW facing ridge. *Aprasia* found on ridge with reef and exposed rocks.**Vegetation (dominant spp. and cover ranges):** Red Ironbark (*Eucalyptus tricarpa*) and Grey Box (*E. microcarpa*)? Overstory cover <50%. Shrubs to 1m - 80% cover.**Rocks.****Number turned:** 500**Sample size of rocks measured:** 50 (on 28/11/02)**Notes:** Scattered rocks in most areas. Small reef with exposed rocks on the ridge.**Habitat notes:** Scattered rocks with medium shrub cover.**Species Found:***Aprasia parapulchella* (1)*Lerista bouganvillii* (7)*Ramphotyphlops nigrescens* (1)

Appendix 4 (cont.)**Site No: 17**

Locality: Mandurang area, eastern half of the southern section (Hogans Rd).

Date: 7/11/01

Time: 1548 - 1653

Observers: GH, PJ, Matt (north of road); PR and AJC (south of road).

Weather: Sunny; although with increasing cloud cover. Easterly breeze, c. 23 °C.

GPS track no: 1

WPT range: PR's GPS = 082 - 092

NRE Garmin = 026 - 044

Coordinates: 258646 5916597

Search effort.

Time spent (person minutes): 325 mins.

Search Method: Active searching (rock rolling).

Topography etc: Opposing sides of a small gully. North of road has south to south east facing slopes, while south of road has north facing slope. North of Hogans Rd rises steeply to a rocky ridge.

Vegetation (dominant spp. and cover ranges): Overstory dominated by Red Box (*Eucalyptus polyanthemos*) and Red Stringybark (*E. macrorhyncha*). Red Ironbark (*E. tricarpa*) features on the upper slopes. Overstory cover approx. 15%. Grey Box (*E. microcarpa*) found on the lower slopes and provides higher cover (c. 30%). Shrub layer low on south easterly slopes. *Brachyloma daphnoides*, *Cassinia arcuata*, *Grevillia ilicifolia* and *G. alpina*. Ground layer of *Stipa* tussocks, with highest cover in the gully.

Rocks.

Number turned: 1302 in total (400 south of road, 902 north of road).

Sample size of rocks measured: 0

Notes: Small outcrops on the upper slopes; loose scattered rock on the mid-lower slopes.

Habitat notes: Open and dry on the higher slopes. Denser vegetation found in the gully; however, little rock occurs in this area.

Species Found:

Lerista bouganvillii (25)

Underwoodisaurus milli (1)

Lampropholis guichenoti (3)

Tiliqua rugosa (1)

Appendix 4 (cont.)**Site No: 18****Locality:** Big Hill Range (Calder Hwy).**Date:** 7/11/01 **Time:** 1900 - 1945**Observers:** GH, PR and AJC**Weather:** Fine clear, easterly breeze approx. 16 °C.**GPS track no:** 1 **WPT range:** 093 - 100 (PR's GPS unit).
Coordinates: 252955 5918164**Search effort.****Time spent (person minutes):** 135 mins.**Search Method:** Active searching (rock rolling).**Topography etc:** West facing slope on the northern edge of Big Hill Range, almost at the peak. Gently sloping.**Vegetation (dominant spp. and cover ranges):** Grey Box (*Eucalyptus microcarpa*) dominates the overstory with Red Stringybark (*E. macroryncha*) in moderate quantities (overstory cover = 20%). Moderate to high shrub cover (20-45%) of *Acacia pycnantha*, *Cassinia arcuata*, *Brachyloma daphnoides* and *Grevillia alpina*. Ground layer dominated by two species of *Stipa* (tall varieties), with *Danthonia* spp., Flax Lily (*Dianella* spp.) and *Helichrysum* spp. Moderately dense ground layer.**Rocks.****Number turned:** 806**Sample size of rocks measured:** 0**Notes:** Scattered rock throughout with occasional 'aggregations' of surface rock. Many rocks resting on soil; although, loose rocks resting on litter were evident. Size range = c. 5-50cm.**Habitat notes:**Rock and shrub structure similar in appearance to known *Aprasia* sites. Apparently fairly moist (high bryophyte and shrub cover). Low disturbance to rock structure.**Species Found:***Lerista bouganvillii* (9)

Appendix 4 (cont.)

