Terrestrial Vertebrate Fauna of the Katjarra area of the Birriliburu IPA.

Report to the Birriliburu Native Title Holders and Central Desert Native Title Services

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Nephrurus levis-Photo M. Cowan

Contents

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Abstract

We undertook standardised sampling with pit, funnel and Elliot traps for frogs, reptiles and mammals at Katjarra over two week periods in August 2012, in May 2013 and again in late March and early April 2014. On each survey the trapping was supplemented with manual searching, spotlighting and the use of infrared motion sensitive cameras. The more than 600 captures and observations resulted in the identification of 90 species, of which almost half (43) were either new additions or confirmations of previously unsubstantiated fauna records. The total known frog, reptile and mammal fauna now stands at 100 native species. Four species of conservation significance, due to listing on State and or Commonwealth Threatened and Priority species lists, were identified in the study area. Evidence of the occurrence of two species now considered locally extinct was also recorded. At least 14 species from those newly recorded are approaching, or are on the limits of their known distributional ranges which highlight the importance of Katjarra for conservation of biodiversity.

1. Introduction

The Birriliburu Indigenous Protected Area (IPA) was declared on the 23rd April 2013 and covers an area of around 66, 000 km^2 encompassing parts of the Little Sandy Desert, Gibson Desert and Gasgoyne Bioregions of the Interim Bioregionalisation of Australia (Thackway and Cresswell, 1995). Within the IPA are three special category areas (IUCN III categories set aside to protect a specific natural monument) of which Katjarra, also known as Carnarvon Range, is one. The Katjarra protected area covers approximately 2,000 km^2 including the ranges, and is primarily within the southern extent of the Trainor subregion of the Little Sandy Desert Bioregion, but its south-western corner also extends into the Carnegie subregion of the Gascoyne Bioregion. The nearest populated centre is the small community of Wiluna which lies approximately 170km to the south (see introduction and Figure 1 in Gibson et al., 2013 for more detail).

Historically there has been little systematic biological survey work undertaken in and around Katjarra consequently documented information on the biodiversity of the area is sparse. The earliest visits in which ground vertebrates were sampled and specimens' lodged with the Western Australian Museum were undertaken in 1975 and 1976 when the then Department of Fisheries and Wildlife made two visits as part of a broader assessment of proposed desert conservation areas (McKenzie and Burbidge, 1979). Following these surveys there appears to have been almost no additional fauna survey until a Landscope Expedition in 2001 (Kenneally et al., 2001) and, while some previously unrecorded species were documented, most of the work was confined to a small area in the southern part of the range close to Kanatukul West, and only for a short period with relatively few pit traps. A bioregional survey of the south western Little Sandy Desert was initiated in 1995 (van Leeuwen, 2002) but the study area for this was to the north of Katjarra. More recently Martu Rangers responsible for the Birriliburu IPA have established monitoring plots, camera trap locations and undertaken systematic ground searches for signs of threatened species and feral animal activity.

At the invitation of the Birriliburu Native Title Holders, and as part of a larger biological survey undertaken by the Department of Parks and Wildlife (DPaW) in partnership with the Birriliburu Native Title holders and Central Desert Native Title Services, terrestrial vertebrate surveys were undertaken over a two week period in August of 2012, May 2013, and again in late March and early April 2014. While these surveys have been coordinated by staff from DPAW's Science Division, at differing times they have also involved Birriliburu Rangers, staff from DPAW's Goldfields Region and members of Central Desert Native Title Services.

The purpose of this first phase of work has been to document vertebrate biodiversity in and around the ranges with an overarching aim to establish long term monitoring sites which will assist with future management, and evaluation of management effectiveness, in respect to biodiversity conservation at Katjarra.

2. Methods

2.1 Site selection

As with many remote areas, access is limited to a few existing tracks which are accessible by four-wheel dive vehicles only. Within these track constraints survey sites were selected to capture the major variation in geology, landform and vegetation types. The position of these sites and their relationship to broad habitat mapping, as defined by Gibson et al. (2013), are shown in Figure 1, and site details are summarised in Table 1.

Two camp sites were chosen from which to run surveys, one at the northern extent of the range and another at the southern extent. In the southern area, Kanatukul West, eight sites were chosen for pit trap establishment (six in August 2012 with two additional sites established in May 2013) and four sites with only Elliot traps (CR1 sites-Figure 2a). Here traps were open for the first week of the first two surveys and the second week of the third survey, except CR1 P9 and CR1 P10 which were not established for August 2012. Another eight pit trap sites were established in the northern area, Yamada North, again six of these established in August 2012 and another two in May 2013, along with three Elliot trap lines (CR2 sites-Figure 2b). The Yamada North sites were operated during the second week of the first two surveys and the first week of the third survey, except for CR2 P7, CR2 P8, CR2 E10 and CR2 E11 which were only established and run during the second and third surveys.
All CR1 sites were open for six nights in August 2012, four nights in May 2013 and seven nights in March/April 2014. For the CR2 sites they were open for three nights in August 2012, five nights in May 2013 and seven nights in March/August 2014.
Photos of each of the pit trapping locations are presented in Appendix 2

During the course of the May 2013 and March/April 2014 surveys three mole trenches were excavated in an effort to determine the presence of marsupial moles. Additional to these Allan Burbidge excavated ten trenches in May 2014 while he was undertaking avifauna survey work at Katjarra. Coordinates of all mole trench locations, along with an image of a mole trench, are presented in Appendix 3.

Table 1 Trapping site details including site codes, coordinates, and trap types used

Site #	Latitude	Longitude	Site details	Traps
CR1 P1	-25.26783	120.62665	Sand dune crest	6 pits 6 funnels
CR1 P2	-25.26891	120.62674	Open spinifex sandplain	6 pits 6 funnels
CR1 P3	-25.26560	120.64729	Stony substrate at base of sandstone range with	6 pits 6 funnels
CR1 P4	-25.26269	120.65051	Drainage zone at base of sandstone range	25 type A 10 type B 6 pits

Site #	Latitude	Longitude	Site details	Traps
				6 funnels
CR1 P5	-25.26385	120.55270	*Acacia* shrubland on breakaway slope	25 type A 6 pits 6 funnels
CR1 P6	-25.27196	120.59509	*Acacia* shrubland on rocky plain	6 pits 6 funnels
CR1 E7	-25.27812	120.69180	Sandstone range	25 type A
CR1 E8	-25.28145	120.69173	Established in August 2012; Elliots only; spinifex sandplain	25 type A
CR1 P9*	-25.25836	120.64681	Mulga over spinifex on sandplain	25 type A 6 pits 6 funnels
CR1 P10*	-25.27218	120.58901	Mulga and grass in drainage tract	6 pits 6 funnels
CR1 E11†	-25.26983	120.56655	*Acacia* shrubland on rocky plain	25 type A
CR1 E12†	-25.270686	120.60302	*Acacia* shrubland on rocky plain	25 type A
CR2 P1	-25.04351	120.74187	Samphire on edge of salt lake	6 pits 6 funnels
CR2 P2	-25.04660	120.74078	Dune crest	25 Type A 6 pits 6 funnels
CR2 P3	-25.04559	120.74113	Spinifex sandplain	25 Type A 6 pits 6 funnels
CR2 P4	-25.10662	120.71425	*Eucalyptus camaldulensis* and dense shrubs in spring	6 pits 6 funnels
CR2 P5	-25.09709	120.72348	Mulga and tussock grass on sandplain	6 pits 6 funnels
CR2 P6	-25.11130	120.70806	Spinifex and *Acacia* stony substrate	25 type A 6 pits 6 funnels
CR2 P7*	-25.05753	120.73875	Dense *Aluta* shrubland on sandplain	6 pits 6 funnels
CR2 P8*	-25.12967	120.71752	Mallee over spinifex on sandplain	6 pits 6 funnels
CR2 E9	-25.11539	120.72224	Sandstone range	50 type A 10 type B
CR2 E10*	-25.12585	120.71647	Sandstone range and foot slopes	50 type A 10 type B
CR2 E11*	-25.13697	120.74317	Boulders along drainage line	10 type B

