

# **Kiwirrkurra Indigenous Protected Area BushBlitz Survey**

*Kiwirrkurra IPA*

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***Survey of Mammals and Reptiles***

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## Abstract

We undertook sampling for reptiles and mammals using pitfall traps (pits), funnel traps (funnels), Elliott traps (elliotts) and observational techniques at 16 sites within the Kiwirrkurra Indigenous Protected Area (IPA), Western Australia, over a period of 12 days in September 2015. From the more than 300 captures and observations we identified a total of 67 species of native vertebrates including one frog, 48 reptiles, and 18 mammals. At least five of the reptiles and eight of the mammals (one dasyurid and seven bats) were new records for the area. This work resulted in the incorporation of over 150 voucher specimens into the Western Australian Museum (WAM) collections along with 265 tissue samples, thus almost doubling the voucher collections and more than doubling tissue samples available for future work. Through local knowledge we also recorded the occurrence of three Commonwealth and State Listed species, two mammals and one reptile.

## 1. Introduction

The Kiwirrkurra IPA is positioned across the boundary between the Gibson Desert and Great Sandy Desert Bioregions (Interim Biogeographic Regionalisation of Australia-Thackway & Cresswell 1995) and covers some 42,000 km<sup>2</sup>. This area possesses extensive areas of hummock grasslands with systems of parallel dunes, open acacia woodlands and shrublands, and palaeodrainage channels supporting melaleuca shrublands as well as chenopod and samphire communities. The extensive sand plains along with areas of lateritic plain are interrupted with other features such as low rugged rocky ranges, numerous isolated boulder piles and the extensive salt lake system of Lake Mackay with its myriad of “islands”. Claypans are another feature in the north east as well as a number of ephemeral wetlands both fresh and saline. Fire plays a significant role in shaping ecological communities in the region, in particular areas dominated by hummock, with a variety of fire ages apparent.

While indigenous biological knowledge of the area is still strong within the Kiwirrkurra community, scientific information on species occurrences for this and surrounding desert areas remains relatively sparse. In an analysis of effort for Western Australia derived from museum collections (How and Cowan 2006), the surrounding areas within the Gibson and Great Sandy Deserts remain some of the most poorly sampled areas with low documented species richness, abundance and survey effort for all vertebrates. Consequently, while many vertebrates are ubiquitous and their occurrence in suitable habitats across the arid zone might be reasonably expected, the verification, documentation and DNA tissue collection remain important scientific endeavours for taxonomy and ecology and are an essential underpinning component of biodiversity conservation planning.

## 2. Methods

### 2.1 Site selection

Three areas were selected for survey to broadly cover the geographic extent and habitat types of the project area. This involved the establishment of six survey sites around Kiwirrkurra, another four sites to the west near Nyinmi and four sites around Murrur, adjacent to Lake Mackay (Fig. 1). As the distance between areas was substantial (~ 100 km) we established a camp at each area and sampled them independently. Sites were selected at each area to represent the major diversity of habitats and/or significant environmental attributes such as long unburnt spinifex or ephemeral damp areas.

Some minor geographic adjustments were made from the initial research plan sites as the level of detail available from imagery and remote sensing is insufficient to identify required attributes on the ground. This was also necessary for the standard survey sites as the pre-determined points did not align with the described targeted habitats. Site codes, coordinates and sampling effort for each of the 14 trapping sites is presented in Appendix 1.