Site No: 19

Locality: One Tree Hill: North of the Tower Car Park

Date: *Aprasia* located 13/11/02 (by PJ). Habitat assessment 20/11/01 (by GH).

Time: 13/11/02: c. 1315 - 1415. 20/11/02: 1354 - 1440

Observers: 13/11/02: PJ + 12 TAFE students. 20/11/02: GH

Weather: 13/11/02: ? 20/11/02: Cool, overcast (c. 95% cloud cover), slight rain overnight following cool change. Temperature: 19.6 C.

GPS track no: 2

WPT range: 003 - 005 (PR Garmin 12)

Coordinates: 258987 5923535

Search effort.

Time spent (person minutes): 13/11/02: 780 mins. 20/11/02: 46 mins.

Search Method: Active search - rock rolling

Topography etc: Very steep, west to north-west facing slopes of One Tree Hill proper. Terrain with multiple gully heads, strewn with large, complex rock outcrops.

Vegetation (dominant spp. and cover ranges): Overstorey dominated by Red Stringybark (*Eucalyptus macrorhyncha*), Grey Box (*E. microcarpa*) and Red Box (*E. polyanthemos*); many tall trees, dbh range = 5 - 50 cm. Red Ironbark (*E. tricarpa*) scattered throughout site. OVC: Mean = 15% (range = 10 - 25%). Shrub layer sparse, dominated by *Cassinia arcuata*, *Acacia pycnantha*, and some *Brachyloma daphnoides*. UVC: Mean = 5% (1 - 10%). Ground layer dominated by *Stipa* spp tussocks with *Carex* spp.(?), *Dianella* spp. and *Lomandra* spp. Open ground layer with lots of litter.

Rocks.

Number turned: 13/11/02: ? 20/11/02: 74

Sample size of rocks measured: 50

Notes: Large, complex outcrops abundant on steeper terrain. Many large, free boulders scattered throughout; however, majority of rocks <50cm length. Scattered rock abundant.

Habitat notes: Shrub and ground layer fairly open due to higher canopy cover. Higher abundance of larger trees at this site than Site 20 (Reservoir Circuit).

Species Found:

13/11/02: *Aprasia parapulchella* (2)

Ramphotyphlops spp. (1)

20/11/02: *Christinus marmoratus* (2)

Appendix 4 (cont.)

Site No: 20

Locality: One Tree Hill: Circuit around reservoir on Edwards Rd.

Date: *Aprasia* located 13/11/02 (by PJ). Habitat assessment 20/11/01 (by GH).

Time: 13/11/02: c. 1045 - 1145. 20/11/02: 1105 - 1300

Observers: 13/11/02: PJ + 12 TAFE students. 20/11/02: GH

Weather: 13/11/02: ? 20/11/02: Cool, overcast (c. 90% cloud cover), slight rain overnight following cool change. Temperature: c. 19.0 C

GPS track no: 1

WPT range: 001 - 002 (PR Garmin 12)

Coordinates: 259405 5924332

Search effort.

Time spent (person minutes): 13/11/02: 780 mins. 20/11/02: 115 mins.

Search Method: Active search - rock rolling

Topography etc: Mid slope. Relatively steep south, south-west and west facing slopes.

Vegetation (dominant spp. and cover ranges): Dense overstorey, with many young trees (dbh range = 5-20cm). Dominated by Red Stringybark (*Eucalyptus macrorhyncha*) and Red Box (*E. polyanthemos*) with scattered Red Ironbark (*E. tricarpa*). OVC: Mean = 15% (range 10 -25%). Shrubs dense in rocky sites. Dominated by *Brachyloma daphnoides* with *Acacia pycnantha*, *Cassinia arcuata*, *Grevillea alpina*, *A. paradoxa* and several *A. baileyana* (Cootamundra Wattle). UVC: Mean = 15% (range 5 - 30%). Ground layer dense on rocky screes, predominantly *Stipa* spp. tussocks and *Dianella* spp. GLC: Mean = 25% (range 10 - 40%)

Rocks.