* established in May 2013
† established in March/April 2014

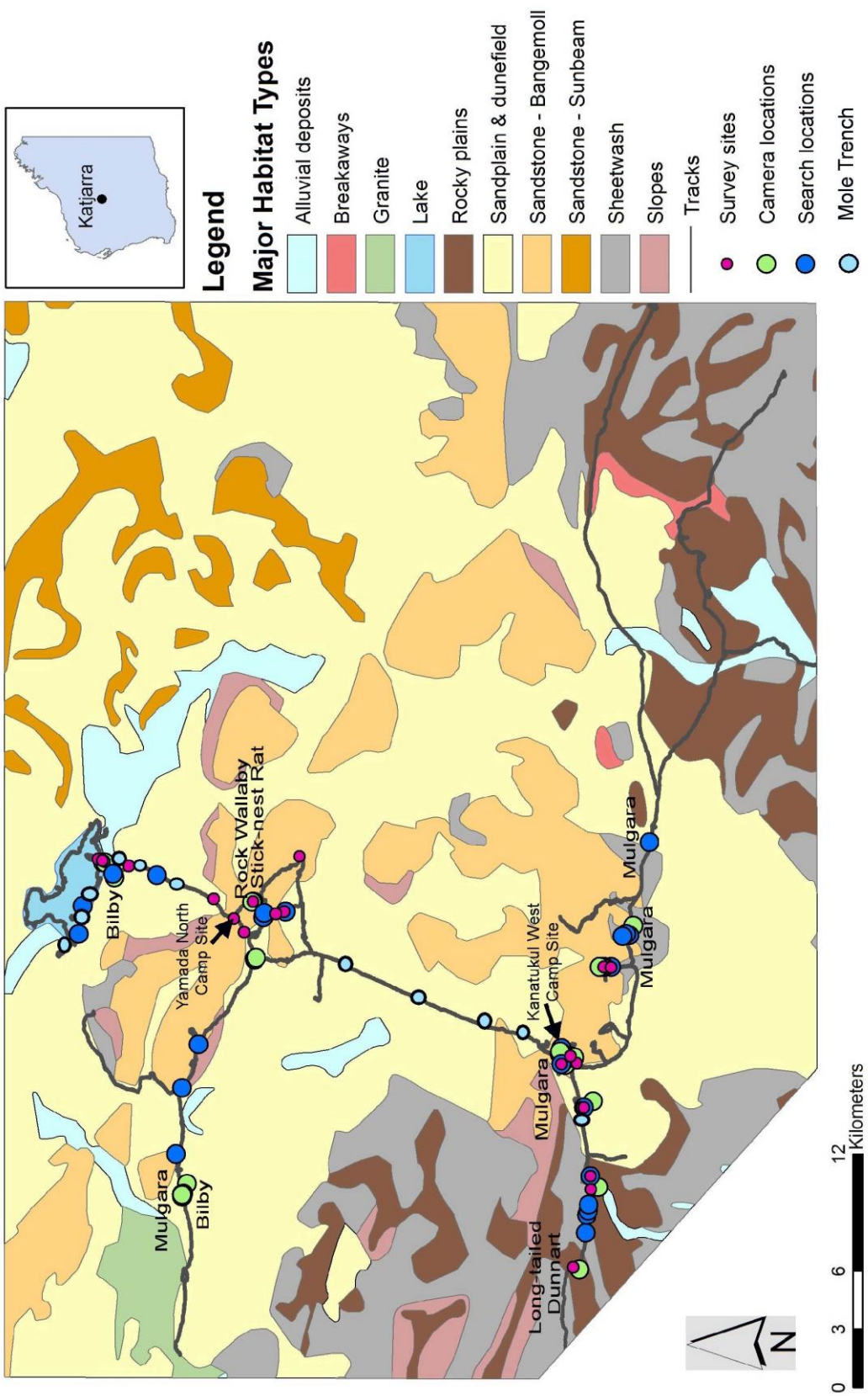

Figure 1 Major habitat types of Katjarra showing survey sites, search locations, mole trenches and, camera trap locations. Sites where there is current evidence of Bilby, Mulgara and Long-tailed Dunnart, along with signs of past occurrence of Rock Wallaby and Stick-nest Rat, are identified. (Habitat map is adapted from Gibson et al., 2013)

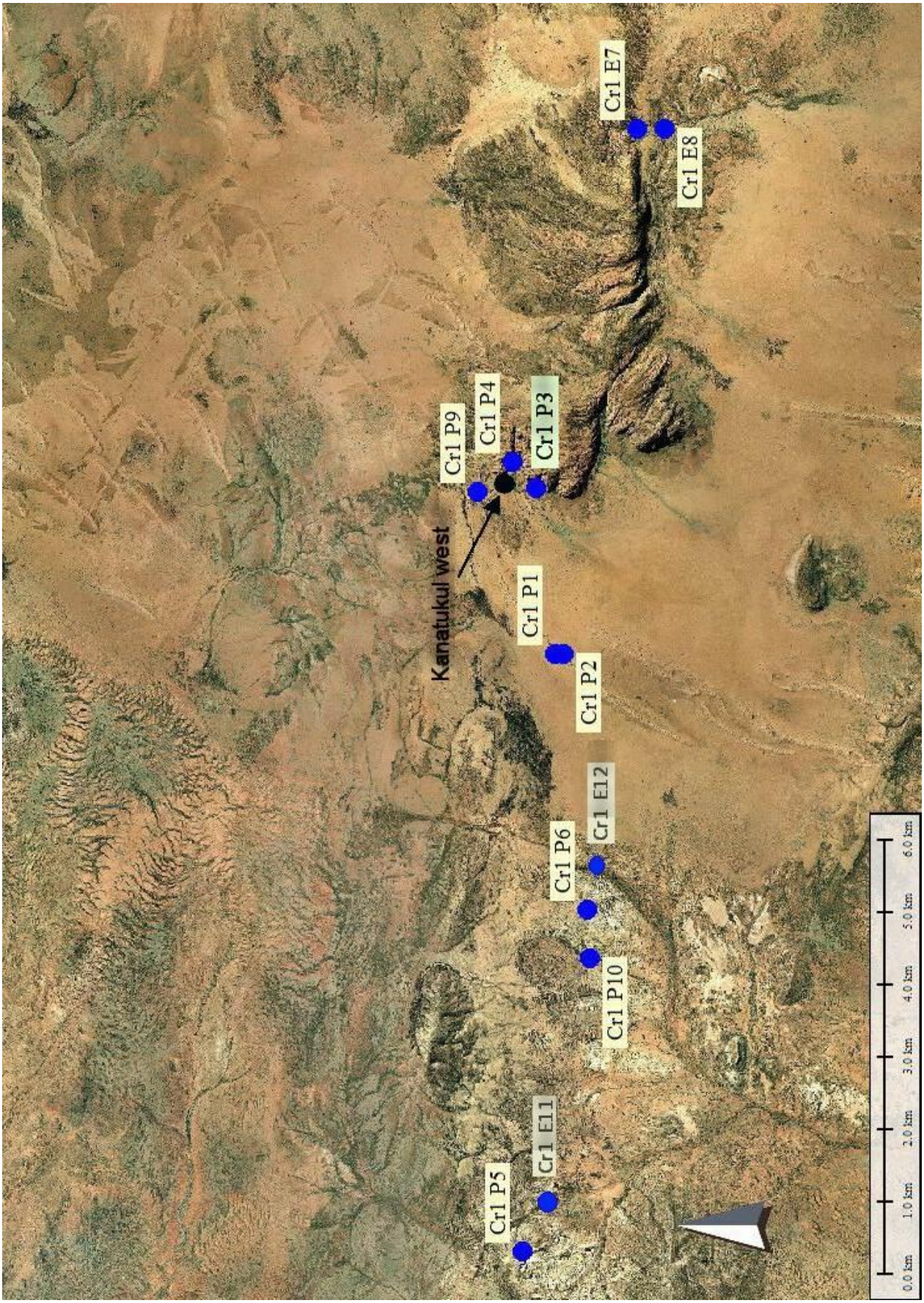

Figure2 a Orthophoto covering Kanatukul West trapping locations

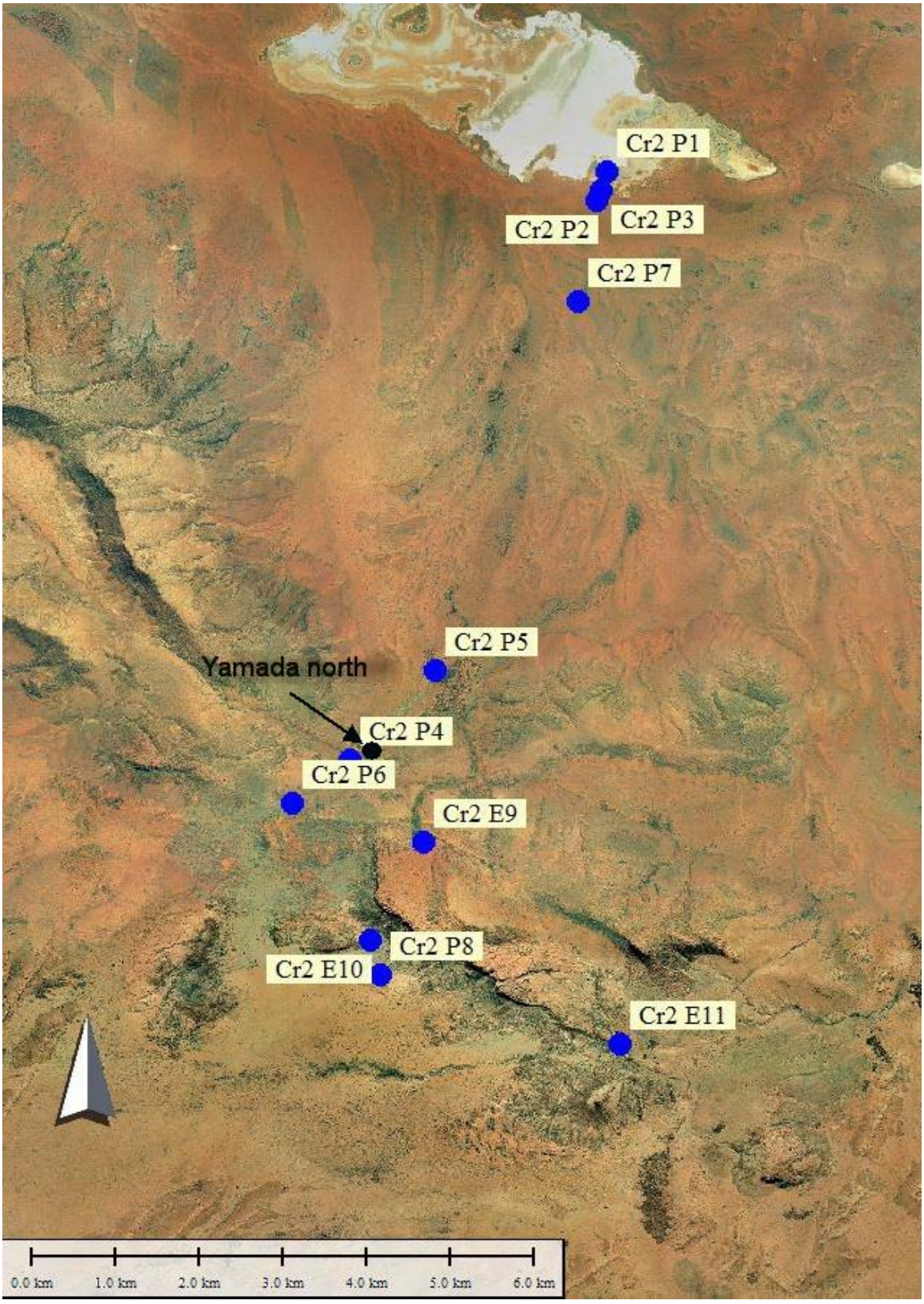

Figure 2b Orthophoto covering Yamada North trapping locations

2.2 Collection methods

Each pit trap survey site was sampled using a single 60 metre drift fence of 30 cm high aluminium fly wire with six 20 litre buckets located at approximately ten metre

intervals along, and buried centrally under, the drift fence (Image 1). Up to six funnel traps were also used to supplement the pits and these were placed in pairs (one either side of the fence) along the same fence as the pit traps and midway between pits. At sites Cr1 P4, Cr1 P5, Cr1 P9, Cr2 P2, Cr2 P3 and Cr2 P2, 25 medium sized Elliot traps (type A) were also used. These were placed at 10 to 20 metre intervals, marked with flagging tape, and baited with universal bait, including the addition of chopped bacon.

Opportunistic sampling and camera trap establishment took place at some of the established survey locations, as well as at a number of additional locations (Figure 1). At these additional sites all sightings were recorded and we undertook active searches by turning rocks and logs or raking leaf litter in search of animals. Motion triggered infrared cameras (Reconyx HC600's) were set up on 450mm pegs and directed at areas of specific interest (e.g. burrow complexes) or baited with universal bait scattered 1.5 – 2 metres in front of the camera.