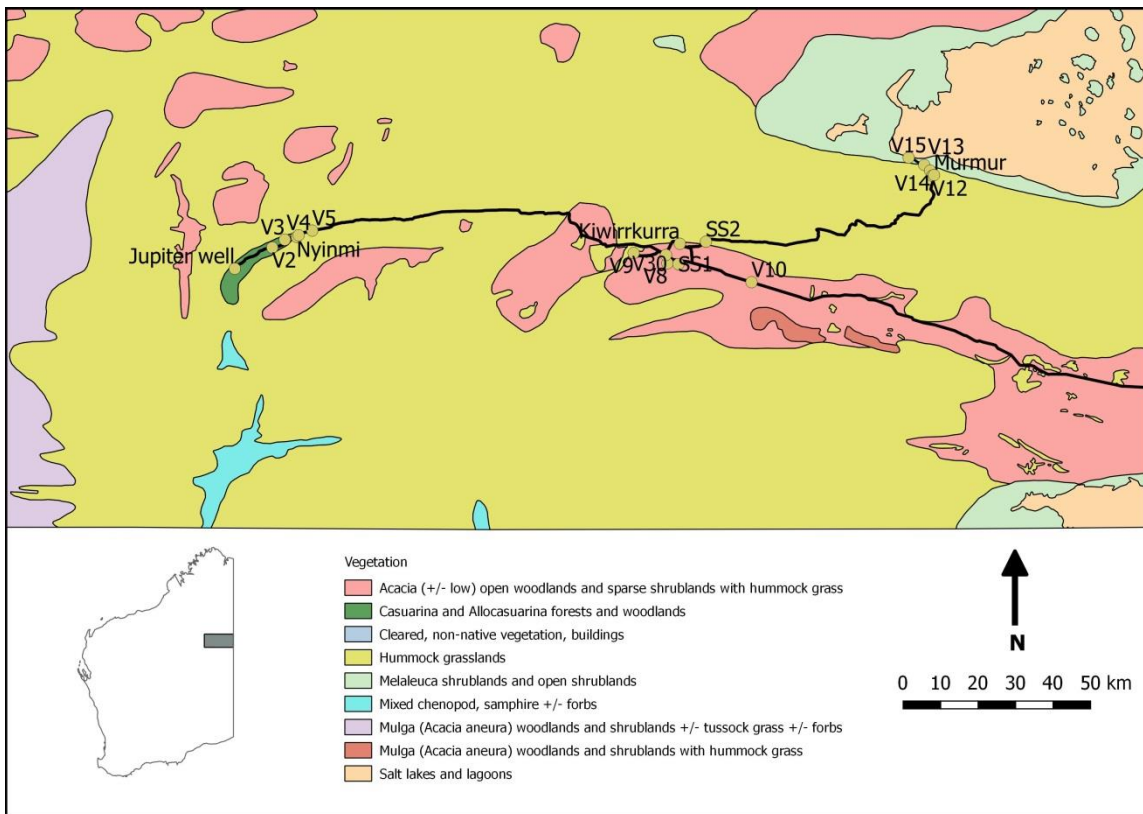


Figure 1. Major vegetation types and survey locations within the Kiwirrkurra Indigenous Protected Area (IPA)

## 2.2 Collection methods

Surveys were undertaken using a variety of standard methods. For most of the predetermined sites a single pit/funnel line was established which consisted of a 50-60 m drift fence, six evenly spaced 20L pits and six funnels set in pairs midway between pits (Image 1 below). Pits were not used at sites V8 and V9 owing to the rocky substrate. Instead, V8 had two 30 m drift lines with three pairs of funnels on each, while V9 had Elliotts only with no funnels or pits. For mammals, a single line of 25 medium-sized Elliott traps (type B) were placed at 10-15 m intervals at each site. Traps were baited with standard universal bait (a combination of oats and peanut butter).



Image 1. Typical trap line with funnel traps in the foreground and pitfall traps behind.

Timed active foraging was undertaken at sites SS1 and SS2 as per BushBlitz instructions in “Survey methods for use at standard survey sites on the Kiwirrkurra BushBlitz”. Opportunistic head torching, hand searching and observations were undertaken across a range of additional sites including those accessed via helicopter to the south of Nyinmi and on island sites in Lake Mackay. Observations also included watching at fire fronts as Traditional Owners implemented localised burning in infrequently visited areas (Image 2 below).

All traps were checked as soon as possible after sunrise. A minimum of two nights/days of trapping were undertaken at each site, with a mean of three nights and maximum of four nights. For standard biological surveys in Western Australia, more time would generally be required to thoroughly document fauna at each site (EPA 2010). However, for this type of rapid survey where time is limited and overall diversity is one of the primary objectives, spreading effort over a larger area for shorter periods is likely to be the more prudent method.

For at least one night at each of the camp sites a Wildlife Acoustics SM2BAT stereo full-wave ultrasonic recorder (192 kHz sampling rate) was run throughout the night. An omni-directional SMX-ultrasonic microphone was used and orientated vertically upwards one and a half metres above ground level to minimise echoes. Data were



captured on 16GB high speed SD cards for later analysis.

We deployed several remote cameras to determine if the bilby (*Macrotis lagotis*) was within the immediate vicinity of the Kiwirrkurra community. While remote cameras are useful in detecting and identifying larger animals and some highly distinctive smaller species (e.g. Spinifex hopping mouse, *Notomys alexis*), resolution of images with infrared filters at night remains problematic for differentiating smaller species such as dunnarts (*Sminthopsis* spp.) and native mice (*Pseudomys* spp.). We detected individuals in both of these genera but it was not possible to identify them to species level.

Reptile and mammal observations from other BushBlitz team members that could be verified through photos or descriptions, and where coordinates could be provided were also collated and included in the accompanying dataset.



Image 2. Burning spinifex south of Nyinmi

## 2.3 Identifying the collections

Captured animals were identified in the field or at camp (for more difficult species), and then either released at point of capture, or collected as a representative voucher specimen for lodgement in the WAM. Voucher specimens were humanely euthanased (DPAW Animal Ethics approval no 18/2015-2018), then placed in a tray and fixed in 10% formalin for seven to eight days after which they were rinsed in water for 12 hours prior to transfer into 70% ethanol for transport. All specimens were labelled with a unique six digit numeric identification tag incorporating an M prefix for mammals, R for reptiles or A for birds. Specimens were then all re-examined in Perth to confirm field identifications.

Tissue samples were taken from the majority of captured animals. These consisted of a small portion of liver for vouchered animals, or for live animals an ear punch for mammals and a tail tip for reptiles. These samples were labelled and preserved in individual vials containing 100% ethanol in preparation for storage within the WAM and future molecular analysis.

We collected basic morphological information for all captures including sex, mass, snout-vent length, tail length along with pes and cranium lengths for mammals.

Identification of bat recordings were undertaken by N.L. McKenzie using call parameters comparison against a reference call library from the ‘Pilbara’, ‘Little Sandy Desert’ and ‘Kimberley’ of W.A. using the procedure described in McKenzie and Bullen (2012).

The primary sources of information for identification in the field were the Western Australian Museum’s reptile field guides (Storr et al. 1983; Storr et al. 1990; Storr et al. 1999; Storr et al. 2002) 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 2004), A Complete Guide to Reptiles of Australia (Wilson and Swan 2008) and Reptiles and Amphibians of Australia (Cogger 2014).