Number turned: 13/11/02: ? 20/11/02: 137

Sample size of rocks measured: 50

Notes: Scattered rock abundant in most areas, particularly in disturbed areas surrounding water channel. Many scattered rocks lying loosely on vegetation. Complex outcrops contain many embedded rocks.

Habitat notes: Area mixture of open sites around rocky outcrops graduating to relatively densely vegetated (overstorey) sites with Grey and Red Box dominating. Shrubs dense on rocky sites.

Species Found:

13/11/02: *Aprasia parapulchella* (1 + slough)

20/11/02: *Aprasia parapulchella* slough (probably PJ's slough).

Appendix 4 (cont.)

Site No: 21

Locality: West of Kairn's Rd, One Tree Hill

Date: 20/11/02

Time: 1555 - 1915

Observers: GH

Weather: Overcast, mild conditions with increasing south-westerly breeze.

Temperature: 22.9 C

GPS track no: 3

WPT range: 007 - 025

Coordinates: 260247 5924655

Search effort.

Time spent (person minutes): 200 mins.

Search Method: Active search - rock rolling

Topography etc: Moderately steep, NE facing slope with rock ridges running longitudinally along slope, creating 'step' like effect from base to peak of slope.

Vegetation (dominant spp. and cover ranges): Grey Box (*Eucalyptus microcarpa*) dominates at base of slope, but gives way to Red Box (*E. polyanthemos*) and Red Stringybark (*E. macrorhyncha*) in higher areas. OVC: Mean = 10% (range 5 - 25%). Shrub layer generally sparse and composed of *Brachyloma daphnoides* with *Cassinia arcuata*, *Acacia pycnantha*, some *Grevillea alpina* and *Hakea* spp. UVC: Mean = 5% (range 1 - 15%). Ground layer variable and highest on rocky ridges where leaf litter sparse. *Stipa* spp. co-dominate with *Carex* spp. (?). *Lomandra* spp. prominent on rocky ridges; some Rock Fern also noted in these localities. GVC: Mean = 25% (range 10 - 40%). Bryophytes common at ground level.

Rocks.

Number turned: 682

Sample size of rocks measured: 50

Notes: Scattered rocks away from outcrops generally small and resting loosely on vegetation. Large stone embedded into soil common within outcrops and apparently favoured by *Aprasia*. Rock collection probably extensive in past, as evident from rock fences on boundary of park at this site.

Habitat notes: Site relatively disturbed. Road and small homestead ruin at base of slope. Grazing appears heavy and rabbit numbers probably high.

Species Found:

Aprasia parapulchella (1 + 2 sloughs)

Lampropholis guichenoti (2)

Lerista bouganvillii (12)

Appendix 4 (cont.)**Site No: 22****Locality:** East off Pioneer Rd, One Tree Hill.**Date:** 28/11/02**Time:** 1045 - 1145**Observers:** GH**Weather:** Fine, clear skies (c. 5% cloud cover), moderate northerly breeze.

Temperature = 26.5°C.

GPS track no: 4**WPT range:** 031 - 044**Coordinates:** 260154 5923920**Search effort.****Time spent (person minutes):** 60 mins.**Search Method:** Active search (rock rolling)**Topography etc:** NW facing slope. Survey mainly restricted to NW aspect of rocky ridge running along the spine of the slope.**Vegetation (dominant spp. and cover ranges):** Lower north-west slope dominated by Red Ironbark (*Eucalyptus tricarpa*), with Red Stringybark (*E. macrorhyncha*) and Red Box (*E. polyanthemus*). Graduating to more open stand of *E. macrorhyncha* on higher slope. OVC: Mean = 15% (range = 10-20%). Shrub cover highest at base of slope; patchy away from rocky ridge. Shrub layer dominated by *Cassinia arcuata* with *Acacia acinacea*, *A. pycnantha*, *Grevillea alpina*, *Astroloma* spp. and *Brachyloma daphnoides* (latter dominates on rocky ridge). UVC: Mean = 20% (range = 5-30%) Groundlayer relatively open with scattered *Stipa* spp. tussocks, *Dianella* spp. and Paper Daisy (*Ozothamnus* spp.). GVC: Mean = 15% (range = 10-35%).**Rocks.****Number turned:** 570**Sample size of rocks measured:** 0**Notes:** Extensive rocky ridge (mud/sandstone) running along ridge of slope. Embedded rocks abundant at the base of ridge (effort concentrated here). Ridge relatively intact; however, old diggings present at top with much exposed shale.**Habitat notes:** Apparently fairly dry site with high leaf litter cover and little bryophyte cover, especially on higher slope. Nonetheless, habitat appeared suitable for *Aprasia*.**Species Found:***Lerista bouganvillii* (10)*Lampropholis guichenoti* (3)*Ctenotus robustus* (1)