Owl pellets that contained vertebrate remains were collected in May 2013 from two caves in a breakaway near site CR1 P5 (46 pellets) and from the rocks around CR1 P4 (8 pellets). These were sent to Georgeanna Story (Scats About) who has over 13 years' experience in identifying vertebrate remains from scats and pellets.

Several nights on each trip involved some track driving and spotlighting but this generally had limited success during the first two surveys due to the coolness of the evenings. Information was also collated from other survey team members for opportunistic sightings providing identifications could be confirmed.

Image 1 Typical drift fence layout showing pit and funnel traps

2.3 Identifying the collections

Animals captured were generally identified in the field. The sex was determined and weights and lengths (pes and cranium for mammals, snout to vent and tail for reptiles) recorded prior to release at point of capture, although initially for some of the more complex species, including some members of the genus of striped skinks (*Ctenotus* species*)*, individuals were taken back to base camp to be keyed out prior to release.

At least one voucher specimen of most species has been taken for lodgement in the WA Museum. These specimens were labelled with a field identification tag and a liver sample taken for preservation in 100% ethanol for future molecular analysis. Voucher specimens were fixed in 10% formalin for seven days and then transferred to 70% ethanol for preservation after flushing for 24 hours in water. Tissue samples were also taken from a number of species that were released and these will be lodged with the WA Museum and accessioned into their DNA tissue collection.

The primary sources of information for identification were the Western Australian Museum's reptile and amphibian field guides (Storr et al., 1983; Storr et al., 1990; Storr et al., 1999; Storr et al., 2002; Tyler et al., 2000) although reference was also sought from The Mammals of Australia (Van Dyck et al., 2008), A Field Guide to the Mammals of Australia (Menkhorst and Knight, 2011) and A Complete guide to Reptiles of Australia (Wilson and Swan, 2008).

2.4 Analysis

Due to the nature of the data collected here a detailed statistical analysis is not warranted however it is necessary to give some indication of the comprehensiveness of this survey from the trapping program, as well as a general comparison among survey sites to develop a broad understanding of community patterning across the study area. To achieve this species accumulation curves from our observations were calculated with two of the more robust indices, Chao 2 and Jacknife 2 (Magurran, 2004). As a result of differences in timing and sampling effort, comparisons between sites used presence/absence data with Sorensen's coefficient (Bray-Curtis where abundance data is used). The resultant association matrix was explored with clustering using unweighted pair group method with arithmetic mean (UPGMA). All analysis was performed with the software package Primer-E Version 6 (Clarke and Gorley, 2006).

3. Results

3.1 Overview of collecting

Prior to the present survey the Western Australian Museum had only 187 reptile and frog specimens and 62 mammal specimens from Katjarra with this representing just 44 species of reptiles and frogs and 10 species of mammals (WAM Database, 2012). For large vertebrates such as red kangaroos and dingos, feral species including cats

and camels or, difficult to observe species such as the bilby, while well known to the Birriliburu Rangers and other Traditional Owners, records are generally absent from formal database systems such as Australia's Living Atlas and NatureMap (Atlas of Living Australia, 2013 and NatureMap, 2007). However, McKenzie and Burbidge (1979) provide an annotated list of all species recorded during their surveys, including some of these larger species. This information is presented in combination with a species list drawn from the collections of the Western Australian Museum, which also includes collections made by the 2001 Landscope Expedition, in Appendix 1.

Summarising the historic information for reptiles and amphibians there were 16 skink, six dragon, four goanna, nine gecko, two legless lizard, one snake, and four frog species known. For the mammals there were six bats, four rodents, two small marsupials (dasyurids), two kangaroos and the dingo previously recorded.

During our recent surveys the August 2012 period had a mean maximum temperature of 28.6°C and the mean minimum temperature 11.2°C with no precipitation (Figure 3a). The May 2013 survey was considerably cooler with a mean maximum temperature of 23°C and a mean minimum temperature of just 9.0°C (Figure 3b), with some precipitation over the 19th and 20th of May. The final survey in late March and early April 2014 was the warmest period with a mean maximum temperature of 33.8°C and a mean minimum temperature of just 18.7°C (Figure 3c). There were two rain events during the 2014 survey with less than a millimetre fall on both the 31/3/2014 and the 5/4/2014, with the latter event resulting in a significant temperature drop. As reptiles are exothermic and generally prefer quite warm temperatures for peak activity, trap success for the first two surveys was less than optimal for this group, particularly in May 2013, and a considerable proportion (more than 30 %) of species were captured and identified through manual foraging by digging, raking, turning rocks and logs and general observation, rather than through trapping. The mammals however tend not to have such a significant response to temperature and trapping rates were reasonable. The trapping in March/April 2014 was productive though with almost half of all the records coming from this survey period alone.

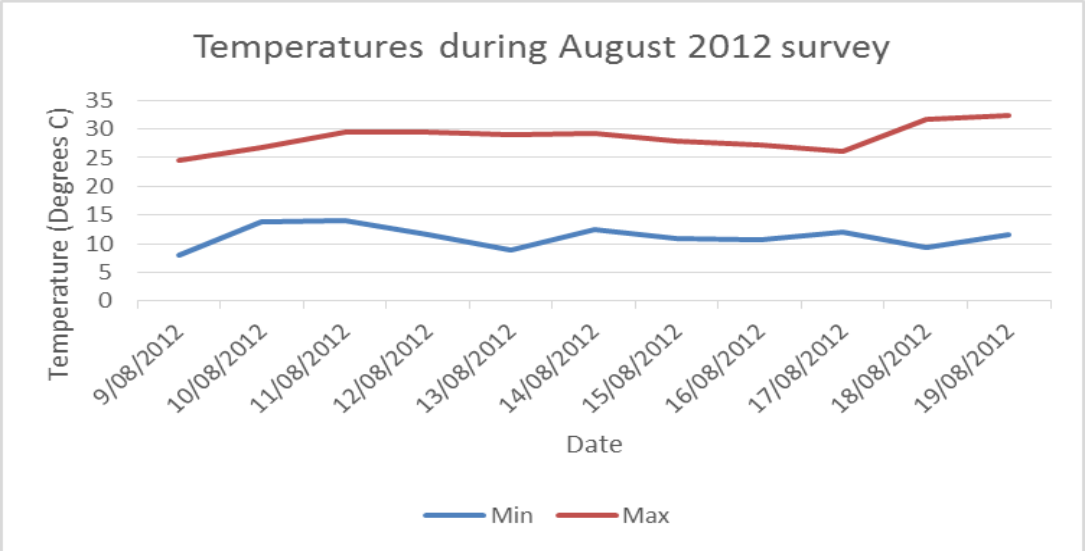

Figure 3a Maximum and minimum daily temperatures during the August 2012 Survey period.

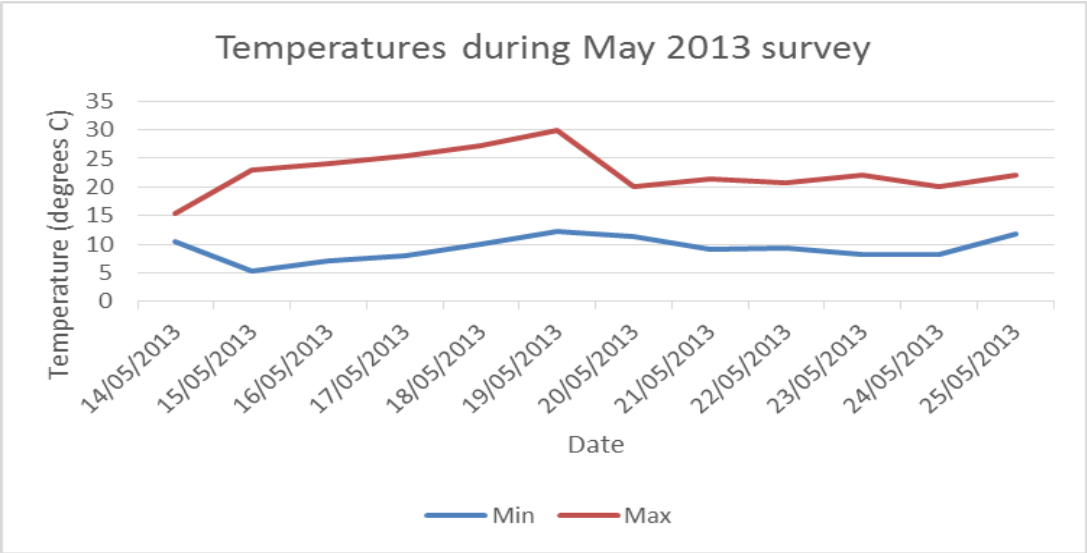

Figure 3b Maximum and minimum daily temperatures during the May 2013 Survey period.

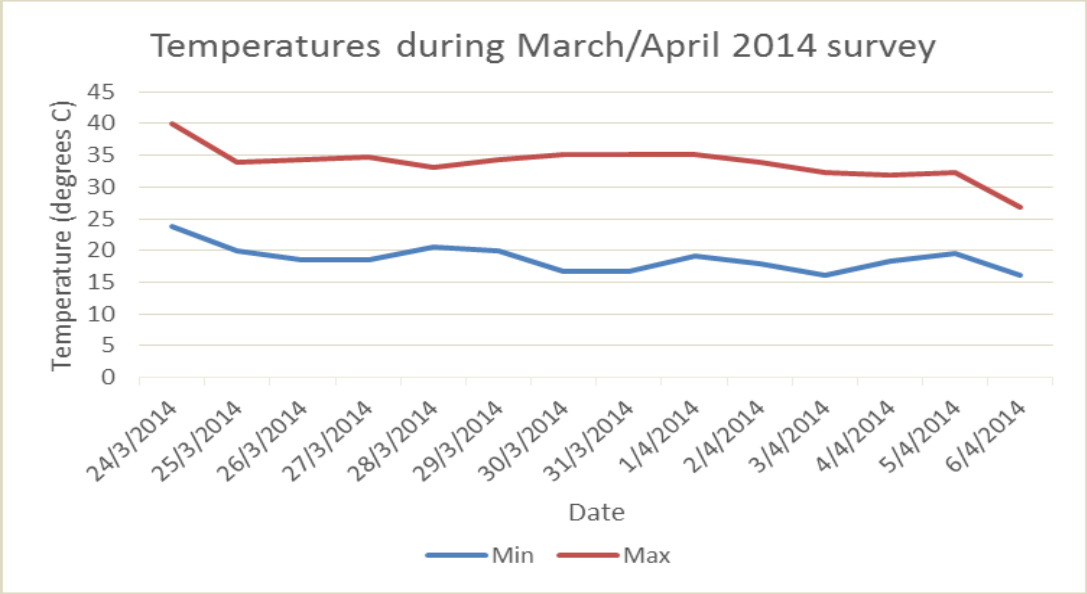

Figure 3c Maximum and minimum daily temperatures during the March/April 2014 Survey period.