Continual taxonomic revision and the description of new taxa post the publication of some of the above field guides necessitate referral to a number of additional publications. Of particular relevance to species encountered during this field work were Doughty et al. (2012), Oliver et al. (2014) and Hutchinson et al. (2014). Other work referred to includes that of Paltridge (2010) in which a comprehensive summary of previously recorded species is given, along with species likely to be encountered. The collections database of the WAM Museum was accessed to identify the extent of previous collections in the area and the number of voucher and tissue samples within its collection.



Image 3. Vertebrate Team checking traps at Kiwirrkurra Standard Site 2 (Photo Brian Hawkins).

### **3. Results and Discussion**

#### **3.1 Overview of collecting**

Fourteen sites were established across the study area and systematically sampled using Elliott traps and/or funnel and pit traps with drift fence as well as hand searching and head torching where possible. In addition to work on specific survey sites, opportunistic sampling was undertaken by hand at a number of additional locations including sites to the south of Nyinmi and islands on Lake Mackay accessed by helicopter.

Temperature and humidity are significant environmental variables associated with activity patterns for reptiles but also influencing to some degree activity in small mammals. Daytime temperatures were warm to hot, however while the minimum temperature on the first night was quite high, this subsequently decreased and night temperatures were moderately cool for the remainder of the trip (Fig. 2). There was a small amount of precipitation on a single night (7/09/2015) early in the trip but overall conditions remained dry with low relative humidity (Fig. 3). As many arid zone species are crepuscular or nocturnal, conditions were not always conducive for high activity.

A total of 1 frog, 48 reptiles and 18 native mammal species were recorded from the entire survey. For the reptiles this consisted of 8 dragons, 11 geckos, 4 legless lizards, 15 skinks, 5 goannas and 5 snakes. An examination of databases indicate there were 49 species recorded from the broad area we worked in, however, from the 48 species we documented almost 10% (5 species) were new records. Through a number of methods including trapping, observation, remote cameras, acoustic sampling, tracks and scats we recorded 7 marsupials, 3 rodents, 7 bats and 1 echidna. There was a single non-volant mammal, a dasyurid, along with 6 bats that were new records for the survey area. A total of six introduced mammals (including the dingo) were recorded.

Acoustic sampling for bats was undertaken at three locations, one night at site V9, three nights at Nyinmi and one night at Murmur. Six species were recorded at Nyinmi, four species at site V9 and only one at Murmur and this is probably a reflection of the complexity of the habitat associated with each of the recording areas.

Two standard survey sites, one incorporating an unburnt dune system (SS2) and the other sandplain with mulga woodland over spinifex (SS1) were sampled using BushBlitz “standard vertebrate survey” methodology. As well as this standard survey methodology both of these sites were also pit and funnel trapped. For site SS1 there were six species of reptile detected and two species of mammal. Two of the six reptiles were only caught in traps. Site SS2 had almost twice the species richness of SS1 with the detection of 11 reptile and four mammal species. Six of these reptile species were only caught in traps. The diversity of habitat associated with the dune site (SS2) from the more uniform and simpler environment of the mulga woodland (SS1) is likely to account for the significant difference in vertebrate richness. Captures from each of the standard survey sites are presented in Appendix 3.



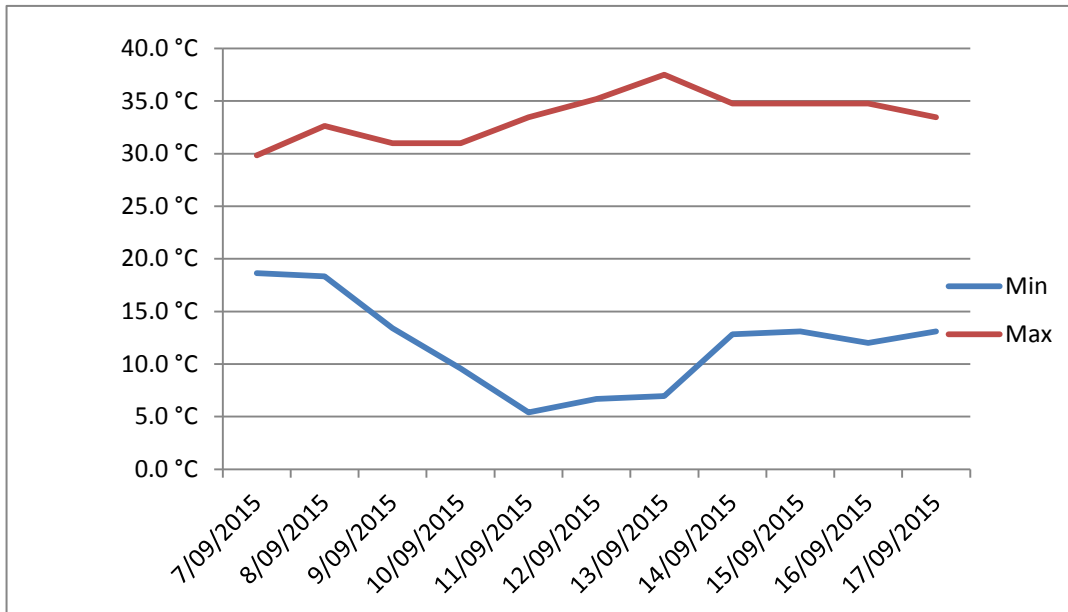


Figure 2. Daily maximum and minimum temperatures at Kiwirrkurra throughout the duration of the survey.