Appendix 4 (cont.)**Site No: 23****Locality:** Wildflower Dr, NE block of Kennington/One Tree Hill.**Date:** 28/11/02**Time:** 1320 - 1445**Observers:** GH and PR**Weather:** Hot, relatively humid conditions as weak cold front passes over.

Temperature: 28.6 C

GPS track no: 5**WPT range:** 045 - 050**Coordinates:** 262414 5925239**Search effort.****Time spent (person minutes):** 170 mins.**Search Method:** Active search (rock rolling)**Topography etc:** Undulating terrain. Majority of survey conducted on SW facing slope. Very small, localised rocky ridges at the peak of shallow hills.**Vegetation (dominant species and cover ranges):** Vegetation divided into three main components.

1. Highly variable at all levels. North of Wildflower Dr, dominated by Red Ironbark (*Eucalyptus tricarpa*) (complete dominance on higher slopes). Understorey of *Cassinia arcuata*, *Acacia pycnantha*, *A. genistifolia*, *Brachyloma daphnoides*, *Allocasuarina* spp. and *Astroloma* spp. (at ground level).

2. South of road mixture of *E. tricarpa* and Yellow Gum (*E. leucoxyton*) with dense *Melaleuca lanceolata* understorey. Moving further south (up-hill) Red Box (*E. polyanthemos*) becomes dominant. On south side of slope, heath like vegetation dominates, primarily *B. daphnoides* with *Hakea* spp., *Persoonia* spp., *A. lanigera*, *A. genistifolia*, *Grevillea alpina*, *A. acinacea*. Dense ground layer of *Stipa* spp. and *Astroloma* spp., with *Osothemnos* spp. (Daisy). High cover of bryophytes indicates relatively moist location (this area looked most promising for *Aprasia*).

3. Moving down slope (further south), forms quickly into dense (re-growth) forest dominated by *E. polyanthemos* and *E. leucoxyton*, with high leaf litter cover and very little ground vegetation (dominated by *Astroloma* spp.). Understorey sparse (*A. pycnantha* and *C. arcuata*).

Cover ranges:

1. OVC: Mean = 15% (Range = 10-25%)
UVC: Mean = 5% (Range = 2.5-10%)
GVC: Mean = <5% (range = 1-5%)
2. OVC: Mean = <5% (Range = 1-5%)

UVC: Mean = 20% (Range = 10-30%)

GVC: Mean = 35% (Range = 25-45%)

3. OVC: Mean = 25% (Range 15-35%)

UVC: Mean = 5%

GVC: Mean = 5%

Rocks.

Number turned: 1249

Sample size of rocks measured: 0

Notes: Rocks predominantly conglomerate sandstone (sandstone with some quartz included). Rocky outcrops small (<15 m²) and restricted to hill crests. Most rocks turned small (c. mean = 10 cm²) and sitting loosely on ground litter.

Habitat notes: Site highly variable in vegetation characteristics, indicating relatively high variation in moisture levels across the site. Majority of site displayed high litter cover and thus little structural complexity at ground level.

Species Found:

Lampropholis guichenoti (3)

Amphibolurus muricatus (2)

Appendix 5. Herpetofauna recorded at each site surveyed for the Pink-tailed Worm-Lizard (*Aprasia parapulchella*) in the Bendigo region, Spring 2001 to Spring 2002.