Overall there were 600 individual animals captured or observed through all surveys (175 in August 2012, 137 in May 2013 and 288 in March/April 2014) using all methods. The number of species caught or observed on each trip was 36 in May 2012, 37 in August 2013 and 65 in March/April 2014 with the higher temperatures in the latter trip contributing to both an increase in abundance and species richness. These captures represented 22 skink, nine dragon, three goanna, 15 gecko, three

legless lizard, nine snake, and three frog species, along with four bats, five rodents, seven small marsupials, two kangaroos, the dingo and four other feral species. One additional species, the Kultarr (*Antechinomys laniger*), was identified post survey from owl pellets collected in May 2013. From these captures at least 41 species are new records for the Katjarra area, however further survey is still likely to produce additional species. Groups with relatively low species numbers, or that are noticeably absent from survey records to date, include blind snakes, pythons, venomous snakes, dragons, goannas, and frogs. For example van Leeuwen (2002) recorded a total of 19 snakes (13 elapid snakes, four blind snakes and two pythons), 13 dragons, nine goannas and six frogs from their Little Sandy Desert Survey. Survey work undertaken to the south east of Katjarra at Lorna Glen has revealed 14 snakes, 10 dragons, seven goannas and five frogs (Cowan, unpublished). A number of species from these two surveys are in common and would be expected to occur within Katjarra. For example the ringed brown snake (*Pseudonaja modesta*), moon snake (*Furina ornata*), stripe tailed monitor (*Varanus caudolineatus*), and broad-banded sand swimmer (*Eremiascincus pallidus*), among others.

The most common mammal species caught during our surveys include the spinifex hopping mouse (*Notomys alexis*), sandy inland mouse (*Pseudomys hermansburgensis*), common rock rat (*Zyzomys argurus*) and the lesser hairy-footed dunnart (*Sminthopsis youngsoni*). Two of these species have reasonably specific habitat requirements with the common rock rat, as its name might suggest, almost exclusively found in rocky areas while the lesser hairy-footed dunnart is generally on sandy substrates. The other two species tend to be a little less habitat specific and may occur on loam and or sand substrates with a variety of vegetation, although often preferring an understorey of tussock or hummock grasses.

Of the reptiles, the leopard skink (*Ctenotus pantherinus*) and the desert slider (*Lerista desertorum*) were the most commonly encountered species. The leopard skink was regularly caught in pit traps where there is sand and spinifex and the desert slider was regularly caught in soil and leaf litter below Eucalyptus and Acacia species while raking. A number of other species of striped skinks (*Ctenotus* species) that favour sandy locations were also prevalent.

3.2 Named taxa newly recorded for the reserve

Table 2 lists 42 species not previously recorded in the reviewed literature or the State's fauna collections databases and images of these along with their known distributions (WA Museum records) is presented in Appendix 4 . The common rock rat (*Zyzomys argurus*), which was caught in large numbers in Elliot traps and on camera traps at sites CR1 P4 and CR1 E7 in August 2012, was far less prevalent in May 2013 and surprisingly to date is only recorded from the northern part of Katjarra within the second survey area at Yamada once by remote camera, and this was during the March/April 2014 survey. This is despite a significant Elliot trapping program of more than 500 Elliot trap nights and the deployment of a number of remote cameras. Its occurrence in the range around Kanatukul West probably represents the most southerly population known for this species. Woolley's false antechinus (*Pseudantechinus woolleyae*) was only recorded three times, once during the first survey at site CR1 E7 and twice in the final survey with one capture at CR1 E4 and also detected on a remote camera at Yamada West. It is likely to be widespread across

that the sandstone uplands however, although its occurrence here probably represents the eastern extent of its known distribution. There were another five species of ground dwelling mammal recorded by this survey that have not previously been reported in the literature (Appendix 1) with three of these having some form of special conservation significance (see section 3.4).

For lizards there are 11 newly recorded skinks, two legless lizards, five geckoes, five dragons and one monitor lizard. There were eight new snakes and one frog. A number of these species are not only new records for Katjarra but also represent occurrences at or towards the edge of known distributions (see Table 2. for details). Surveying in warmer and more humid conditions will continue to reveal additional species albeit at a reduced rate.

While museum records do not exist for a number of other larger species, including the perentie *(Varanus giganteus)*, echidna (*Tachyglossus aculeatus)*, euro *(Macropus robustus)* and red kangaroo *(Macropus rufus)* etc, these are all well known from across Australia's arid interior and would still be frequently observed and sometimes hunted by Traditional Owners travelling on Country.

Table 2. Named taxa previously unrecorded from Katjarra.

Taxon	Comment
Notaden nichollsi	Widespread throughout arid interior usually associated with dune systems.
Amphibolurus longirostris	Widespread throughout arid interior often associated with riparian zones and drainage tracts.
Ctenophorus nuchalis	Widespread throughout arid interior associated with spinifex sandplains, particularly after fire.
Ctenophorus scutulatus	North eastern limit of range. Associated with Acacia on loamy soils with sparse understorey.
Diporiphora amphiboluroides	First records for the Little Sandy Desert and probably at the north easterm limit of the species range. Associated with Mulga flats.
Tympanocryptis cephalus	Found on gravelly surfaces. No records from Little Sandy Desert.
Crenadactylus ocellatus	Found in rocks and leaf litter. Taxonomic status for the species at Katjarra is uncertain.
Diplodactylus granariensis	First records for Little Sandy Desert and at the limits of north eastern extent.
Lucasium squarrosum	First records for Little Sandy Desert and at the limits of north eastern extent.
Strophurus elderi	Usually only found in spinifex although our single record came from samphire at the edge of Lake Kerrylyn. Widespread.
Brachyurophis semifasciatus	Found in deep leaf litter. Northern extent and not recorded in Little Sandy Desert or Gascoyne bioregions.
Gehyra punctata	Towards eastern extent of range. Collected from rocks at Yamada.
Demansia psammophis	Occurs in a variety of habitats. Close to its north-eastern limit in WA.
Parasuta monachus	Only two records from Little Sandy Desert and towards north eastern extent of range.
Pseudonaja mengdeni	Widespread and occurring across most of Western Australia other than the more mesic south west corner.
Simoselaps anomalus	Found on sandy substrates with spinifex. At limit of south-

Taxon	Comment
	western extent.
Simoselaps bertholdi	Found in sandy substrates. Edge of north-eastern extent.
Delma desmosa	Usually associated with spinifex on sand. South-western edge of extent.
Delma nasuta	Usually associated with spinifex on sand. Widespread but few records from Little Sandy Desert or Gascoyne Bioregions.
Ctenotus ariadnae	Few records from Little Sandy Desert despite area being around centre of distribution. Usually associated with sand dunes.
Ctenotus brooksi	Sand dune with spinifex. Edge of range.
Ctenotus helenae	Within distributional range.
Ctenotus leonhardii	Very few records from Little Sandy Desert and towards northern extent of range although within expected distribution.
Ctenotus nasutus	Sand dune with spinifex. At south-western extent of known range.
Eremiascincus pallidus	Few records from Little sandy desert and these records form part of the southern boundary of known distribution.
Lerista bipes	Loose sand. A widespread common species.
Lerista ips	In sand usually associated with spinifex. At southern extent of known range.
Lerista timida	Under rocks or logs and in leaf litter. Widespread and common.
Menetia greyii	Common in a variety of soil and vegetation habitats.
Morethia ruficauda	Generally in rocky areas. South-western edge of range.
Anilios hamatus	No previous records from the Little Sandy Desert and occurrence is beyond north eastern extent of known distribution.
Anilios sp.	
Varanus brevicauda	Very few records from the Little Sandy desert but within expected range.
Antechinomys laniger	Identified from remains in owl pellets
Dasycercus blythi	Caught at site CR1-P9 and recorded on camera at two additional locations.
Pseudantechinus woolleyae	Caught at site CR1-E7. Eastern edge of range.
Sminthopsis longicaudata	Only recorded at breakaway CR1-P5 but likely to be widespread on rocky substrates. Edge of range.
Sminthopsis macroura	Found on stony substrates and in samphire.
Notoryctes sp.	Old burrows identified in "Mole trenches" excavated on sand dunes across the survey area. Not possible to determine which of the two species is present from burrows but distributional records would indicate that it should be the Northern Marsupial Mole (*Notoryctes caurinus*).
Zyzomys argurus	Caught in high numbers at CR1-P4 and CR1-E7 during August 2012. Lower abundance at same sites in May 2013. Most south-western records.
Tachyglossus aculeatus	Diggings and scats observed at numerous locations close to ranges.
Macrotis lagotis	Scats recorded ~15 km west of Yamada North camp site. Diggings and burrows observed around Lake Kerrylyn.

3.3 Introduced species

A list of introduced species is presented in Table 3. Signs of the presence of feral cats (*Felus catus*) were prevalent across many of the survey sites and this introduced predator is widespread across the arid interior and other parts of Australia. A large number of images were captured by remote camera around water, in particular at sites in the Yamada North area.

While wild dogs or dingos were not visually observed, their tracks were regularly seen over our vehicle tracks and they were heard on several nights around the camp at Kanutukul West. There is still considerable debate as to the role of this species in limiting activity and abundance of other predators such as cats and foxes. Never the less, it is likely that dingoes will predate on species such as the bilby where the opportunity arises.

Camels or signs of them were observed in both the northern and southern areas of Katjarra and prevalence of individuals and herds is likely to be driven by local conditions as they often move over significant distances in search of food and water.

Table 3. Introduced species

Species	Location sighted/observed	Indication of abundance
Felis catus	Caught on remote cameras at site CR2 E9 and CR2 E10. Tracks observed most sites with sand substrate and tracks often found crossing vehicle tracks on a daily basis during all three surveys.	Common
Canis lupus	Tracks seen regularly at most locations and animals heard during several evenings. Caught on remote cameras around Yamada and Kanatukul.	Likely to be common
Vulpes vulpes	Caught on remote cameras around Yamada and Kanatukul.	Likely to be moderately common, particularly in vicinity of permanent water
Camelus dromedaries	Animals sighted at Lake Kerrylyn and tracks also evident at numerous sites.	Nomadic but common
Oryctolagus cuniculus	Lake Kerrylyn as well as Yamada and Kanatukul camp sites.	Likely to be locally common, particularly in good seasons.
Mus musculus	This species is widespread and was found at a number of survey sites	Common.