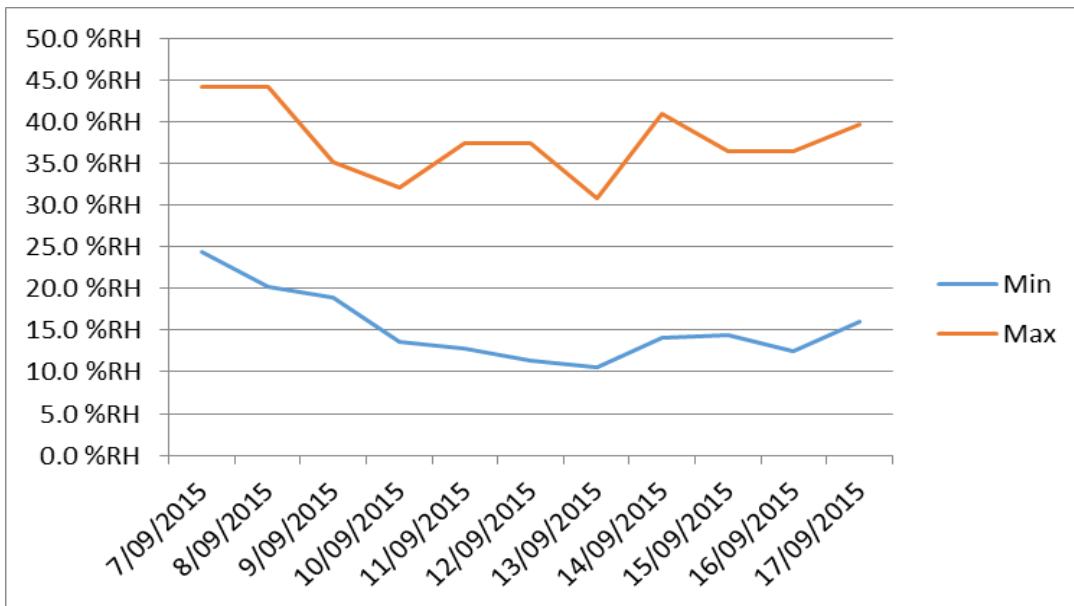


Figure 3. Maximum and minimum relative humidity at Kiwirrkurra throughout the duration of the survey.

An examination of species accumulation data derived from all reptile and small mammal data show that a total of 53 species were detected from 300 individuals (Fig. 4). Using these data with the Chao1 and Jackknife1 species accumulation indices there were predicted species counts of 58 and 64 respectively. This indicates we had detected around 83% to 91% of the fauna likely to occur across the habitats sampled. This result is consistent with the total known number of trappable vertebrates recorded for the IPA. Subsequently, it is reasonable to postulate that there will be a small number of additional species which still remain undetected in the Kiwirrkurra IPA. Further work will also continue to add to tissue collections and resolve finer scale patterning in relation to environmental parameters for all species.

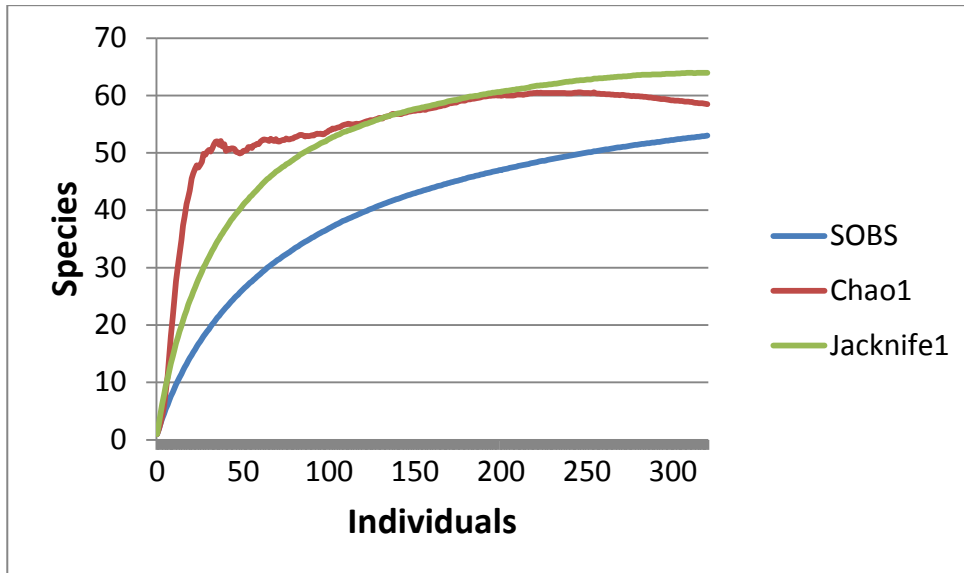


Figure 4. Species accumulation for species observed (SOBS) along with predicted species richness from the Chao1 and Jackknife1 indices.

In addition to the biological material collected and observed, there was strong cross-cultural exchange between the scientific team and traditional owners. As well as the transfer of knowledge of tracking animals and learning scientific trapping and processing methods (Image 4, below), there was a sharing of many wonderful stories of traditional desert life and first experiences of meeting Australians of European heritage. We greatly appreciated the chance to learn about Kiwirrkurra culture as well as language names for many of the animals and sites.



Image 4. Checking traps at Kiwirrkurra Standard Site 1 (SS1; Photo Brian Hawkins).