	Site number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15*	16	17	18	19	20	21	22	23	Total sites recorded	
Total person minutes		380	102	195	304	88	128	223	230	246	360	280	325	300	465	300	450	325	135	826	895	200	60	170		
Total rocks turned		1085	245	1317	1878	757	645	905	982	1600	960	798	976	1000	566	1199	500	1302	806	?	?	683	570	1249		
COMMON NAME	SCIENTIFIC NAME																									
Gekkonidae																										
Marbled Gecko	<i>Christinus marmoratus</i>	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	2	
Thick-tailed Gecko	<i>Nephrurus milii</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	
Pygopodidae																										
Pink-tailed Worm-Lizard	<i>Aprasia parapulchella</i>	3	-	2	-	-	-	-	-	-	2	-	-	-	7	4	1	-	-	2	2	3	-	-	9	
Agamidae																										
Tree Dragon	<i>Amphibolurus muricatus</i>	-	-	-	-	-	1	-	-	1	1	-	3	1	-	-	-	-	-	-	-	-	-	2	6	
Scincidae																										
Large Striped Skink	<i>Ctenotus robustus</i>	2	-	-	-	-	-	2	3	-	3	1	1	-	1	-	-	-	-	-	-	-	1	-	8	
White's Skink	<i>Egernia whitii</i>	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
Garden Skink	<i>Lampropholis guichenoti</i>	4	-	2	2	-	1	-	5	5	-	-	1	1	-	3	-	3	-	-	-	2	3	3	13	
Bougainville's Skink	<i>Lerista bougainvillii</i>	35	1	4	31	5	19	16	14	31	18	7	4	4	9	17	7	25	9	-	-	12	10	-	20	
Stumpy-tailed Lizard	<i>Tiliqua rugosa</i>	-	-	-	1	-	-	-	2	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	3	
Typhlopidae																										
Gray's Blind Snake	<i>Ramphotyphlops nigrescens</i>	1	-	-	-	-	-	2	-	-	2	-	-	-	1	-	1	-	-	-	-	-	-	-	5	
Blind Snake sp.	<i>Ramphotyphlops</i> sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	
Elapidae																										
Eastern Brown-snake	<i>Pseudonaja textilis</i>	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
Little Whip Snake	<i>Suta flagellum</i>	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
Species diversity		5	1	3	3	1	3	5	4	4	6	2	4	3	4	3	3	4	1	3	1	3	3	2		

* Site 15 was examined twice during the survey period (7/11/01, 28/11/02). Records provided are combined results from the two survey periods (see Appendix 4).

Appendix 6. Details of Pink-tailed Worm-Lizard (*Aprasia parapulchella*) recorded in the Bendigo region, 2001 to 2002.