3.4 Vulnerable, threatened, endangered or priority species

Four species, the bilby (*Macrotis lagotis*), the brush-tailed mulgara (*Dasycercus blythi*), marsupial moles (*Notoryctes sp* but based on geography likely to be the northern

marsupial mole, *Notoryctes caurinus)* and the long-tailed dunnart (*Sminthopsis longicaudata*) are of particular significance. The bilby and marsupial mole are threatened species and listed as Vulnerable under both state and commonwealth legislation while the brush-tailed mulgara and long-tailed dunnart are both listed as Priority 4 species in Western Australia which means they are in need of monitoring. Images and sign of these species are presented below (Image 2, 3, 4 and 5). Locations from where signs or captures of these species were made are presented in Figure 1.

Image 2. Bilby scats

Image 3. Brush-tailed mulgara

Image 4. Long-tailed dunnart

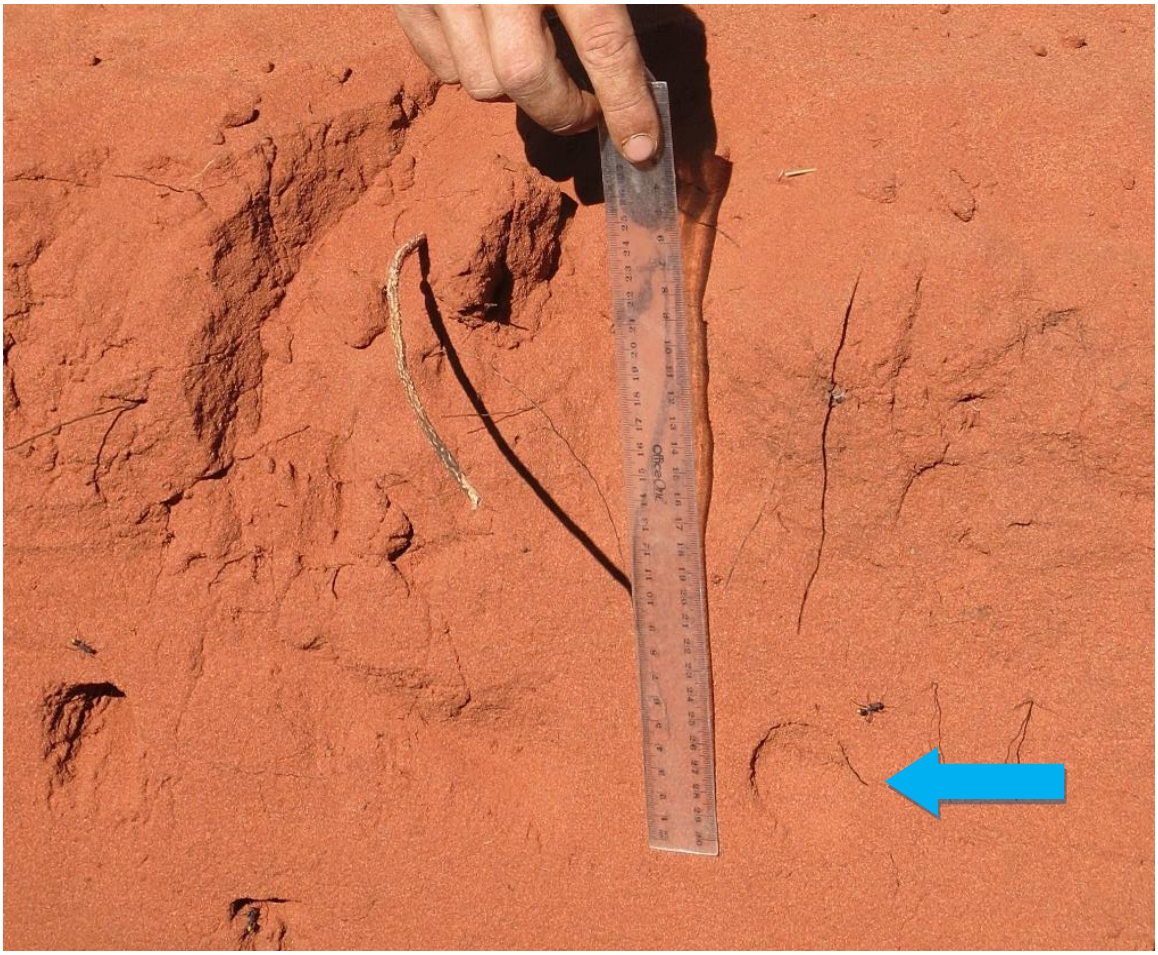

Image 5. Marsupial mole burrow in wall of excavated trench on dune crest west of Kanatukul campsite (site CR1 P1).

Historically the area would have also supported a species of rock wallaby (*Petrogale sp.*) and stick nest rats (*Leporillis sp.*). Evidence of these was also recorded in the form of scats and a partial skull for the rock wallaby (Image 6 and 7) and old nest remains for the stick-nest rat (Image 8). Localities where these species were recorded are presented in Figure 1. It is also likely that the actual sandstone ranges within Katjarra would have supported the northern quoll (*Dasyurus hallucatus*) but we have been unable to find any evidence of it persisting, although habitat would seem suitable at a number of locations.

Another species of conservation significance that might be expected to occur around Katjarra is the great desert skink or tjakura (*Egernia kintorei*). There is still some work to be done in resolving the status of the crest-tailed mulgara (*Dasycercus cristicauda*) in Western Australia but it is a species that could also have a distribution within Katjarra as early records from the 1940's exist from several locations along the canning stock route (Woolley, 2005). During May 2013, March/April 2014 and again in May 2014 we established a number of "mole trenches" (Benshemesh, 2005), that gave good overall geographic coverage across the study area from Kanatukul West through to Lake Kerrylyn. Evidence of mole activity (Image 5) was found at nine of the 13 trenches that were excavated indicating this species is likely to be quite common. There are extensive sand dune areas where methods such as this can be applied in an effort to reveal more detail about the presence of this species.

Image 6. Rock wallaby scats

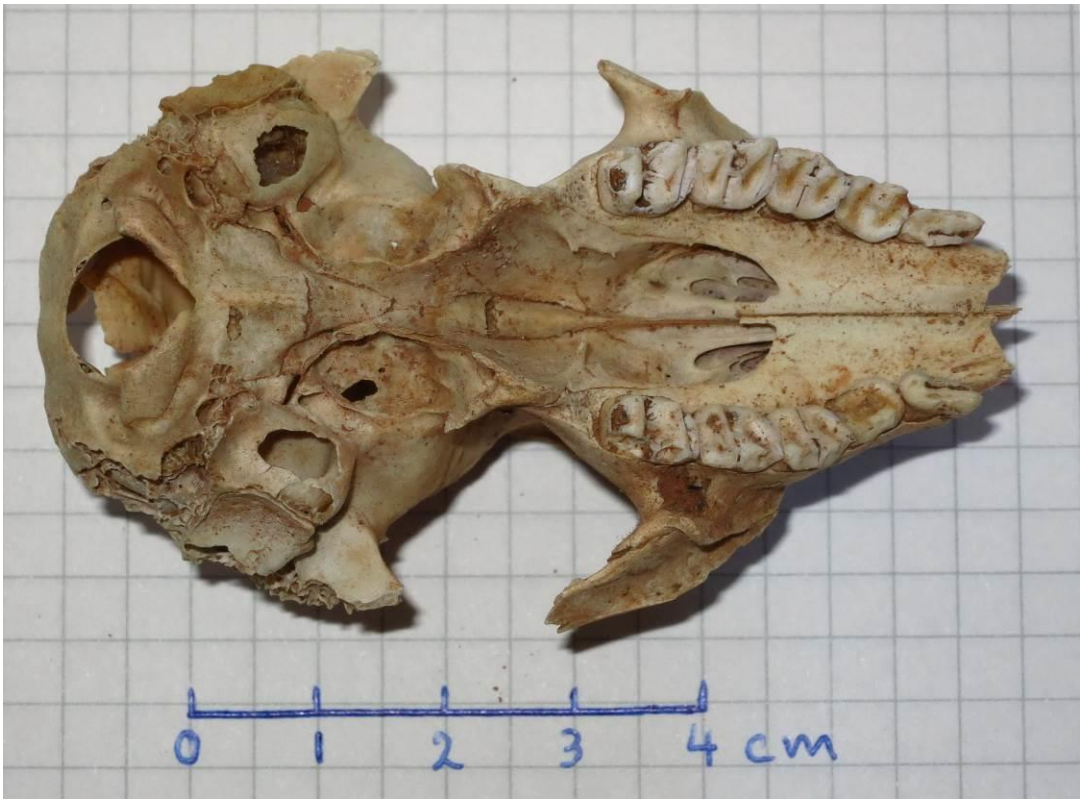

Image 7. Partial rock wallaby skull

Image 8. Stick-nest rat nest remains

3.5 Survey effort and survey site similarity

From the approximately 600 individual records and 77 native ground dwelling vertebrate species identified, the Chao2 index and Jacknife 2 index predict a total of 95 and 104 species respectively (Figure 4.) The species observed (77) therefore represent 74% predicted by the Jacknife 2 index and as high as 81% from the Chao 2 index indicating that further sampling effort is likely to reveal additional species not recorded during the three surveys undertaken for this program.

Few of the survey sites show high similarity to one another based on species composition (Figure 5), however further sampling under appropriate climatic conditions will continue to reveal additional species at the site scale and consequently this is likely to increase similarity, particularly for sites with comparable environmental attributes. Sites that show a moderate level of similarity(>50%) includes all those directly associated with sand dunes or immediately adjacent sand plains (CR1 P1, CR1 P2, CR2 P2 and CR2 P3), those with a stoney substrate incorporating spinifex and Acacia shrubs (CR1 P3 and CR2 P6) and those comprising of deep red sands on plains (CR2 P7 and CR2 P8). Site CR1 P10 has low richness but also has the only record of western stone gecko (*Diplodactylus granariensis*) and consequently this site has little similarity with any other site. Site CR1_4 is also differentiated from most other sites, in part due to the presence of two species of frogs, the desert tree frog (*Litoria rubella*) and main's frog (*Cyclorana maini*), not recorded on any other trapping site, and the occurrence of the common rock-rat (*Zyzomys argurus*). It does not appear that there is any significant difference amongst sites based on whether they are positioned in the northern or southern parts of the project area.

