UNIVERSITY OF CANBERRA
Institute for Applied Ecology
Ecological Solutions for a Healthy Environment

The extent of habitat for the vulnerable Pink-tailed Worm Lizard (*Aprasia parapulchella*) in the West Belconnen – Ginninderra Creek investigation area - confirmatory distribution surveys and mapping

Photo: D. Wong

Report commissioned by:

The Riverview Group Pty Ltd
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Report Summary

This report presents the results of an assessment of the extent of habitat for the Vulnerable Pink-tailed Worm-lizard (*Aprasia parapulchella*) within the West Belconnen – Ginninderra Creek investigation area to the west of Canberra in the ACT and NSW. GIS based mapping of potential habitat was undertaken using a combination of aerial photography and on-ground mapping. All mapped units were examined and checked during fieldwork conducted throughout the investigation area and given a ranking of either Suitable Habitat (moderate and high quality habitat combined as a mapping unit) or Low Quality Habitat (highly disturbed and degraded habitat that is likely to no longer likely to support the species). On-ground surveys were then undertaken to confirm the extent of occupation by Pink-tailed Worm-lizards in patches that were selected to represent the potential range of the species within the study area. The report includes geographic information on the locations where specimens were found in the present surveys, as well as during previous surveys conducted by Kevin Mills and associates.

Potential habitat for Pink-tailed Worm-lizards was found to the far western sector of the investigation area where it occurs along the ridges and slopes associated with the Murrumbidgee River. The most extensive areas of habitat were found to occur in the ACT, mostly within the Murrumbidgee River Corridor (Woodstock Nature Reserve). A broad belt of potential habitat, up to one kilometre in width in places, was found to extend largely unbroken from Stockdill Drive in the ACT northwards to about one kilometer north of the ACT Border (the southern boundary of the Armitage and Shaw property). To the north of this location potential habitat was found to be uncommon, being confined to a series of small discrete patches that occur through to the northern limit of the study area near Ginininderra Falls. Habitat within the study area was found to vary considerably in quality, but most was in good condition (a good cover of native grasses, and at least some presence of plants that are indicator species). However some grazing susceptible species appear to have declined in the area from former land-clearing, grazing and pasture improvement. Unfortunately weeds present a problem in many areas of potential habitat. Of most concern are African Lovegrass and St Johns Wort and Blackberry.

Fifty-one adult Pink-tailed Worm-lizards and three juvenile lizards were found at 45 sites that supported the species. In the north of the study area, occupied habitat was not found in the pasture-improved landscapes to the east of Ginninderra Falls. However, several very small and quite isolated patches of habitat in the central part of the study area were found to still support specimens. Some of these patches were a considerable distance into the pasture-improved paddocks and indicate the capacity for the species to survive under these conditions.

The study area provides an extremely important area of habitat for the Pink-tailed Worm-lizard. It supports a very large regional population that is of national significance in terms of ACT and Commonwealth Government legislation. The extensive habitat found along the Murrumbidgee River Corridor, including the more isolated patches that form “stepping stones” through the landscape in NSW, provide a link with the rugged, rocky woodlands near Ginninderra Falls (Hyles property). To the north of Ginninderra Creek there is a potential link through private properties to the few poorly known sites that have been found north of this area near the Murrumbidgee River. To the south, the large population in the Murrumbidgee Corridor links directly with the regionally important populations along the Molonglo River in the ACT. Stockdill Drive and the infrastructure associated with the Lower Molonglo Water Quality Control Centre (at the south-western edge of the study area) provide a partial barrier to the species dispersal to the south of the study area. However, there is still a linkage through

the landscape to the west of the LMWQCC.

A continuation of controlled levels of livestock grazing will be required to prevent these modified native grasslands from becoming rank and overgrown and no longer suitable for the species. Any pasture improvement should be discontinued in PTWL habitat and in surrounding buffer areas. During any property development, the protection of potential habitat will be an issue that should be considered, including the need to establish a managed buffer zone 20 metres in width around the outer edge of the habitat (as prescribed by the Commonwealth Government).

Introduction

The Pink-tailed Worm Lizard (or Granite Worm Lizard) (*Aprasia parapulchella*) (Figures 1 - 3) is listed as a vulnerable species in the ACT (*Nature Conservation Act 1980*), NSW (*Threatened Species Conservation Act 1995*) and nationally (*Environment Protection and Biodiversity Conservation Act 1999*). The ACT region is considered to be the main stronghold for the species, although in recent years new populations have been found in NSW (e.g. near Cooma, Bathurst and Albury) and at Bendigo in Victoria (Wong *et al.* 2011). Sites occupied by Pink-tailed Worm-lizards typically support a rich reptile fauna suggesting that the protection of well-buffered landscapes containing the species is likely to benefit an entire reptile community (Osborne and Jones 1995). Any development of land where the species occurs also requires consideration of national legislation for the protection of threatened species (Osborne 2009). Osborne (2007) presents a set of principles for guiding urban development with respect to this species.

Knowledge of the distribution of threatened species is essential for undertaking well-informed land development. Considerable effort has been put into broad scale surveys for the Pink-tailed Worm-lizard in the ACT (Osborne *et al.* 1991; Barrer 1992; Osborne and McKergow 1993; Rauhala 1993; Rauhala 1995; NPWS 1999; Osborne and Coghlan 2004; Wong and Osborne 2010; Osborne and Wong 2010). These surveys indicate that the species has a patchy distribution along the slopes of the Molonglo and Murrumbidgee River corridors and on some adjacent outlying hills such as Mt Taylor, Cooleman Ridge, Urambi Hills and The Pinnacle in the ACT, and in the Googong-Tralee region of NSW south of Queanbeyan (Figure 1). Despite these surveys, mapping of the distribution and extent of habitat of the species remains quite limited, with some areas, such as the Molonglo River Corridor and parts of Canberra Nature Park, being subject to more intensive survey than others (e.g. Murrumbidgee River Corridor and leased farm land).

Plate 1. A Pink-tailed Worm-lizard *Aprasia parapulchella*. Photo: W. Osborne.

Plate 2. A small rock has been lifted to reveal a Pink-tailed Worm-lizard and a network of ant burrows. The lizards shelter in the burrows and feed on the brood of a number of small ant species. Photo: D. Wong

Plate 3. A sloughed skin of the Pink-tailed Worm-lizard found under a rock. Photo: D. Wong

A large, regionally important population of Pink-tailed Worm-lizards occurs in the Lower Molonglo Valley (Figure 1) (Barrer 1992; Osborne and Coghlan 2004), an area now subject to urban development as set out in the Molonglo and North Weston Structure Plan (ACT Legislation Register 2008). The species has also been recorded at a number of locations near the Murrumbidgee River including near the Lower Molonglo Water Quality Control Centre (Wong *et al.* 2011). In considering the present study area which lies entirely to the to the

north and east of the treatment plant, there are scattered records of the species from near Stockdill Drive northwards to nearby parts of NSW (Kevin Mills and Associates 2009a,b; Osborne and Wong 2010 b; Osborne and Coghlan 2004; Osborne *et al.* 1991) (Figure 1). Specific searches for specimens have been quite limited in this area and the species is likely to be quite widespread in rocky areas that have not been pasture improved.