### 3.2 Named taxa newly recorded for the reserve

We documented five species of reptile and eight species of mammal previously unrecorded in the IPA (Table 2). For the reptiles, this comprised of two snakes, two legless lizards and a gecko, while for the mammals one small marsupial and seven bats, with the latter comprising three separate families. Only two of the reptile species were detected through trapping with the remainder all single observations. The gecko, smooth knob-tail gecko (*Nephrurus levis* – Image 5, below), was caught on seven occasions at sites around Kiwirrkurra and Nyinmi while the hooded scaly-foot (*Pygopus nigriceps*) was caught only once near Lake Mackay. The small dasyurid, the fat-tailed false antechinus (*Pseudantechinus macdonnellensis*), was locally abundant in the rock pile sampled at site V8 and although only caught once at V9 would likely be abundant there also considering the type and extent of rocky habitat (Image 6, below). Six of the seven females caught of this species were carrying pouch young. The probable lack of prior sampling for bats may account for the single species record prior to this survey. The development of the newer generation of sophisticated ultrasonic recorders such as the SM2Bat, along with call libraries and methodology developed by McKenzie and Bullen (2012), now make field aspects of bat sampling comparatively straightforward, although the resulting data files still require considerable effort to analyse. None of the species identified in this table are range extensions and as all are widespread through the arid regions none are remarkable in their occurrence.

There were a number of additional species we documented through a variety of means such as the bilby, the great desert skink (*Liopholis kintorei*), the centralian blue-tongue (*Tiliqua multifasciata*), the northern marsupial mole (*Notoryctes caurinus*), kangaroos and large goannas (Image 7, below). We did not incorporate these in the table listing here, despite the lack of incorporation in any formal databases covering the IPA, as all these species would be well known, and in some cases hunted, by local Kiwirrkurra residents.





Image 5. Smooth knob-tail gecko (*Nephurus levis*).



Image 6. The fat-tailed false antechinus (*Pseudantechinus macdonnellensis*).



Image 7. A Perentie (*Varanus giganteus*; Photo Dan Driscoll).



Table 2. Named taxa newly recorded from Kiwirrkurra IPA.

| Taxon                                  | Comment   |
|--|---|
| Reptiles                               |   |
| <i>Lialis burtonis</i>                 | Single record of deceased individual from 22.8011S, 126.7624E |
| <i>Nephrurus levis</i>                 | Nine individuals with records from SS1,SS2, V30 and Nyinmi    |
| <i>Pseudechis australis</i>            | Single individual dead on road at 22.8559S, 127.7537E         |
| <i>Pseudonaja mengdeni</i>             | Single observation from V13                                   |
| <i>Pygopus nigriceps</i>               | Single record from V13  |
| Mammals                                |   |
| <i>Pseudantechinus macdonnellensis</i> | Seven captures from rocky areas at V9 and V8                  |
| <i>Saccolaimus flaviventris</i>        | Recorded nightly at Nyinmi                                    |
| <i>Taphozous hilli</i>                 | Recorded at site V9 and Nyinmi                                |
| <i>Mormopterus beccarii</i>            | Recorded at site V9 and Nyinmi                                |
| <i>Chaerephon jobensis</i>             | Recorded nightly at Nyinmi                                    |
| <i>Nyctophilus geoffroyi</i>           | Recorded nightly at Nyinmi                                    |
| <i>Scotorepens balstoni</i>            | Recorded one night at Nyinmi and again at Murmur              |
| <i>Vespadelus finlaysoni</i>           | Recorded one night at Nyinmi and again at site V9             |

### 3.3 Un-named taxa

There were no un-named or non-formalised vertebrate taxa recorded.

### 3.4 New species to be described

No new species awaiting description have been identified from this survey. However, the collection of 265 tissue samples across the range of species captured, along with 158 voucher specimens lodged in the WAM collections, will ensure the availability of material to contribute to future taxonomic examinations of taxa recorded here. There are several species groups we did record that may be the focus of future revision and/or for which this work contributes additional resolution on the extent of distributions and ecology. Specifically, species of the genera *Diporiphora*, *Gehyra* and *Diplodactylus*.

### 3.5 Weed or pest species

There were five introduced pest mammals recorded during this trip with camels (*Camelus dromedaries*), cats (*Felis catus*), foxes (*Vulpes vulpes*), rabbits (*Oryctolagus cuniculus*) and mice (*Mus musculus*) all being detected (Table 3). These species are all widely distributed throughout the arid, although foxes and rabbits are often more closely

associated with particular parts of the landscape than the other three species. In the case of rabbits, this association is often with the heavier soils and succulent vegetation around salt lakes and ephemeral wetlands, although they were also recorded around the large rock piles such as those at V9. Almost all fox detections occurred on and around the small islands within Lake Mackay. They are likely to occur in other parts of the landscape but probably at a lower density than cats since they have a greater dependence on free water. Cat detections were typical of those for any other arid environment with tracks frequently seen on the sandplains and dunes but animals likely to be present in all of the major environments at a moderate but significant density. Camels were observed as individuals and small groups and there was sign of camels (scats, tracks and browsing) in many of the areas we and our colleagues worked. Mice were caught at all major trapping locations but were most abundant at sites around Lake Mackay. This species will occur in most habitats but is particularly successful after disturbances such as fire and depending on environmental conditions go through dramatic population increases. The damage this species has done through competition, predation and disease spread is impossible to discern but likely to be significant to other species of small mammals.