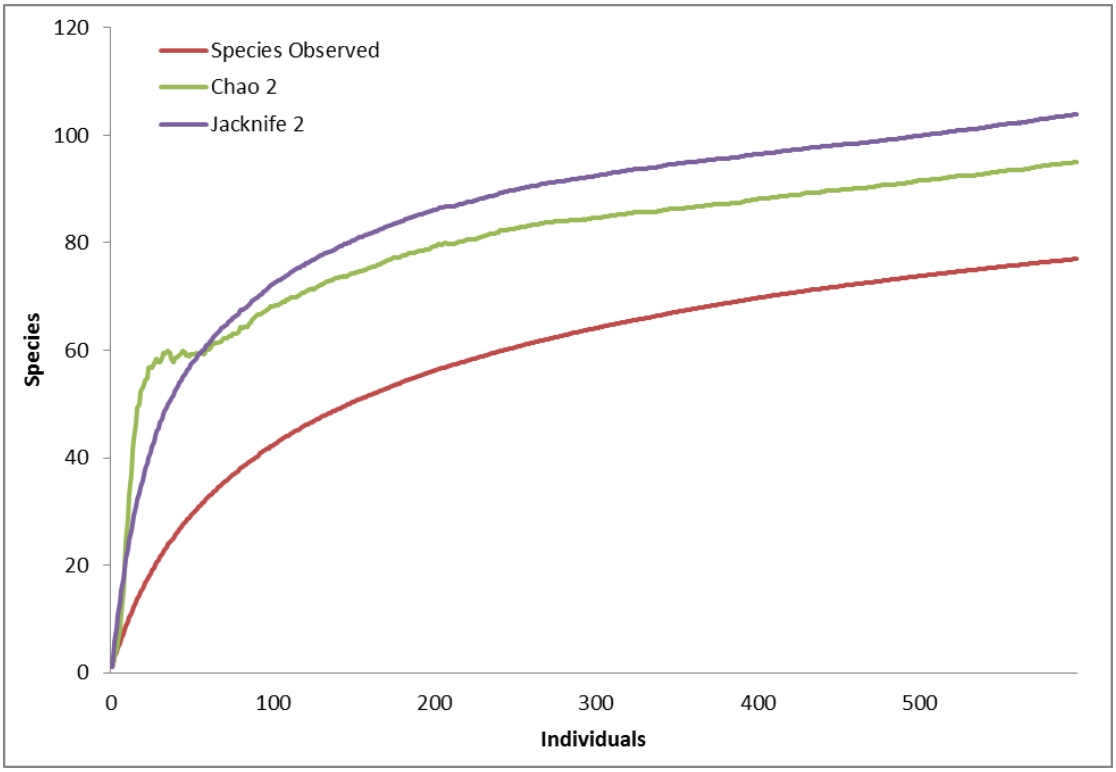

Figure 4. Permutated species accumulation for all surveys (species observed) along with the Chao 2 and Jacknife 2 indices.

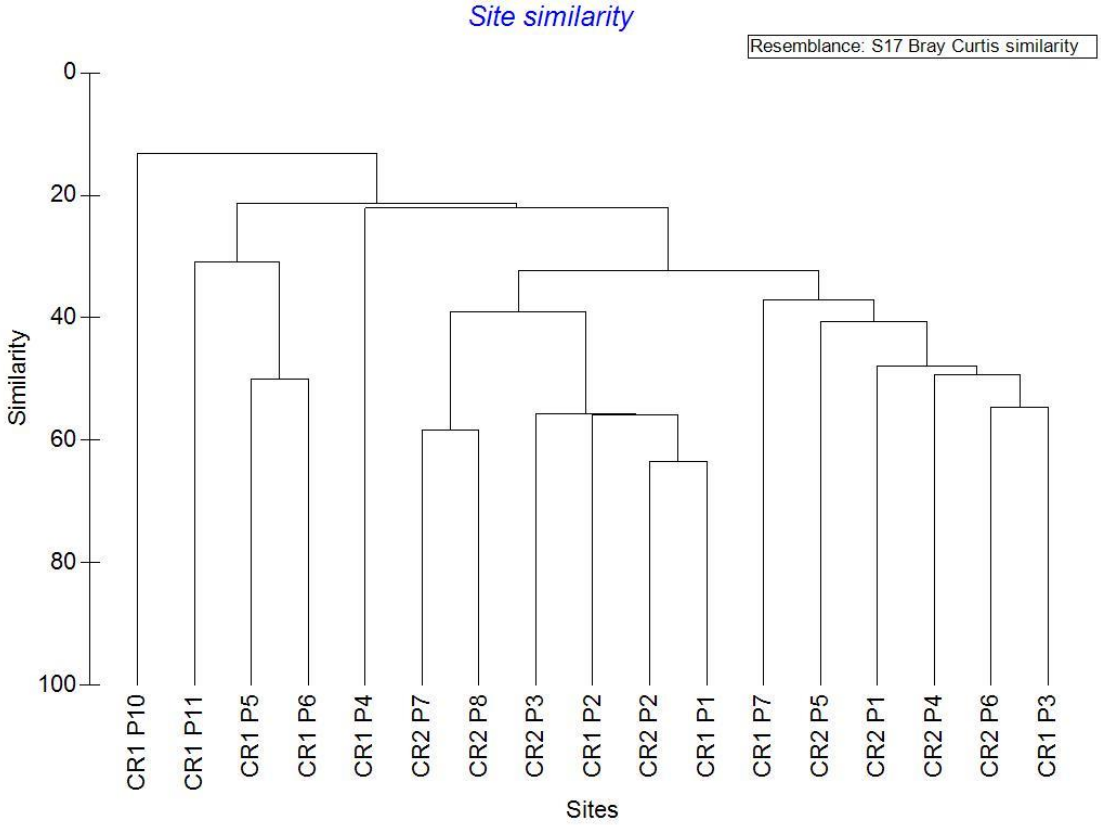

Figure 5. Similarity among all pit trapped sites (Sorensen's coefficient) for presence/absence data.

4. Discussion

Only limited vertebrate species information was available for Katjarra prior to these surveys and this information was derived from two earlier surveys. An expedition in 1975 by the then Department of Fisheries and Wildlife and more recently by a Landscope Expedition (run by the former Department of Conservation and Land Management) in 2001 of which the author was also involved. The current survey work is the most comprehensive to date for Katjarra with the establishment of 16 pit trap lines and five Elliot trap lines. The techniques employed through this work, including the use of remote cameras and manual searching, continue to identify new species records for the area as well as providing more detailed distributional data for species already known. Tissue collections from all species will contribute to taxonomic and population studies both now and into the future and the lodgement of material within the collections of the Western Australian Museum will ensure the long term validity of data gathered from this survey. These types of collections and surveys are essential for understanding vertebrate biogeographic patterning and ecology at a number of spatial scales. In this case we are able to view Katjarra more broadly and begin to develop an understanding within its regional context of the Little Sandy Desert Bioregion.

Important finds include those of the bilby, brush tailed mulgara and long-tailed dunnart and further work may reveal more populations of these species as well as identifying other species of conservation significance. The current list of recorded species now stands at four frogs, 57 reptiles, 16 native ground dwelling mammals and six species of bat. The number of introduced mammals, including the dingo stands at five. As many as 14 of the 21 previously unrecorded taxa are towards or at the known limits of their ranges signifying the overall importance of Katjarra for conservation. Given the diversity of habitats and the still comparatively small survey effort for the area, along with the diversity of species known to occur both north and south of the area, it is reasonable to expect the list of fauna to continue to grow with continuing effort. This is particularly the case for reptiles as most survey work has been undertaken at times when activity might be expected to be quite low due to the prevailing cool conditions.

Feral species in the arid interior continue to pose a threat to the persistence of some native species through both competition and predation. The presence of the feral cat around permanent and semi-permanent water points may be a significant problem, especially as where cats were detected to be in high abundance via camera traps the detection of small mammals was very low to negligible. If capacity to undertake feral cat management eventuates areas of refugia around water sources would probably be important to include in any control program.

Acknowledgements

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assistance in establishing and running survey lines. Rob Thomas, Lindsey Langford and Hamish Morgan from the Central Desert Native Title Services provided logistic support and coordination as well as assisting with on ground work. Staff from the Department of Parks and Wildlife's Goldfields Regional Office were involved in the first two surveys. Last but not least we are grateful to our survey colleagues who provided additional observations. Permission was given by staff of the Western Australian Museum to access the vertebrate collection records. This work was carried out under AEC permit number 2013/11 and scientific fauna licence number 54747.

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Appendices

Appendix 1. List of Frogs, Reptiles and Mammals occurring at Katjarra.

Number of taxa: 100 species with six introduced

FAMILY	Species	Previous Survey	2012-2014 Survey	New record	Introduced	EPBC-Act Listed	State Listed
Hylidae	*Litoria rubella*	+	+				
Hylidae	*Cyclorana maini*	+*	+				
Limnodynastidae	*Neobatrachus sutor*	+					
Limnodynastidae	*Neobatrachus wilsmorei*	+					
Limnodynastidae	*Notaden nichollsi*		+	×			
Agamidae	*Amphibolurus longirostris*	+	+				
Agamidae	*Ctenophorus caudicinctus*	+	+				
Agamidae	*Ctenophorus isolepis*	+	+				
Agamidae	*Ctenophorus nuchalis*		+	×			
Agamidae	*Ctenophorus scutulatus*		+	×			
Agamidae	*Diporiphora amphiboluroides*		+	×			
Agamidae	*Diporiphora winneckei*	+					
Agamidae	*Moloch horridus*	+	+				
Agamidae	*Pogona minor*	+	+				
Agamidae	*Tympanocryptis cephalus*		+	×			
Carphodactylidae	*Nephrurus laevissimus*	+	+				
Carphodactylidae	*Nephrurus levis*	+	+				
Diplodactylidae	*Crenadactylus ocellatus*		+	×			
Diplodactylidae	*Diplodactylus conspicillatus*	+					
Diplodactylidae	*Diplodactylus granariensis*		+	×			
Diplodactylidae	*Lucasium squarrosum*		+	×			
Diplodactylidae	*Lucasium stenodactylum*	+	+				
Diplodactylidae	*Oedura marmorata*	+	+				
Diplodactylidae	*Rhynchoedura ornata*	+**	+	×			
Diplodactylidae	*Strophurus ciliaris*	+**	+	×			
Diplodactylidae	*Strophurus elderi*		+	×			
Diplodactylidae	*Strophurus wellingtonae*	+					
Gekkonidae	*Gehyra punctata*		+	×			