The present assessment of potential habitat in West Belconnen – Ginninderra Creek provides the first detailed mapping of habitat in the entire study area. It follows on from more generalised mapping that shows the occurrence of rocky terrain (Kevin Mills and Associates 2009a,b) and from specific mapping of Pink-tailed Worm-lizard habitat on parts of the "Strathnairn" and "Parkwood" properties for the ACT Planning and Land Authority (Osborne and Wong 2010b).

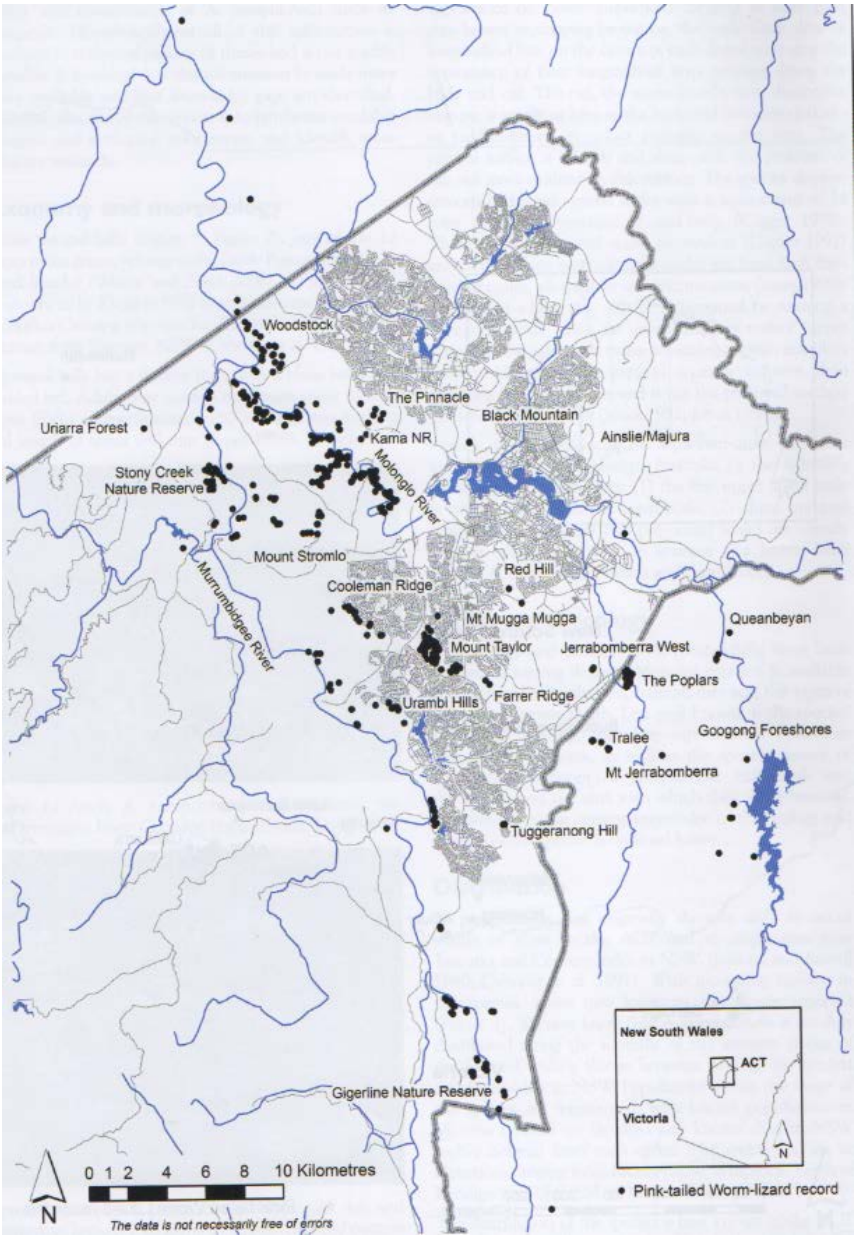

Figure 1. Distribution of the Pink-tailed Worm-lizard *Aprasia parapulchella* in the ACT (From Wong *et al.* 2011). Black dots represent confirmed records of occurrence. Note the close proximity of the West Belconnen population with the extensive population along the Molonglo River Corridor.

Purpose of the study

This study was established as one component of a series of investigations into the flora and fauna of the West Belconnen – Ginninderra Creek area undertaken for the Riverview Group. The study includes mapping of all areas of potential habitat for Pink-tailed Worm-lizards in the investigation area and specific surveys (hand searches) to confirm the general extent of their occupancy throughout the mapped areas. These findings are discussed in terms of regional conservation requirements and wildlife corridors.

Study Area

The West Belconnen – Ginninderra Creek study area is located north of Stockdill Drive and the Lower Molonglo Water Quality Control centre between the western edge of Canberra and the Murrumbidgee River and extends northwards to Ginninderra Creek in NSW (Figure 2). The study area is approximately 5 km in its north-south extent and between 2.5 and 5 km in width and comprises an area of approximately 1700 ha. It includes the entire east bank of the Murrumbidgee River Corridor in the ACT north of the Lower Molonglo Water Quality Treatment Plant, parts of the "Strathnairn" and "Parkwood" rural leases in the ACT and other Riverview Group properties in NSW, as well as several smaller private properties in the north-west portion of the area (Armitage and Shaw, Flemming and Moore, Hyles and Scibberas. Nominal land tenure Areas for the study area (here after referred to as 'Areas') were provided by the Riverview Group (Figure 3).

The main features of the central and eastern portion of the study area are the gently undulating tableland topography, lack of rocky terrain and open farmland that has been pasture improved. By contrast, steep, rocky slopes leading down to the Murrumbidgee River dominate the western portion. Parts of the study area include a rocky gorge-like environment (e.g. near Ginninderra Falls). The entire study area is underlain by late Silurian volcanic geology (Finlayson 2008). In the ACT region the occurrence of Pink-tailed Worm Lizards is thought to be strongly associated with late Silurian volcanic geology types such as those that occurring in the study area (Osborne *et al*. 1991; Osborne and McKergow 1993; Wong et al. 2011). Most of the study area has been cleared of tree cover and converted to improved pastures, but in the more steeply dissected country the ground cover is dominated by native grasses and forbs. Further information on the flora and fauna is provided in reports by Kevin Mills and Associates (2009a,b) and a detailed description of the riparian areas is available in a technical report prepared by the ACT Government (Johnston *et al*. 2009).
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Most of the central, eastern and north-eastern parts of the study area have been highly disturbed by former land clearing and pasture improvement (Plate 7). There are, however, small patches of potential habitat associated with rocky areas that still support a higher content of native plant species. Some of these patches still support Pink-tailed Worm-lizards (Kevin Mills and associates 2009a,b) and were included in surveys in the present study.

Figure 2. Location of the West Belconnen – Ginninderra Creek investigation area. It includes lands in the ACT north of Stockdill Drive between the western suburbs of Belconnen and the Murrumbidgee River and contiguous land in NSW as far north as Ginninderra Creek.