Table 3. State or National weed or pest species recorded in Kiwirrkurra IPA.

| <b>Pest/weed species</b>     | <b>Location sighted/observed</b>                                | <b>Indication of abundance</b>                                     |
|------------------------------|---|--|
| <i>Camelus dromedarius</i>   | Around site V10 and near Lake Mackay.                           | Relatively common and individuals seen on most days of the survey. |
| <i>Felis catus</i>           | Track observed in most areas we worked.                         | Probably typical of arid environments.                             |
| <i>Mus musculus</i>          | Recorded from most areas.                                       | Third most abundant mammal species with 18 captures.               |
| <i>Oryctolagus cuniculus</i> | Site V8 and in habitats adjacent to lakes and drainage systems. | Sign suggests abundant in certain habitats.                        |
| <i>Vulpes vulpes</i>         | Tracks on and around islands in Lake Mackay.                    | Not able to determine.   |

### 3.6 Vulnerable, threatened or endangered species

As a result of the local knowledge of Traditional Owners we recorded evidence of three vertebrate species of conservation significance, the bilby (image 8A), the great desert skink (image 8B) and the northern marsupial mole (image 8C).

For the bilby more than 15 burrows, numerous diggings and lots of scats were located with the assistance of Traditional Owners. All of these were at a known location within several kilometres of the Kiwirrkurra community. We placed cameras for a total of eight nights on two burrows that appeared to have had recent activity but were only successful in recording one bilby at one of these on a single night. It was therefore not possible to make an assessment of abundance.

The great desert skinks were also at a location known to Traditional Owners approximately 20 km east of the community in an area where some burning had been

undertaken. We only spent a relatively short time in this vicinity but identified at least four active burrow complexes, all with substantial latrine areas, which are typical for this species (McAlpin 2001). There was an additional observation by one of the BushBlitz team members at a location approximately 65 km west of Kiwirrkurra on the road to Nyinmi and Jupiter Well. Here an individual was sighted as it was entering a burrow.

While marsupial moles are thought to be relatively common within sand dune habitats across much of the states arid interior, they are rarely seen. Mole presence is usually detected through observations of tracks after surfacing, frequently following rain, or through the establishment of “mole trenches” (Benshemesh 2004). The record here was of a short track of less than a metre (Image 7C, below) found by one of the Traditional Owners in the sand at site V15, adjacent to Lake Mackay.

For the bilby and the great desert skinks, detections were in close proximity to the Kiwirrkurra community and it is likely that land management practices through fire in particular, and to a lesser extent perhaps feral cat hunting, is providing assistance in supporting these species. It was evident that within close proximity to Kiwirrkurra the size of fires was smaller and the heterogeneity of fire ages in the landscape greater than what appeared to be the case further from the community. This type of fine “fire mosaic” is recognised as important in supporting viable populations for many species.

Table 4. Vulnerable, threatened or endangered species from Kiwirrkurra IPA.

| Species                    | Listing status and level (EPBC, State/Territory) | Location sighted/observed                            | Indication of abundance                     |
|----------------------------|--|--|---|
| <i>Liopholis kintorei</i>  | Vulnerable under EPBC and State Listing          | 20 km east-south-east and 65 km west of Kiwirrkurra. | Several active burrow complexes found.      |
| <i>Macrotis lagotis</i>    | Vulnerable under EPBC and State Listing          | Images of one individual from camera trap.           | Only one location where sign was prevalent. |
| <i>Notoryctes caurinus</i> | Endangered under State Listing                   | A single track located by traditional owners.        | Likely to be common in sand dune systems.   |



Image 8A. A Bilby visiting a burrow near Kiwirrkurra.



Image 8B. Great desert skink caught by traditional owners 20 km east of Kiwirrkurra.



Image 8C. Marsupial mole tracks located by traditional owners adjacent to Lake Mackay.



## **4. General comment on species lists**

Species lists that were accessed prior to the survey were reasonably comprehensive although larger fauna are often absent from these as was the case here. Many conspicuous animals that would be well known to the local Kiwirrkurra community were missing and these include animals such as the kangaroos, large goannas, large snakes, larger skinks and threatened species. As much of our databased information is derived from museum collections of voucher specimens and tissue samples these absences generally come about through lack of collection.

## **5. Conclusions**

Surveys such as these continue to fill important gaps in ecological and distributional knowledge across Western Australia, as well as providing much needed samples that assist in resolving taxonomy of a very diverse reptile fauna.

Of particular relevance in this project was the collaboration with Traditional Owners without whose involvement and intimate knowledge of country we would not have identified or recorded a number of species. This was particularly the case for all of the threatened fauna. Collaboration between traditional knowledge and science-based methods significantly increased overall success for vertebrate sampling.

There is still scope for much more work in the IPA to document the extent and size of populations of threatened species. While the overall confirmed species list for native reptiles, frogs and mammals is 64, two and 21 respectively, more work will uncover more species of frogs and reptiles in particular. While species lists for areas are important from conservation planning perspective it is also just as important to detail patterns in assemblages across the landscape as it is these components that begin to reveal aspects of functional ecosystems.