FAMILY	Species	Previous Survey	2012-2014 Survey	New record	Introduced	EPBC-Act Listed	State Listed
Gekkonidae	*Gehyra purpurascens*	+	+				
Gekkonidae	*Gehyra variegata*	+	+				
Gekkonidae	*Heteronotia binoei*	+	+				
Pygopodidae	*Delma desmosa*		+	×			
Pygopodidae	*Delma nasuta*		+	×			
Pygopodidae	*Lialis burtonis*	+	+				
Pygopodidae	*Pygopus nigriceps*	+					
Scincidae	*Cryptoblepharus buchananii*	+	+				
Scincidae	*Ctenotus ariadnae*		+	×			
Scincidae	*Ctenotus brooksi*		+	×			
Scincidae	*Ctenotus calurus*	+	+				
Scincidae	*Ctenotus dux*	+	+				
Scincidae	*Ctenotus grandis*	+	+				
Scincidae	*Ctenotus helenae*		+	×			
Scincidae	*Ctenotus leonhardii*		+	×			
Scincidae	*Ctenotus nasutus*		+	×			
Scincidae	*Ctenotus pantherinus*	+	+				
Scincidae	*Ctenotus quattuordecimlineatus*	+	+				
Scincidae	*Ctenotus saxatilis*	+	+				
Scincidae	*Ctenotus schomburgkii*	+	+				
Scincidae	*Ctenotus uber*	+*	+	×			
Scincidae	*Cyclodomorphus melanops*	+					
Scincidae	*Egernia depressa*	+	+				
Scincidae	*Egernia formosa*	+*					
Scincidae	*Eremiascincus pallidus*		+	×			
Scincidae	*Lerista bipes*		+	×			
Scincidae	*Lerista desertorum*	+	+				
Scincidae	*Lerista ips*		+	×			
Scincidae	*Lerista kingi*	+*					
Scincidae	*Lerista timida*		+	×			
Scincidae	*Liopholis striata*	+	+				
Scincidae	*Menetia greyii*		+	×			
Scincidae	*Morethia ruficauda*		+	×			
Scincidae	*Tiliqua multifasciata*	+					
Varanidae	*Varanus acanthurus*	+*					
Varanidae	*Varanus brevicauda*		+	×			
Varanidae	*Varanus eremius*	+	+				
Varanidae	*Varanus giganteus*	+	+				
Varanidae	*Varanus gouldii*	+	+				

FAMILY	Species	Previous Survey	2012-2014 Survey	New record	Introduced	EPBC-Act Listed	State Listed
Varanidae	*Varanus panoptes*	+*					
Elapidae	*Brachyurophis semifasciatus*		+	×			
Elapidae	*Demansia psammophis*		+	×			
Elapidae	*Parasuta monachus*		+	×			
Elapidae	*Pseudechis australis*	+	+				
Elapidae	*Pseudonaja mengdeni*		+	×			
Elapidae	*Simoselaps anomalus*		+	×			
Elapidae	*Simoselaps bertholdi*		+	×			
Typhlopidae	*Anilios hamatus*		+	×			
Typhlopidae	*Anilios sp.*		+	×			
Tachyglossidae	*Tachyglossus aculeatus*	+**	+				
Dasyuridae	*Antechinomys laniger*		+[$]	×			
Dasyuridae	*Dasycercus blythi*		+	×			×
Dasyuridae	*Ningaui ridei*	+	+				
Dasyuridae	*Pseudantechinus woolleyae*		+	×			
Dasyuridae	*Sminthopsis longicaudata*		+	×			×
Dasyuridae	*Sminthopsis macroura*		+	×			
Dasyuridae	*Sminthopsis ooldea*		+	×			
Dasyuridae	*Sminthopsis youngsoni*	+	+				
Macropodidae	*Macropus robustus*	+**	+				
Macropodidae	*Macropus rufus*	+**	+				
Notoryctidae	*Notoryctes sp.*		+	×		×	×
Peramelidae	*Macrotis lagotis*		+	×		×	×
Muridae	*Mus musculus*	+	+		×		
Muridae	*Notomys alexis*	+	+				
Muridae	*Pseudomys desertor*	+	+				
Muridae	*Pseudomys hermannsburgensis*	+	+				
Muridae	*Zyzomys argurus*		+	×			
Camelidae	*Camelus dromedarius*	+**	+		×		
Leperoridae	*Oryctolagus cuniculus*		+		×		
Canidae	*Canis lupus dingo*	+**	+		×		

FAMILY	Species	Previous Survey	2012-2014 Survey	New record	Introduced	EPBC-Act Listed	State Listed
Canidae	*Vulpes vulpes*		+		×		
Felidae	*Felis catus*		+		×		
Emballonuridae	*Saccolaimus flaviventris*	+	+				
Molossidae	*Mormopterus beccarii*	+					
Molossidae	*Tadarida australis*	+	+				
Vespertilionidae	*Chalinolobus gouldii*	+					
Vespertilionidae	*Nyctophilus geoffroyi*	+					
Vespertilionidae	*Vespadelus finlaysoni*	+					

* - recorded at Katjarra but not within close proximity of current survey locations.
** - recorded by McKenzie and Burbidge (1979) but no specimens.
$ - sub-fossil remains identified from owl pellets

Appendix 2. Site Photos

Site CR1 P1

Site CR1 P2

Site CR1 P3

Site CR1 P4

Site CR1 P5

Site CR1 P6

Site CR1 P9

Site CR1 P10

Site CR2 P1

Site CR2 P2

Site CR2 P3

Site CR2 P4

Site CR2 P5

Site CR2 P6

Site CR2 P7

Site CR2 P8

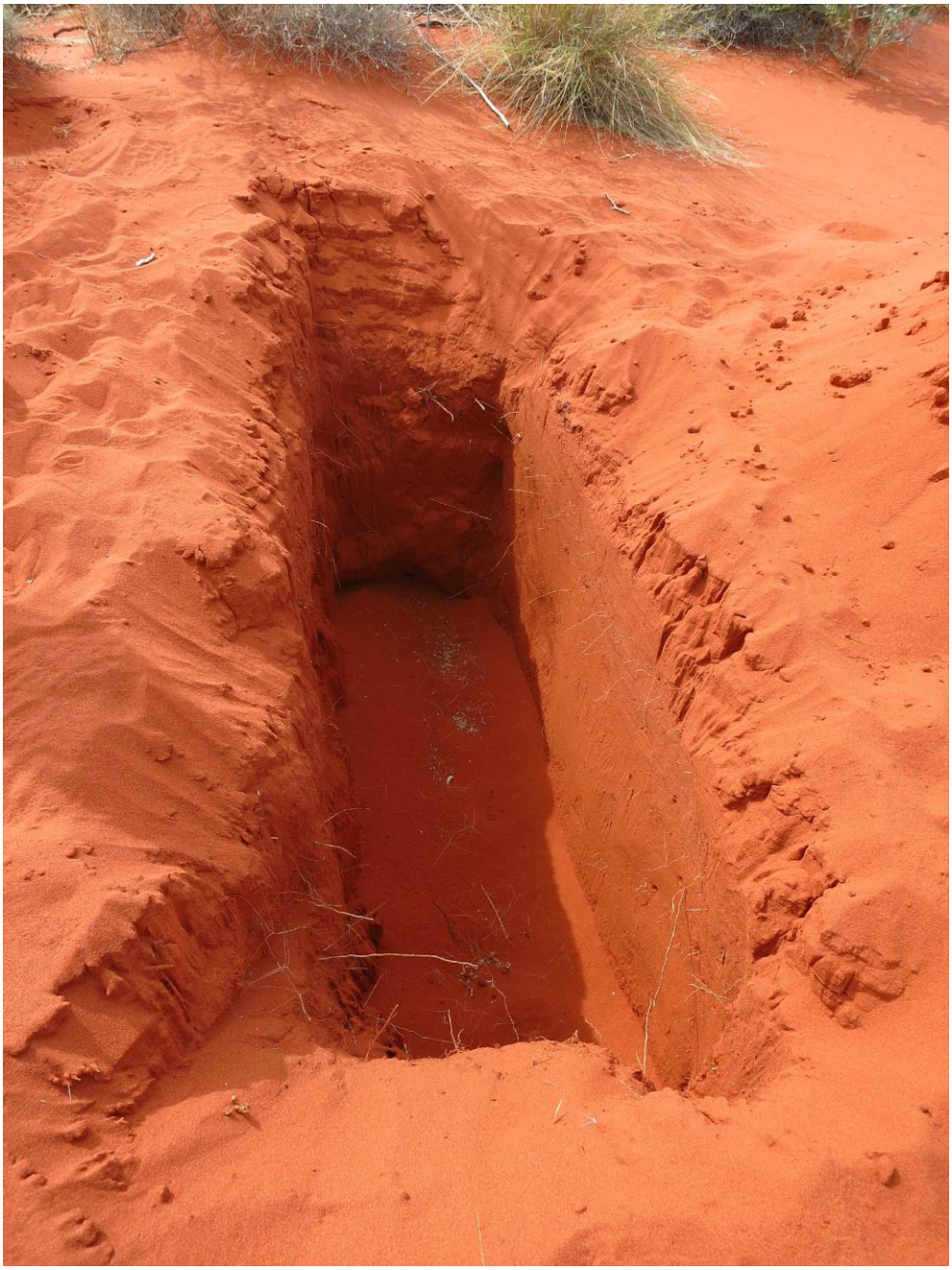
CR2 E9 Elliot trapping location at Katjarra (Virgin Springs)

CR2 E10 Elliot trapping through spinifex side of range to base of cliffs

CR2 E11- Elliot trapping location, Talbot's Rockhole

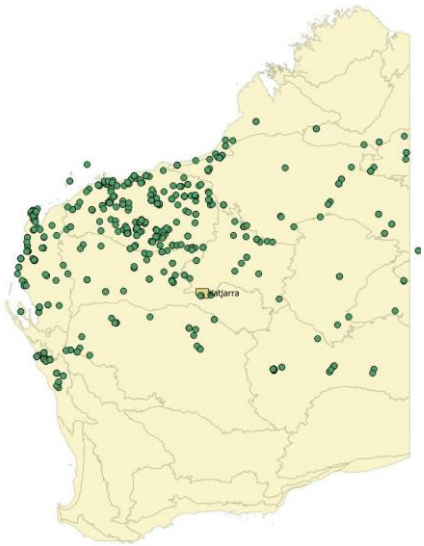
Appendix 3. Mole Trench Locations

Site Code	Latitude	Longitude	Evidence of Burrows	Time established
MC1	-25.26672	120.627798	yes	May 2013
MC2	-25.072655	120.734161	yes	March/April 2014
MC3	-25.079506	120.727867	no	March/April 2014
MT#1	-25.026528	120.698333	no	May 2014
MT#2	-25.036139	120.712472	yes	May 2014
MT#3	-25.039667	120.722056	yes	May 2014
MT#4	-25.054278	120.737833	no	May 2014
MT#5	-25.061722	120.742028	yes	May 2014
MT#6	-25.266056	120.629083	yes	May 2014
MT#7	-25.243667	120.660861	yes	May 2014
MT#8	-25.224278	120.664639	yes	May 2014
MT#9	-25.191972	120.678639	yes	May 2014
MT#10	-25.155	120.692389	yes	May 2014

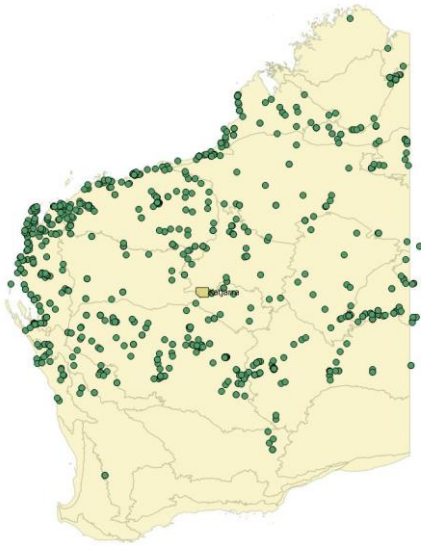


Appendix 4. Photos and Museum distributional records for previously unrecorded species.