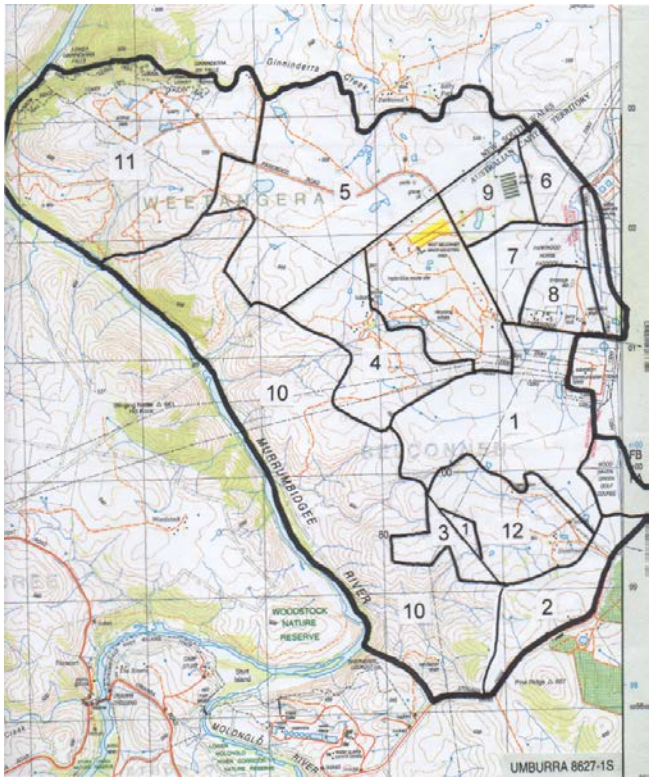

Figure 3. Land tenure designation provided by the Riverview Group (boundaries are approximate). Note that Area 10 is designated as river corridor and includes land in the ACT and NSW. Area 2 is designated "hills, ridges and buffers" in the ACT Government Territory Plan. Industrial land in West Belconnen is not in the investigation area.

Plate 5. The rocky hill slopes within and near the Murrumbidgee River Corridor provide extensive areas of potential habitat for the Pink-tailed Worm-lizard. Photo: W. Osborne

Plate 6. The northern end of the Murrumbidgee River Corridor photographed from the ACT in Area 10. The Pink-tailed Worm-lizard habitat continues as a series of smaller patches ("stepping stones") though this landscape.

Plate 7. View across the central part of the study area north of "Strathnairn". There is very little suitable Pink-tailed Worm-lizard habitat in this rolling agricultural landscape. Photo: W. Osborne

Figure 8. Some small patches of potential habitat that occur in paddocks that are pasture improved still support a native ground cover within the rocky areas. These patches may still be suitable for Pink-tailed Worm Lizards and were checked during the present study. Photo: W. Osborne

Methods

Mapping of potential habitat

Potential habitat has not been previously mapped in most of the study area. The extent and accuracy of any existing mapping in West Belconnen (Osborne and Wong 2010b) was checked in the field and all polygons were then remapped more accurately with newer photography (see below).

High-resolution orthophotographs (ACTPLA 2009) were used to identify potential Pink-tailed Worm-lizard habitat throughout most of the study area. The orthophotographs had a resolution of 10cm (10cm pixel size). Rocky areas (low outcroppings of rocks, scattered boulders and other surface rock debris) were mapped from aerial photographs using heads-up (on screen) digitising in ArcGIS. All possible habitat patches identified from orthophotographs were checked in the field and the habitat classed as Potentially Suitable (high quality or moderate quality after Osborne and Wong 2010) or of Low Quality potential habitat unlikely to be occupied by the species. Any areas not detected in the aerial photograph interpretation within the study area were examined during fieldwork and mapped with a GPS.

Because of the large size of the study area it was not possible to delineate high and moderate quality habitat as separate map units because habitat condition was found to vary considerably with high quality (least disturbed) habitat being highly fragmented and scattered as very small patches through broader landscapes dominated mainly by moderate quality habitat. The criteria for classification into the two habitat classes are described below.

Habitat Classification

Based on previous findings in the ACT (Jones 1999, Osborne *et al.* 1991, Osborne and Wong 2010a,b; Wong and Osborne 2010) it was considered that well-drained sites with a cover of partially embedded rocks of igneous or metamorphic origin (e.g. rhyodacite, rhyolite, quartz) would provide suitable habitat for the species. The specific rock types are listed in Osborne *et al.* (1991) but a common feature of the sites is that they contain numerous scattered surface rocks which are well-weathered and partially embedded in the soil and grass. The lizards are commonly found beneath rocks that range from about 10 to 30 cm in diameter.

In terms of vegetation, potential habitat in the ACT is usually characterised by an absence or low cover of trees (e.g. a lack of forest cover) and by a cover of predominantly native grasses, particularly kangaroo grass (*Themeda triandra*), red-leg grass (*Bothriochloa macra*) and mat-rush (*Lomandra filiformis*), purple wire grass (*Aristida ramosa*) and barbed wire grass *Cymbopogon refractus* (Osborne *et al.* 1991; Jones 1992, 1999). The likelihood of the occurrence of the lizards is increased with an increasing cover of these species. By contrast, increases in the occurrence of spear grasses (*Austrostipa scabra*, *Austrostipa bigeniculata*) and river tussock (*Poa labillardieri*) decrease the likelihood of finding the species. Jones (1999) also found that some disturbed sites dominated by exotic pasture species such as oats (*Avena barbata*), squirrel tail grass (*Vulpia bromoides*), flatweed (*Hypocheirus radicata*), soft brome (*Bromus hordaceous*), delicate hairgrass (*Aira elegantissima*), haresfoot clover (*Trifolium arvense*), and the native species *Bothriochloa macra* (red-leg grass) supported at least some individuals. We have also found this to be the case at the many sites that we have surveyed (D. Wong unpublished data).

The highest quality sites are considered to be those dominated by kangaroo grass (*Themeda*

triandra) – however this feature may simply mean that these are the least disturbed sites since *Themeda* is sensitive to intensive livestock grazing and pasture improvement. We have found the abundance of the lizards to be equally high in both high and moderate quality habitat (Wong *et al.* 2011) and as explained above these two categories were grouped together for the present survey. Pink-tailed Worm-lizards are generally not found in areas that have been heavily modified or pasture improved to the extent that all native species have been eliminated from the ground layer (Osborne and McKergow 1993; Jones 1999).

The results of these earlier studies guided our approach to the classification of the habitat into the following two classes based on suitability.

1. Potential habitat
Suitable rocky areas generally dominated by, or with a large component of, kangaroo grass *(Themeda triandra)* and also often containing *Aristida ramosa*, *Cymbopogon refractus*, *Poa sieberiana* and/or *Austrodanthonia* spp., a range of native forbs species and graminoides such as *Lomandra* spp. or; suitable rocky areas not dominated by kangaroo grass but containing a number of disturbance sensitive species of forbs and graminoides. Exotic annual species such as hares foot clover *(Trifolium arevense)* and *Vulpia* spp. may also be present. Or suitable rocky areas that have a less diverse ground cover usually dominated by spear grasses (*Austrostipa* spp.) and wallaby grasses (*Austrodanthonia* spp.). Native forb species and exotic annual species such as haresfoot clover (*Trifolium arvense*), wild oats (*Avena* sp.), and saffron thistle (*Carthamus lanatus*) may also be present but in reduced abundance when compared to higher quality habitat.

3. Low quality potential habitat – Suitable rocky areas that have been subject to high levels of disturbance in the recent past. The sites are likely to have high levels of disturbance to the soil layer (erosion, compaction and particularly nitrification) and any vegetation present will be dominated by sown pasture grasses, other agronomic species and weeds; includes former sheep camps that no longer support native ground cover.