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## Appendices

### Appendix 1. Site codes, coordinates and survey effort for each of the systematically sampled locations

| Site Code | Latitude | Longitude | Date opened | Date closed | nights open | Elliot trap nights | pit trap night | funnel trap nights |
|-----------|----------|-----------|-------------|-------------|-------------|--------------------|----------------|--------------------|
| SS1       | -22.8662 | 127.7604  | 08/09/2015  | 11/09/2015  | 4           | 100                | 24             | 24                 |
| SS2       | -22.8121 | 127.8327  | 08/09/2015  | 11/09/2015  | 4           | 100                | 24             | 24                 |
| V2        | -22.8262 | 126.6970  | 11/09/2015  | 14/09/2015  | 4           | 100                | 24             | 24                 |
| V3        | -22.8072 | 126.7297  | 12/09/2015  | 14/09/2015  | 3           | 75                 | 18             | 18                 |
| V4        | -22.7966 | 126.7661  | 12/09/2015  | 14/09/2015  | 3           | 75                 | 18             | 18                 |
| V5        | -22.7853 | 126.8017  | 12/09/2015  | 14/09/2015  | 3           | 75                 | 18             | 18                 |
| V8        | -22.8640 | 127.7318  | 09/09/2015  | 11/09/2015  | 3           | 75                 | 18             | 18                 |
| V9        | -22.8394 | 127.6433  | 09/09/2015  | 11/09/2015  | 3           | 75                 | 18             | 18                 |
| V10       | -22.9097 | 127.9521  | 09/09/2015  | 11/09/2015  | 3           | 75                 | 18             | 18                 |
| V12       | -22.6531 | 128.4251  | 15/09/2015  | 17/09/2015  | 3           | 75                 | 18             | 18                 |
| V13       | -22.6270 | 128.4043  | 16/09/2015  | 17/09/2015  | 2           | 50                 | 12             | 12                 |
| V14       | -22.6407 | 128.4198  | 16/09/2015  | 17/09/2015  | 2           | 50                 | 12             | 12                 |
| V15       | -22.6094 | 128.3636  | 16/09/2015  | 17/09/2015  | 2           | 50                 | 12             | 12                 |
| V30       | -22.8441 | 127.7281  | 09/09/2015  | 11/09/2015  | 3           | 50                 | 18             | 18                 |

### Appendix 2. List of mammals, reptiles and frogs occurring in the vicinity of Kiwirrkurra

Reserve Name: Kiwirrkurra IPA

Number of taxa: 92 (including subspecies and varieties but without double counting).

| Family          | Species                           | IPA Records | Kiwirrkurra Area Records | BushBlitz Survey 2015 | New Record | Pest | EPBC Listed | State Listed |
|-----------------|-----------------------------------|-------------|--------------------------|-----------------------|------------|------|-------------|--------------|
| <b>Anura</b>    |                                   |             |                          |                       |            |      |             |              |
| Limnodynastidae | <i>Notaden nicholli</i>           | +           |                          | +                     |            |      |             |              |
| Limnodynastidae | <i>Uperoleia micromeles</i>       | +           |                          |                       |            |      |             |              |
| <b>Squamata</b> |                                   |             |                          |                       |            |      |             |              |
| Agamidae        | <i>Amphibolurus longirostris</i>  | +           | +                        | +                     |            |      |             |              |
| Agamidae        | <i>Ctenophorus clayi</i>          | +           | +                        |                       |            |      |             |              |
| Agamidae        | <i>Ctenophorus isolepis</i>       | +           | +                        | +                     |            |      |             |              |
| Agamidae        | <i>Ctenophorus nuchalis</i>       | +           | +                        | +                     |            |      |             |              |
| Agamidae        | <i>Diporiphora lalliae</i>        | +           | +                        | +                     |            |      |             |              |
| Agamidae        | <i>Diporiphora paraconvergens</i> | +           | +                        | +                     |            |      |             |              |