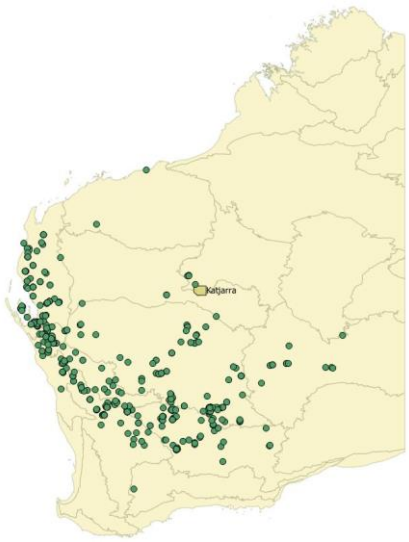
Notaden nichollsi



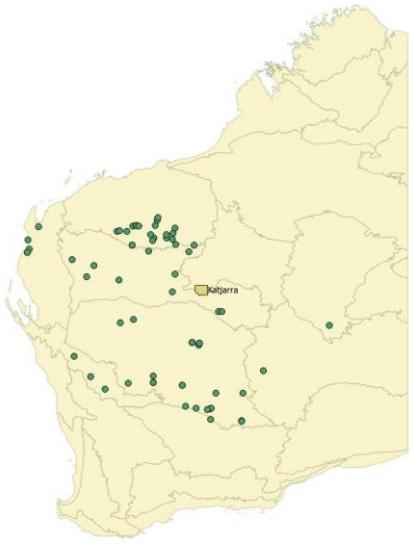
Amphibolurus longirostris



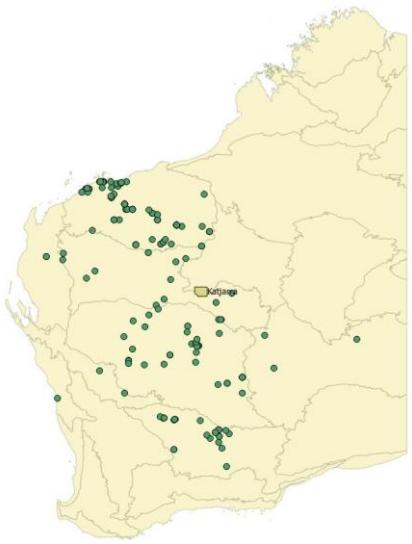
Ctenohorus nuchalis



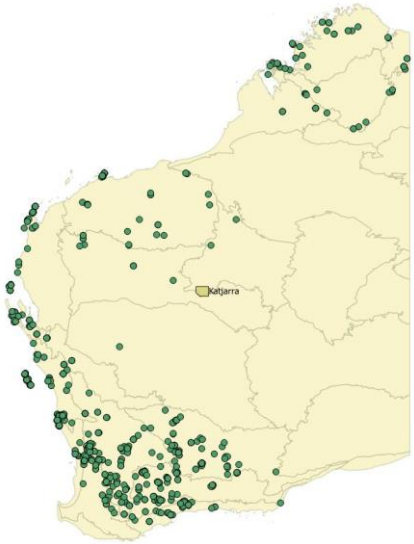
Ctenophorus scutulatus



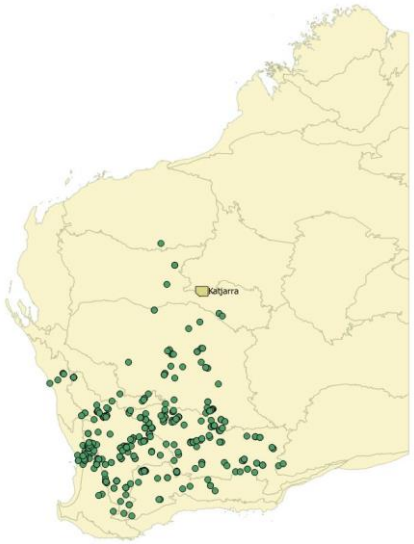
Diporiphora amphiboluroides



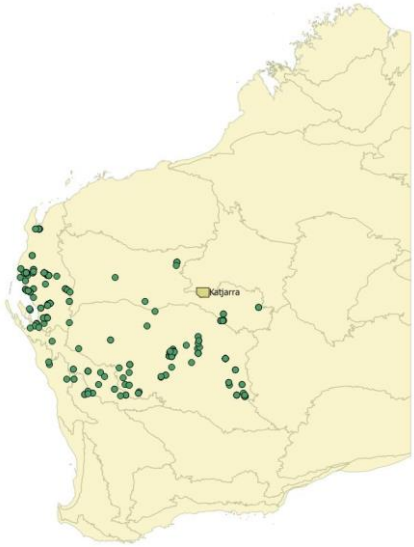
Tympanocryptis cephalus



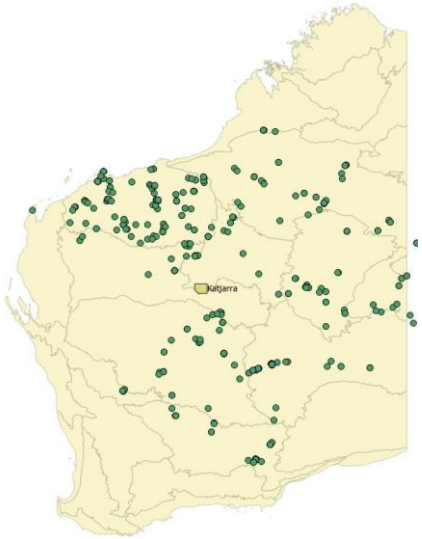
Crenadactylus ocellatus



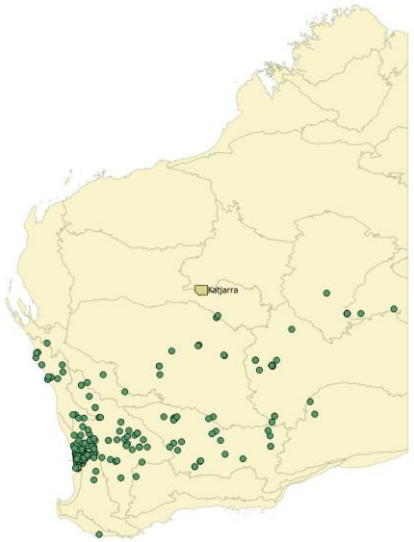
Diplodactylus granariensis



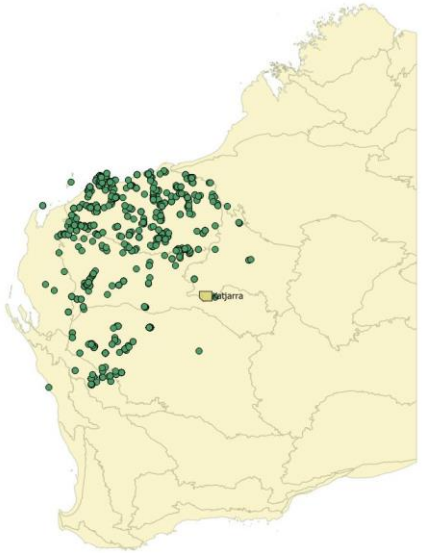
Lucasium squarrosum



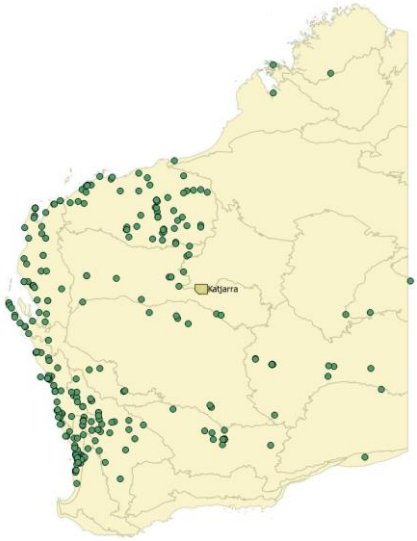
Strophurus elderi



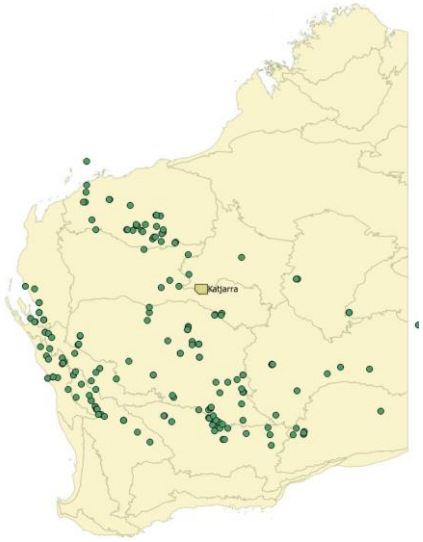
Brachyurophis semifasciata



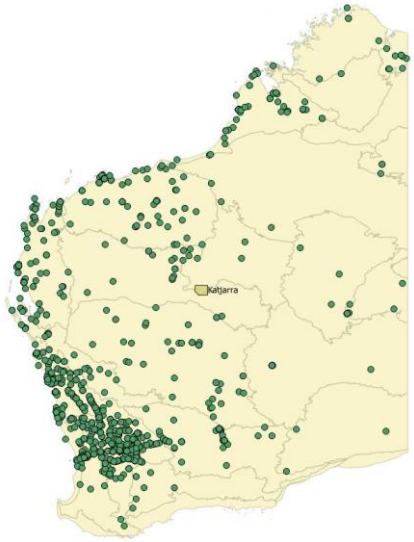
Gehyra puncata



Demansia psammophis



Parasuta monachus



Pseudonaja mengdeni