The entire study area was examined on foot. Potential habitat was mapped directly onto aerial photographs, and was mapped as one of the two categories of habitat quality described above. Areas of forest were not included in the survey. Habitat areas were mapped if they were larger than 25 m^2. In areas where there were many small patches of habitat in close proximity these were mapped as one area of habitat. Single rocks, deeply embedded boulders and solid rock outcropping (including cliffs) as well as areas with only a few scattered loose surface stones (dislodged by some form of disturbance) were not considered to provide potential habitat, and were not mapped, unless they occurred within broader areas of suitable habitat.

Serious infestations of weeds were recorded on maps during fieldwork. Potential habitat that was highly invaded with weeds (e.g. smothered with blackberry or completely over grown with exotic grasses) was given a ranking of Low Quality.

Determining current distribution in the study area

Previous records of Pink-tailed Worm Lizards in the ACT were obtained from the wildlife atlas records of the ACT and NSW governments and from data listed in Osborne and Coghlan (2004) and Kevin Mills and Associates (2009a,b). These records are reliable and were added to the GIS database for mapping purposes. We also conducted hand searches for the species at 54 sites within the study area (see below).

Field survey techniques followed Osborne and McKergow (1993). Survey sites were chosen authoritatively by reference to maps of potential habitat that we prepared and by direct visual inspection in the field. An attempt was made to search all parts of the study area (all mapped polygons). For purposes of efficiency, we generally avoided sampling specific sites previously surveyed by Kevin Mills and associates (2009a,b) if positive records of the species had been made at these sites. Some negative sites surveyed by Mills were resurveyed in this study because the habitat looked suitable. Hand searching for specimens was conducted during suitable weather in areas of mapped habitat and in other potential habitat encountered during fieldwork conducted from late August to early December 2011. Sites to be surveyed comprised patches of stone-covered ground (for example part of a hillside or series of adjacent rock outcrops that were closer than 20 metres).

Because the species was found to be comparatively easy to detect when compared to some other locations in the region (Osborne and McKergow 1993; Osborne and Wong unpublished data) a minimum of 500 stones was considered to be adequate for confirming occurrence at large sites (based on averages for detection presented in Jones 1999). Searches for specimens were made by carefully turning stones over and then placing them back into position. As required by the animal ethics permit, specimens were generally left *in situ* and not handled unless they had fallen out of their burrows. We attempted to search beneath at least 500 stones at each site if specimens were not found. For some plots, it was not possible to do this because of a shortage of surface rock. Density of lizards at single sites was not estimated - instead search effort was put into confirmatory detection (presence only) across a very large study area. Each site was surveyed until a specimen was found, or in the case of non-detection, until 500 stones were turned (when possible).

Results

Extent of potential habitat

Much of the central and eastern portion of the West Molonglo – Ginninderra Creek investigation area was found to be dominated by exotic vegetation (improved pasture) and lacks surface rock (Areas 5, 6,7,8 and 9). These areas therefore are not suitable for the Pink-tailed Worm-lizard and have not been mapped as potential habitat. Some small patches with native ground cover still persist in Areas 1, 3, 4 and 12 and these were included on the maps (Figure 4). By contrast, the western third of the investigation area, although substantially cleared of its former tree cover, is dominated by native vegetation including grassland and some woodland (See Kevin Mill and associates 2009a,b for more information). Derived native pasture (i.e. cleared of original tree and shrub cover) is very widespread in the study area and some diverse natural grassland patches are also present near the Murrumbidgee River and at several locations within the fenced off banks of Ginninderra Creek. It is this derived and naturally occurring native grassland in rocky areas of volcanic origin that comprises potential habitat for Pink-tailed Worm-lizards (Wong *et al.* 2011). The full extent of potential habitat in the investigation area is shown on the map of potential habitat (Figure 4). This map includes all habitat areas identified during the survey.

Most of the potential habitat occurs in Area 10 (Murrumbidgee River Corridor). Within this area there are very extensive areas of habitat suitable for the species, extending almost continuously from Stockdill Drive to the southern edge of the Armitage and Shaw property north of the ACT border. Further north in NSW there is considerably less potential habitat, and the patches are small and are scattered along the western edge of the open country. Within Area 11, most potential habitat was found to occur on the Moore and Flemming

property and along the western edge of the cleared country on the Hyles property. No potential habitat that was likely to be occupied by Pink-tailed Worm-lizards was found east of the Hyles property (Area 5) along the Ginninderra Creek. The rocky areas here were all examined on foot and had a cover of improved exotic pasture and did not support the lizards (see below). Several very small patches of remnant habitat still occur on a hills slope immediately south of the large pond (with wildlife habitat island) south of Parkwood Road in Area 5 (the larger of these patches was found to still support the species; see survey results below). Very little potential habitat was found on the Armitage and Shaw property and the most suitable patches were found close to the Murrumbidgee River. Some small patches of potential habitat occur in Area 2 (Hill, Ridges and Buffers) at the southern end of the study area (Figure 4).