Site	Date	Time	UTM coordinates AGD66		WPT no.	Aspect	Slope	Weather					Microhabitat	Invertebrates	Habitat description										Aprasia measurements and notes									
			easting	northing				UR/S, UR/R, UR/V, G, UT, UV, UL	rock size (mm)	small ant galleries (<4mm)	Large ants	scorpion			termites	percentage projective cover	Rocks	Habitat notes	weight (g)	S-V (mm)	tail original	tail regen	sex	Comments / Activity										
						U/M/L	U/M/L	temp. °C	sun Y/N	cloud Y/N	rain Y/N	wind dir	UR/S, UR/R, UR/V, G, UT, UV, UL	rock size (mm)	L X thick	small ant galleries (<4mm)	Large ants	scorpion	termites	canopy spp.	tree	shrub	grs/hrb	rock	litter	b grnd	None, Single, Scattered, SOutcrop(<30), LOutcrop(>30+> 1sqm)	Habitat notes	weight (g)	S-V (mm)	tail original	tail regen	sex	Comments / Activity
0	16-Oct-01	18:00	258317	5924153		N	U/M/L				N		UR/S	290*6			*			RI	15	30	15	5	15	20	SC	Ridge, diverse shrubs & ground layer	2.4	143	96		F	Sheltering
1	17-Oct-01	11:55	257706	5921980	24	NE	M	23	Y	Y	N	W	UR/S	115*50		*			RS, RB	5	20	30	15	25	25	SO	Small low ridge, diverse shrub layer	1.6	117	84		M	Sheltering; ant gallery no active	
1	17-Oct-01	12:00	257708	5921982	25	NE	M	23	Y	Y	N	W	UR/V	110*60					RS, RB	5	20	30	15	25	25	SO	Small low ridge, diverse shrub layer	0.2	53	32		J	1m from previous specimen	
1	17-Oct-01	12:02	257709	5921981	26	NE	M	23	Y	Y	N	W	UR/S	80*50		*			RS, RB	5	20	30	15	25	25	SO	Small low ridge, diverse shrub layer						Retreated to gallery	
3	18-Oct-01	11:10	275206	5931452	2	NW	L-M	24	Y	Y	N	W	UR/S	105*50					GB, RS	10	40	<5	5	30	40	SC	Close to large outcrop (c. 15m)	1.3	104	75		M	Sheltering	
3	18-Oct-01	11:15	275198	5931444	3	NE	L-M	24	Y	Y	N	W	UR/S	105*40		*			GB, RS	10	35	<5	20	25	40	SO	On the verge of large outcrop.						Went down gallery; old slough in same hole.	
3	18-Oct-01	11:37	275206	5931423	6	NW	M	23	Y	Y	N	W	UR/S	200*45		*			RS	15	5	35	40	40	10	LO	Open rocky site.						Slough only	
10	6-Nov-01	16:32	261644	5921716	42	NE	M	17.3	N	Y	N	S	UR/S	210*60		*			RS, RB	15	5	10	35	25	35	SO	Bare patch with many surface rocks	1.9	127	66	8	M	Sheltering	
10	6-Nov-01	16:50	261637	5921726	47	NE	M	17.3	N	Y	N	S	UR/S	160*30					RS, RB	15	5	10	35	25	35	SO	Small surface rock						Slough only	
10	6-Nov-01	17:00	261638	5921728	48	NE	M	17.3	N	Y	N	S	UR/S	380*110					RS, RB	20	10	40	25	30	30	SO	Large rock surrounded by tussocks							
14	7-Nov-01	12:35	260058	5923149	13	NE	U	24.0	Y	N	N	E	UR/V	310*30					RB	15	35	20	10	25	30	SC	Heathy shrub land	2.1	131	91		F	Coiled amongst compressed grass under rock	
14	7-Nov-01	12:40	260056	5923135	14	NE	U	23.0	Y	N	N	E	UR/V	140*30					RB, RS	5	15	20	15	20	35	SC	Open site, next to excavations	0.3	72	45		J	Sheltering; warm and quick once disturbed.	
14	7-Nov-01	12:45	260046	5923169	18	NE	U	23.0	Y	N	N	E	UR/V	?					RB, RS	10	20	15	35	25	35	SC	On rock pile.						Sharing shelter site with specimen below.	
14	7-Nov-01	12:45	260046	5923169	18	NE	U	23.0	Y	N	N	E	UR/V	?					RB, RS	10	20	15	35	25	35	SC	On rock pile.						Sharing shelter site with previous specimen.	
14	7-Nov-01	12:50	260043	5923171	19	NE	U	23.0	Y	N	N	E	UR/V	150*10					RB, RS	10	20	15	35	25	35	SC	1.5m from previous, not on rock pile						Juvenile specimen; escaped from Diane.	
14	7-Nov-01	13:30	260038	5923185	22	SW	U	22.0	Y	N	N	E	UR/S	210*70		*			RB, RS	5	30	30	30	10	20	SO	Small reef; open canopy	1.8	119	61	9	M	Hill top with no real aspect.	
14	7-Nov-01	13:40	260072	5923069	23	SW	U	22.0	Y	N	N	E	UR/S	170*50		*			RB, RS	5	10	25	15	30	30	SO	Edge of slope; rock in full sun.	1.2	108	74		F	Sheltering	
15	7-Nov-01	12:30	261605	5923054	67	W	U	24.0	Y	N	N	SW	UR/S	120*30		*			RS, RB, GB	10	25	15	15	25	20	SO	Went down Sugar Ant gallery						Not caught; went down gallery	
15	28-Nov	17:30	261605	5923063	51	W	U	?	NA	NA	NA	NA	UR/S	16*5					RB, RS	15	15	5	15	10	25	SC	Open slope, high moss cover						Slough only	
15	28-Nov	17:30	261617	5923105	52	W	U	?	Y	Y	N	SW	UR/S	15*4		*			RB, RS	5	30	10	<5	35	25	S	High Brachyloma cover with mosses	2.8	134	99		F	Gravid - two distinct eggs. Body width at eggs = 5mm (2cm anterior of vent)	
15	28-Nov	17:30	261637	5923063	53	W	U	?	Y	Y	N	SW	UR/S	45*12		*	*		RB, RS	5	30	5	10	35	15	SO	Slightly dryer, moderate rock cover	2.1	29	95		F	Gravid - two distinct eggs visible. Body width at eggs = 4mm (1cm anterior of vent).	
16	7-Nov-01	13:00	261554	5923861		SW	U		Y	Y	N	S	?	250*150			*		RI, RS, RB	40	10	80	75	20	5	SC	Dry heathy, open forest.	4	150	16	18	F	With termites; On top of knoll facing SW but almost flat.	
19	13-Nov-02	c. 1330	258987	5923535	4	W	L	?	?	?	?	?	UR/S	?					RS, RB, GB	<5	5	15	50	15	20	LO	Rock scree at base of steep slope	?	?	??	?	?	Specimen recorded by PJ	
19	13-Nov-02	c. 1345	259027	5923609	5	NNW	M	?	?	?	?	?	G/V						RS, RB, GB	25	<5	10	30	60	5	LO	V. steep incline, specimen amongst complex outcrop	?	?	??	?	?	Specimen recorded by PJ	
20	13-Nov-02	c. 1100	259405	5924332	1	SW	M	?	?	?	?	?	UR/V	23.5*5.5					RB, RS	5	20	35	30	40	10	SO	Structurally diverse scree slope	NA	NA	NA	NA	NA	PJ record, slough only	
20	13-Nov-02	c. 1100	259263	5924473	2	SSW	L	?	?	?	?	?	UR/S	38.5*9		*			RB, RS	10	5	10	40	10	45	SC	Disturbed channel bank	?	?	??	?	?	PJ record	
21	20-Nov-02	1609	260220	5924683	10	NE	M	21.8	Y	Y	N	SW	UR/S	43*16		*	*		RB, RS	5	<5	20	35	35	20	SO	Open, mudstone ridge						Slough only	
21	20-Nov-02	1630	260218	5924687	12	NE	M	23.1	N	Y	N	SW	UR/S	34*10		*			RB, RS	<5	<5	5	30	50	15	SO	Open, mudstone ridge - grazing evident.	2.7	14.1	9.4	0	F	Abdomen extended above vent - gravid?	
21	20-Nov-02	1809	260115	5924708	22	NE	M	18.9	N	Y	N	SW	UR/S	29*11		*			RB, RS	5	<5	20	20	30	30	SO	Rocky ridge on steep slope						Slough only	