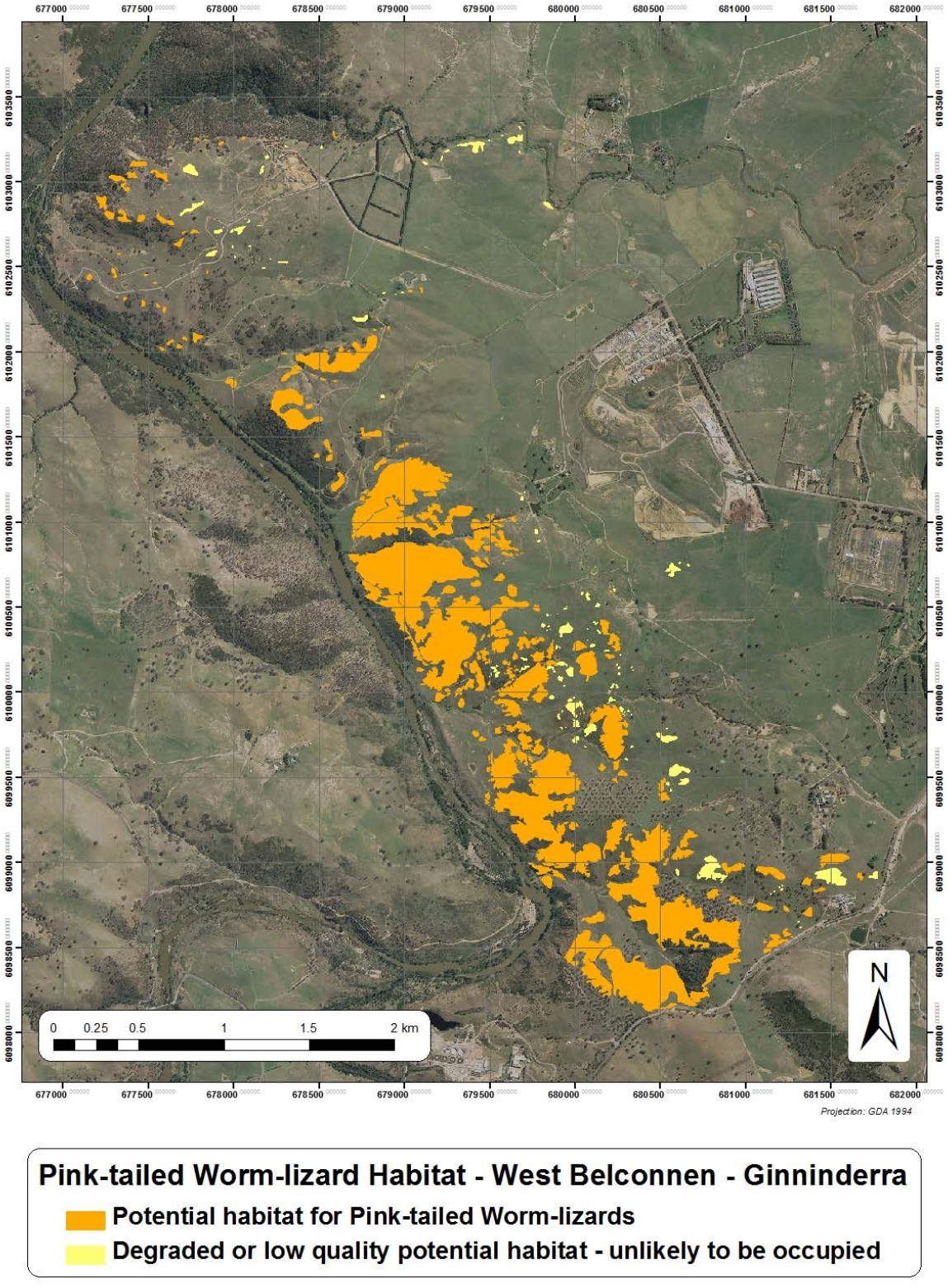

Figure 4. Extent of potential habitat for Pink-tailed Worm Lizards in the West Molonglo-Ginninderra Creek investigation area. See legend for details.

Plate 9. An example of potential habitat for Pink-tailed Worm-lizards found near the western edge of Area 1. This patch still supports a good cover of native grasses and forbs including kangaroo grass *Themeda triandra.* Very few weeds occur at this site. Kevin Mills and Associates (2009) recorded a Pink-tailed Worm Lizard from this site and specimens were found at the site during the present study.
Photo: W. Osborne

Plate 10. A small patch of low quality habitat found in Area 1. The patch comprises deeply imbedded rocks and a dense cover of exotic pasture species and weeds. These sites are considered to be very unlikely to support Pink-tailed Worm-lizards and have been mapped as low quality and degraded habitat. Photo: W. Osborne

Plate 11. Extensive areas of potential habitat occur on the steeper slopes near the Murrumbidgee River.
Photo: W. Osborne.

Plate 12. Steep-sided ridges and gullies support considerable areas of Pink-tailed Worm-lizard habitat in Area 10. Photo W. Osborne

Plate 13. In area 11 (northern end of study area) Pink-tailed Worm-lizard habitat is confined mainly to the extreme western edge of the flatter agricultural country, near the upper edge of the dry woodland that occurs along the slopes of the Murrumbidgee River. Photo: W. Osborne

MOVE TO NEXT SECTION

Plate 14. Occupied habitat on the Hyles property within the former deer enclosure. Photo: W. Osborne

Plate 15. There are many small patches of occupied habitat on the Moore and Fleming property. Photo: W. Osborne

Distribution of Pink-tailed Worm Lizards in the study area

Pink-tailed Worm-lizards were found to be distributed throughout much of the hilly and steeply dissected western third of the study area. Most records were from within the Murrumbidgee River Corridor in the ACT, but the species also was found to continue into New South Wales at locations mostly within about 1 km of the Murrumbidgee River and near Ginninderra Creek west of the gravel extraction quarry on the Hyles property (Figure 5).

Kevin Mills and Associates (2009a,b) found specimens at 30 sites in the ACT and two sites in NSW. An additional 45 occupied sites were found in the present study (Figure 5; Appendix 1), with 14 of these being located in NSW, mainly in the far north-west of the study area. Note that sites within 20 metres of each other are shown as a single site on the maps presented in this report. Two earlier occupied locations recorded by Osborne and Coghlan (2004) are included in the distribution maps because the habitat looks unchanged at these sites. The distribution of the species within specific land tenure areas is shown in Figure 6. Most records (75% of sites) of the lizard were obtained in the corridor area (Area 10). An additional eight occupied sites were found in Area 11, four in Area 2, two in Area 1, and single sites in Areas 4 and 5.

Pink-tailed Worm-lizards were confirmed to occur in almost all of the extensive patches of potential habitat that were mapped (Figure 7). Although it was not possible to search for the lizards in many of the smaller patches, specimens were found at most of the small patches that were checked (for example on the Hyles property, Moore and Flemming property and in Area 2 near Stockdill Drive). No specimens were found in searches conducted within the Armitage and Shaw property and little suitable habitat in good condition was found at this location. Small patches of potential habitat occur on the lower slopes of the property near the river and it is possible that the species still occurs in that area. Higher upslope the rocky areas were observed to be very overgrown with exotic agronomic species. No specimens were found at any of the small sites searched in the pasture-improved paddocks near Ginniderra Creek in Area 5 north of Parkwood Road and it is very unlikely that the species occurs in that part of the study area.

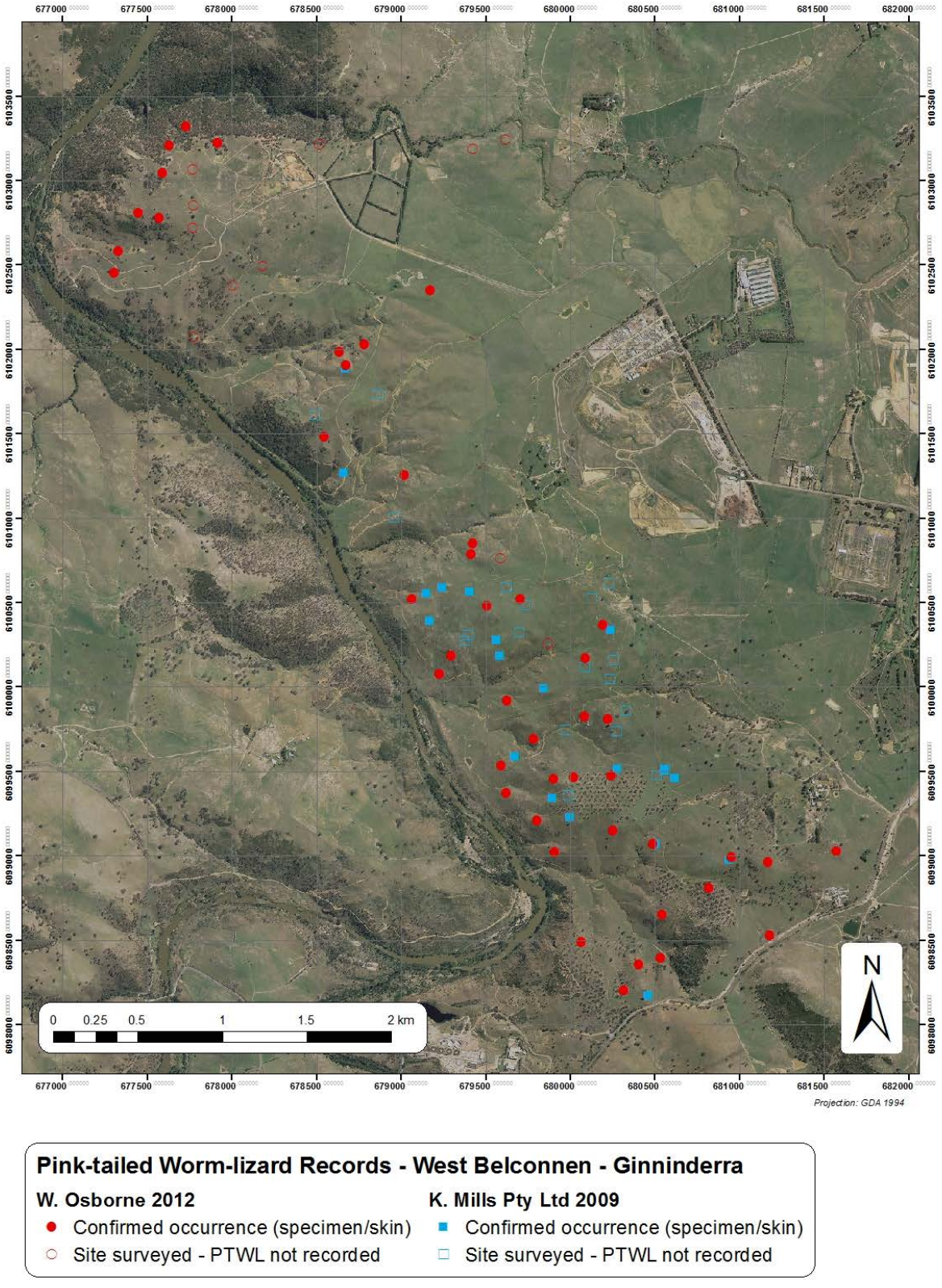

Figure 5. Distribution of Pink-tailed Worm-lizards in the study area. The map includes all records obtained during this study and two previous surveys by Kevin Mills and associates (2009a,b). Some records shown as a single dot represent more than one record from a site or from a site within 30 metres.

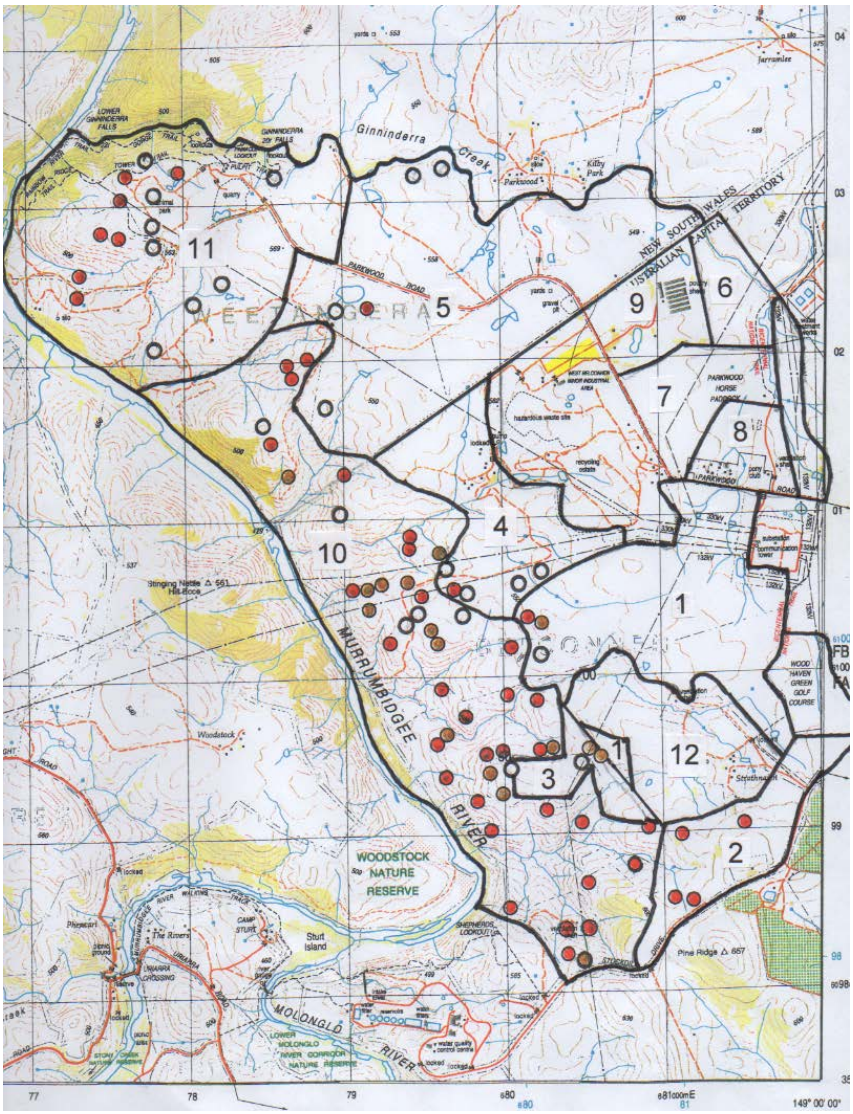

Figure 6. Approximate location of sites that were found to support Pink-tailed Worm-lizards in the different land tenure areas in the study area. Closed red circles - this study; closed brown circles - Kevin Mills and associates 2009a,b; open circles - site surveyed (this study only) where the species was not found. Some records shown as a single dot represent more than one record from a site or from a site within 30 metres.