Appendix 7. Summary of surveys undertaken for the Pink-tailed Worm-Lizard (*Aprasia parapulchella*) in the Bendigo and Heathcote areas, 2003.
(Reproduced from Robertson & Heard, 2004)

Locations of all sites examined during the 2003 survey, between 18th November and 3rd December, with approximate coordinates of the start of each traverse.

Site No.	Locality	Aust. Map Grid (AGD66)		Date	Time
		Easting	Northing		
1	Mt Ida, SE slope near summit	295799	5915828	18/11/2003	10.00 - 11.15
2	Mt Ida, NE of summit	295856	5916244	18/11/2003	11.45 - 13.00
3	Mt Ida	295803	5917519	18/11/2003	14.15 - 15.45
4	Viewing Rock, Mclvor Range	295798	5917534	21/11/2003	09.30 - 11.00
5	Mclvor Range	297494	5911294	21/11/2003	09 15 - 10.55
6	Mclvor Range	297013	5911074	21/11/2003	11.25 - 12.50
7	Mclvor Range	297247	5911053	21/11/2003	11.45 - 13.00
8	Mclvor Range	297507	5910888	21/11/2003	13.45 - 15.05
9	Mclvor Range	297502	5910875	21/11/2003	13.45 - 15.15
10	Jn. Pioneer Track & Guys Hill Track, One Tree Hill NP	261919	5923702	1/12/2003	08.45 - 12.10
11	Osborne Lane extension, One Tree Hill NP	261824	5923980	1/12/2003	13.10 - 14.00
12	Pannell's track, Mclvor Range	298195	5909974	3/12/2003	08.35 - 09.30
13	Hyland Track, Mclvor Range	297560	5911956	3/12/2003	09.55 - 10.35
14	Spring Plains NCR	299089	5905426	3/12/2003	11.00 - 12.00
15	Granites, Little Crosbie NCR	290611	5925848	3/12/2003	13.35 - 14.05