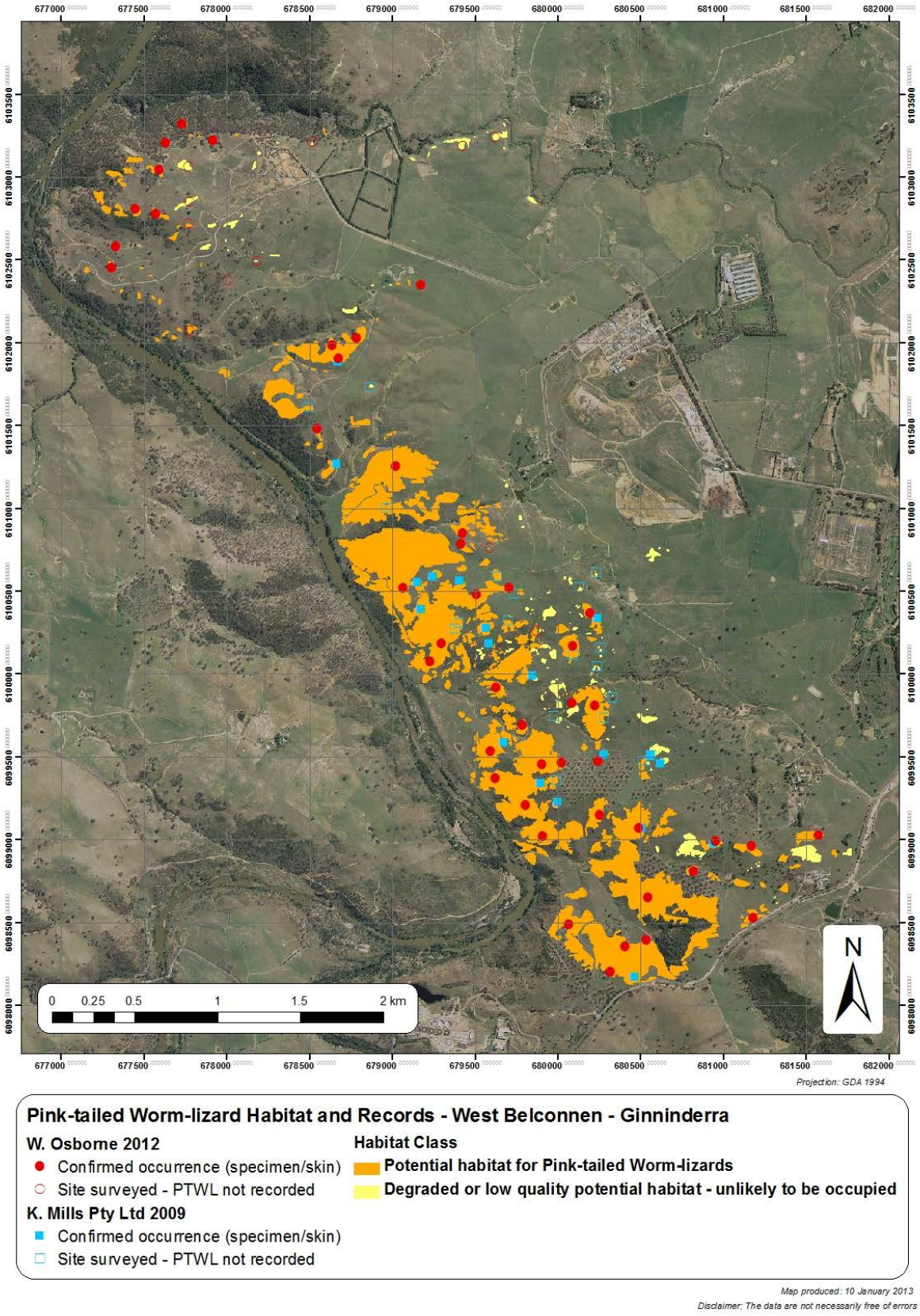

Figure 7. Confirmed location records for Pink-tailed Worm-lizards overlaid on to the map of potential habitat.

Discussion

This report presents the results of on-ground GIS-based mapping of the distribution of habitat for the Pink-tailed Worm Lizard (*Aprasia parapulchella*) in the West Molonglo-Ginninderra Creek investigation area. Potential habitat was found to be confined to the far western sector of the investigation area where it is in good condition and occurs very extensively along the slopes of the Murrumbidgee River from the southern edge of the investigation area at Stockdill Drive northwards to about one kilometer north of the ACT Border. Small patches of occupied habitat are present in the landscape further to the north in NSW through to the northern limit of the study area near Ginninderra Falls. Occupied habitat does not occur in the eastern two-thirds of the investigation area. The population in the investigation area is confined to the far western third of the area where its habitat is associated with the more steeply dissected terrain near the Murrumbidgee River (Figure 7).

The recovery plan for the Pink-tailed Worm-lizard (Osborne and Jones 1995) identifies three areas of national conservation significance for the Pink-tailed Worm Lizard in the ACT region. These are: Mount Taylor; the Molonglo River Corridor and the Murrumbidgee River Corridor. The potential habitat in the West Belconnen – Ginninderra Creek investigation area clearly comprises an important component of the populations found along the slopes of the Murrumbidgee River. In the ACT, much of this area is protected within the Murrumbidgee River Corridor (Woodstock Nature Reserve). However there are some large patches of habitat near the upper edges of the slopes that are not contained within the reserve. This land is protected to some extent by land management agreements that include protection of rocky areas from undue disturbance including removal of surface rock.

Plate 16. The transition between tableland agricultural landscapes and the rocky hilly terrain occupied by Pink-tailed Worm-lizards can be quite sharp. During any future development within these areas will require suitable buffers to protect the habitat.

Habitat within the study area contributes greatly to the potential dispersal corridor for the Pink-tailed Worm-lizards and other species of wildlife. The main corridor in this area is associated with the steeper slopes close to the Murrumbidgee River. The rocky corridor through this part of the ACT and NSW provides an important link between the biologically very diverse Ginninderra Falls area in NSW and the important Molonglo River corridor in the ACT where there are many records of Pink-tailed Worm-lizard along the full extent of the corridor (Osborne and Wong 2011).

The Lower Molonglo Water Quality Control Centre presents a partial barrier to this corridor,

but fortunately there are patches of protected habitat within the grounds of the centre and to the north and west of the centre within the MRC that potentially facilitate dispersal in this area (Figure 8). At the northern end of the study area, Ginninderra Creek provides a partial barrier to dispersal by small reptiles. Movement across this barrier might occur during floods when lizards are accidently washed into the stream and perhaps at times of very reduced low flow when the streambed is dry. A genetic study currently underway at the University of Canberra (T. Knopp pers. comm.) has confirmed that populations of the Pink-tailed Worm-lizard on either side of the Molonglo River and Murrumbidgee River have consistent genetic differences, providing some evidence that these major rivers can also be barriers to dispersal.

In this study, and during the surveys conducted by Kevin Mills and Associates (2009a,b), it was found that some of the small patches of habitat in agricultural areas (in pasture improved areas and paddocks that have been ploughed for many years) appear to be quite degraded. Despite this surrounding disturbance and the fact that some of the patches are located a considerable distance out into the surrounding agricultural landscape, some rocky patches are still occupied by Pink-tailed Worm-lizards. Although the long-term survival of such small populations is very unlikely – it does indicate that small isolated patches of habitat should still be considered if these areas are subject to further development. Moreover if the patches occur close together they may act as a corridor for movement through poorer quality parts of the landscape. This highlights the importance of such small and less obvious habitat patches in maintaining connectivity and assisting in the long-term conservation of the species. Small patches located at important points in the landscape are likely to be important (for example near and within the Lower Molonglo Water Quality Control Centre and in the extreme north of the study area near Ginninderra Creek). It is very likely that they will act as stepping-stones between larger areas of occupied habitat.

Sites occupied by Pink-tailed Worm Lizard often support a rich reptile population and the rocky habitats that they occupy are often hotspots for diversity supporting up to 19 species of reptiles (Osborne and McKergow 1993; Osborne 2007). With rehabilitation and restoration, rocky outcrops in degraded areas may also be able to contribute generally to habitat for reptiles and other species. It is important that this be considered during land development in the West Belconnen – Ginninderra Creek study area. In the case of very small and isolated populations (for example in Areas 1, 4 and 5) that are not obviously within such a potential movement corridor it is hard to argue a strong case for their protection. It is very unlikely that there will be movement between these relict populations across agricultural landscapes with exotic pastures to more substantial areas of habitat within the main corridor area. Nevertheless, the small populations in agricultural areas are still of considerable interest, because they allow us to understand better the processes that limit and threaten the species in the ACT region (this issue was considered by David Wong in his PhD thesis; Wong 2012). Other important considerations that relate to any future development include appropriate positioning of future roads and careful planning of the location of other infrastructure and utilities so as not to impact on the populations in the main corridor area (Area 10 and the western parts of Area 11 and Area 2). Habitat areas protected for the species should contain appropriate buffer areas and should not be impacted by construction of roads or other large-scale infrastructure. Finally, as mentioned above, it will be important to continue a regime of livestock grazing (or kangaroo grazing if numbers build up) to prevent the grassland condition from declining and becoming rank and overgrown. A very active program of weed control will also be required.

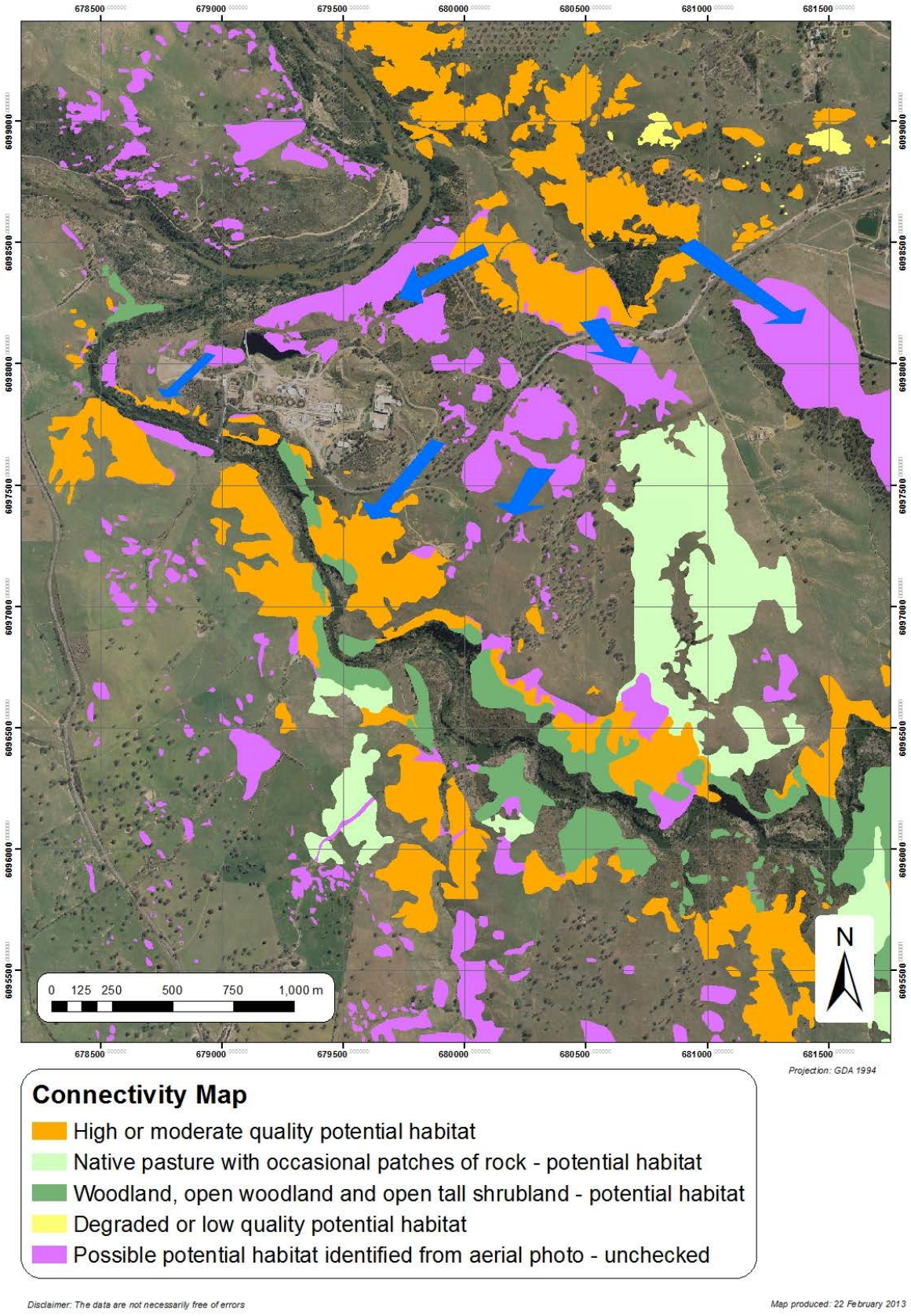

Figure 8 The most likely dispersal routes through rocky parts of the landscape linking populations in the study area with those further south along the Molonglo River. Stockdill Drive is likely to be a major barrier because it is unlikely that the Pink-tailed Worm-lizard will move over such a wide bitumen surface. The potential corridor with the least disturbance occurs to the north and east of the water quality control centre**.**

Plate 17. Very extensive areas of potential habitat occur within the steeply dissected river corridor near the Murrumbidgee River. Although cleared of their original tree cover these native pastures and grasslands provide very important reptile habitat. It is important that controlled levels of livestock grazing continue in these rocky landscapes to prevent the vegetation becoming tall and rank, to help reduce weed invasion and to lower fire risk. Photo: W. Osborne

Conclusions

The study area provides an extremely important area of habitat for the Pink-tailed Worm-lizard. The extensive habitat found along the Murrumbidgee River Corridor, including the more isolated patches that form "stepping stones" through the landscape in NSW provide an important dispersal corridor for the species that link populations north of Ginninderra Falls to the regionally important populations along the Molonglo River in the ACT.

The population of Pink-tailed Worm-lizards in the Molonglo River Corridor within the study area is of national conservation significance. The population in this area should be given maximum levels of protection during development and land management activities. Planning should take into account the national significance of the population and environmentally sensitive planning should take place in order to conserve the species in Areas 2, 10 and 11. Where possible any habitat areas in Areas 1 and 4 (the extreme western edge) should also be protected although these areas are of considerably less importance in terms of existing and potential corridors and may be difficult to manage. During any property development, the protection of potential habitat will be an issue that should be considered, including the need to establish a managed buffer zone 20 metres in width around the outer edge of the habitat (as prescribed by the Commonwealth Government and required in the ACT and NSW).

A continuation of controlled levels of livestock grazing will be required to prevent the Pink-tailed Worm-lizard habitat from becoming rank and overgrown. Any pasture improvement should be discontinued in PTWL habitat and in surrounding buffer areas

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approval number CEAE 11/12 (University of Canberra). ACT Parks Conservation and Lands provided permission to undertake fieldwork in the study area as well as providing GIS data.

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Appendix 1

GPS location records for all confirmed Pink-tailed Worm-lizard records from the West Belconnen – Ginninderra study area. Data from Kevin Mills and associates 2009a,b and Osborne 2012 (this study).

Mills 2009a

0679567	610 0278
0679407	610 0561
0679154	6100552
0679244	6100588
0680623	6099460
0679676	6099585
0679899	6099338
0680507	6099070
0680944	6098978
0680244	6100337
0679173	6100393
0679586	6100182
0679845	609989
0680451	6099326
0680282	6099514
060002	6099226
0678673	6101885
0678663	6101266

Mills 2009b

679567	6100278
679407	6100561
679154	6100552
679244	6100588
680623	6099460
679676	6099585
679899	609 9338
679967	6099439
680507	6099070
680944	6098978
680244	6100337
679173	6100393
679586	6100182
679845	6099989
680463	6098171

Osborne 2012

698546	6083636
679905	6099019
680487	6099070
680190	6100364
680087	6100168
680223	6099807

680084	6099825
680244	6099475
680021	6099462
679902	6099456
679785	6099692
679626	6099916
680253	6099150
679802	6099206
679621	6099368
679593	6099534
680063	6098489
680314	6098203
679705	6100517
679505	6100479
679294	6100182
681177	6098525
681573	6099023
681167	6098959
680953	6098988
680817	6098810
680544	6098651
679211	6108729
679413	6100783
679421	6100851
679020	6101255
679063	6100519
677587	6103045
677627	6103206
677727	6103319
677917	6103219
678782	6102028
678636	6101981
678676	6101902
679172	6102349
678544	6101480
677568	6102777
677447	6102806
677328	6102578
677301	6102449
679228	6100074
680534	6098392
680403	6098354