Survey effort employed at all sites examined during the survey of November and December 2003.

Site No.	Survey Effort		
	No. Observers	Time (person min)	No. Rocks
1	5	315	2800
2	5	315	3000
3	5	450	2500
4	6	540	2300
5	5	500	2514
6	5	425	1848
7	5	375	2817
8	5	400	2494
9	5	450	2000
10	8	1640	6304
11	8	400	293
12	5	275	1600
13	5	200	1600
14	5	300	1494
15	5	150	705

Details of all Pink-tailed Worm-Lizard (*Aprasia parapulchella*) located during the 2003 survey. Two individuals observed at site 10 (see above) on 1st December.

Date	Time	Site No.	UTM coord.		Topography		Weather					Microhabitat		Habitat description										Temps.		Inverts.					Aprasia measurements and notes									
			AGD66		Aspect	Slope	Slope (degrees)	shaded air temp.	sun	cloud	rain	wind strength	wind direction	UR/S UR/R UR/V G UT UV UL	rock size (cm)	canopy spp.	percentage projective cover (5m X 5m)										Rocks	ground	under shelter site	small ants/galleries (<4mm)	large ants/galleries	scorpion	termites	weight	S-V	tail original	tail regen	sex	Comments / Activity	
			easting	northing													U/M/L	°C	Y/N	0-8	Y/N	0-3	L X thick	RI	RB	RS														etc
1-Dec-03	9:58	10	261726	5922865	N	U		23	Y	2	N	1	E	UR/G	26 X 8	RS, RB, LLB	5	1	1	10	5	5	25	<1	40	20	SO	25							1.4	114	80	orig.	M	Coiled under rock
1-Dec-03	10:56	10	261758	5923194	NE	U		26	Y	2	N	1	E	UR/G	170 X 80	RS	5	5	10	10	5	10	15	<1	30	15	SO	29	a	g										Went down ant hole

Appendix 8. Summary of surveys undertaken for the Pink-tailed Worm-Lizard (*Aprasia parapulchella*) in the Harcourt area, October 2003.
(Reproduced from Robertson & Heard, 2003)

Summary of surveys for the Pink-tailed Worm-Lizard in the Harcourt area, October 2003.

Site	Date	Survey effort (rocks turned)	Comments
1	25/10/03	449 (other debris=78)	Good quality vegetation, few rocks. Moderate-low habitat potential for <i>Aprasia</i>
2	25/10/03	1209 (logs=93) (other debris=43)	Moderate but variable quality vegetation. Moderate habitat potential for <i>Aprasia</i>
3	25/10/03	Nil	Low-nil habitat potential for <i>Aprasia</i>
4	26/10/03	2355 (logs=28)	Moderate but variable quality vegetation. Moderate-low habitat potential for <i>Aprasia</i>
5	26/10/03	840 (logs=25) (other debris=11)	Moderate-low quality vegetation. Low habitat potential for <i>Aprasia</i>
6	26/10/03	1060 (logs=10)	Low quality vegetation. Low habitat potential for <i>Aprasia</i>
7	26/10/03	Nil	Low-nil habitat potential for <i>Aprasia</i>
8	30/10/03	2280	Moderate but variable quality vegetation. Moderate-low habitat potential for <i>Aprasia</i>
9	30/10/03	1367	Moderate-low quality vegetation. Moderate-low habitat potential for <i>Aprasia</i>

Approximate locations of the seven sites surveyed in the Harcourt area, October 2003.
Pink circles indicate centres of sites – survey at each extended beyond limits of circle.