| Family           | Species                               | IPA Records | Kiwirrkurra Area Records | BushBlitz Survey 2015 | New Record | Pest | EPBC Listed | State Listed |
|------------------|---------------------------------------|-------------|--------------------------|-----------------------|------------|------|-------------|--------------|
| Agamidae         | <i>Moloch horridus</i>                | +           | +                        | +                     |            |      |             |              |
| Agamidae         | <i>Pogona minor</i>                   | +           | +                        | +                     |            |      |             |              |
| Agamidae         | <i>Tympanocryptis centralis</i>       | +           | +                        | +                     |            |      |             |              |
| Agamidae         | <i>Tympanocryptis cephalus</i>        | +           |                          |                       |            |      |             |              |
| Carphodactylidae | <i>Nephrurus laevis</i>               | +           | +                        | +                     |            |      |             |              |
| Carphodactylidae | <i>Nephrurus levis</i>                | +           |                          | +                     | ✓          |      |             |              |
| Diplodactylidae  | <i>Lucasium stenodactylum</i>         | +           | +                        | +                     |            |      |             |              |
| Diplodactylidae  | <i>Rhynchoedura ornata</i>            | +           | +                        | +                     |            |      |             |              |
| Diplodactylidae  | <i>Strophurus ciliaris</i>            | +           | +                        | +                     |            |      |             |              |
| Diplodactylidae  | <i>Strophurus elderi</i>              | +           | +                        | +                     |            |      |             |              |
| Gekkonidae       | <i>Diplodactylus laevis</i>           | +           | +                        | +                     |            |      |             |              |
| Gekkonidae       | <i>Gehyra pilbara</i>                 | +           | +                        | +                     |            |      |             |              |
| Gekkonidae       | <i>Gehyra purpurascens</i>            | +           | +                        | +                     |            |      |             |              |
| Gekkonidae       | <i>Gehyra variegata</i>               | +           | +                        | +                     |            |      |             |              |
| Gekkonidae       | <i>Heteronotia binoei</i>             | +           | +                        | +                     |            |      |             |              |
| Pygopodidae      | <i>Delma desmosa</i>                  | +           | +                        | +                     |            |      |             |              |
| Pygopodidae      | <i>Delma nasuta</i>                   | +           | +                        | +                     |            |      |             |              |
| Pygopodidae      | <i>Lialis burtonis</i>                | +           |                          | +                     | ✓          |      |             |              |
| Pygopodidae      | <i>Pygopus nigriceps</i>              | +           |                          | +                     | ✓          |      |             |              |
| Egerniidae       | <i>Liopholis kintorei</i>             |             |                          | +                     |            |      | +           | +            |
| Egerniidae       | <i>Liopholis striata</i>              | +           | +                        | +                     |            |      |             |              |
| Egerniidae       | <i>Tiliqua multifasciata</i>          | +           |                          | +                     |            |      |             |              |
| Eugongylidae     | <i>Carlia triacantha</i>              | +           | +                        | +                     |            |      |             |              |
| Eugongylidae     | <i>Cryptoblepharus buehneri</i>       | +           | +                        |                       |            |      |             |              |
| Eugongylidae     | <i>Menetia greyii</i>                 | +           | +                        | +                     |            |      |             |              |
| Eugongylidae     | <i>Morethia ruficauda</i>             | +           | +                        | +                     |            |      |             |              |
| Sphenomorphidae  | <i>Ctenotus brooksi</i>               | +           | +                        | +                     |            |      |             |              |
| Sphenomorphidae  | <i>Ctenotus calurus</i>               | +           | +                        | +                     |            |      |             |              |
| Sphenomorphidae  | <i>Ctenotus grandis</i>               | +           | +                        |                       |            |      |             |              |
| Sphenomorphidae  | <i>Ctenotus hanloni</i>               | +           |                          |                       |            |      |             |              |
| Sphenomorphidae  | <i>Ctenotus helenae</i>               | +           | +                        | +                     |            |      |             |              |
| Sphenomorphidae  | <i>Ctenotus leae</i>                  | +           | +                        |                       |            |      |             |              |
| Sphenomorphidae  | <i>Ctenotus nasutus</i>               | +           | +                        | +                     |            |      |             |              |
| Sphenomorphidae  | <i>Ctenotus pantherinus</i>           | +           | +                        | +                     |            |      |             |              |
| Sphenomorphidae  | <i>Ctenotus quattuordecimlineatus</i> | +           | +                        |                       |            |      |             |              |
| Sphenomorphidae  | <i>Cyclodomorphus melanops</i>        | +           |                          |                       |            |      |             |              |

| Family                  | Species                                | IPA Records | Kiwirrkurra Area Records | BushBlitz Survey 2015 | New Record | Pest | EPBC Listed | State Listed |
|-------------------------|--|-------------|--------------------------|-----------------------|------------|------|-------------|--------------|
| Sphenomorphidae         | <i>Eremiascincus pallidus</i>          | +           | +                        | +                     |            |      |             |              |
| Sphenomorphidae         | <i>Lerista bipes</i>                   | +           | +                        | +                     |            |      |             |              |
| Sphenomorphidae         | <i>Lerista ips</i>                     | +           | +                        | +                     |            |      |             |              |
| Sphenomorphidae         | <i>Lerista vermicularis</i>            | +           | +                        |                       |            |      |             |              |
| Sphenomorphidae         | <i>Lerista xanthura</i>                | +           | +                        |                       |            |      |             |              |
| Sphenomorphidae         | <i>Notoscincus ornatus</i>             | +           | +                        | +                     |            |      |             |              |
| Varanidae               | <i>Varanus acanthurus</i>              | +           | +                        | +                     |            |      |             |              |
| Varanidae               | <i>Varanus brevipauda</i>              | +           | +                        |                       |            |      |             |              |
| Varanidae               | <i>Varanus eremius</i>                 | +           | +                        | +                     |            |      |             |              |
| Varanidae               | <i>Varanus giganteus</i>               |             |                          | +                     | ✓          |      |             |              |
| Varanidae               | <i>Varanus gilleni</i>                 | +           | +                        | +                     |            |      |             |              |
| Varanidae               | <i>Varanus gouldii</i>                 | +           |                          | +                     | ✓          |      |             |              |
| Varanidae               | <i>Varanus tristis</i>                 | +           | +                        |                       |            |      |             |              |
| Boidae                  | <i>Aspidites ramsayi</i>               | +           | +                        |                       |            |      |             |              |
| Boidae                  | <i>Antaresia stimsoni</i>              | +           | +                        | +                     |            |      |             |              |
| Elapidae                | <i>Furina ornata</i>                   | +           |                          |                       |            |      |             |              |
| Elapidae                | <i>Pseudechis australis</i>            |             |                          | +                     | ✓          |      |             |              |
| Elapidae                | <i>Pseudonaja mengdeni</i>             |             |                          | +                     | ✓          |      |             |              |
| Elapidae                | <i>Pseudonaja modesta</i>              | +           |                          |                       |            |      |             |              |
| Elapidae                | <i>Simoselaps anomalus</i>             | +           | +                        | +                     |            |      |             |              |
| Typhlopidae             | <i>Anilius endoterus</i>               | +           | +                        | +                     |            |      |             |              |
| Typhlopidae             | <i>Anilius grypus</i>                  | +           |                          |                       |            |      |             |              |
| <b>Dasyuromorphia</b>   |  |             |                          |                       |            |      |             |              |
| Dasyuridae              | <i>Dasyurus cristicauda</i>            | +           |                          |                       |            |      |             |              |
| Dasyuridae              | <i>Ningaui ridei</i>                   | +           | +                        | +                     |            |      |             |              |
| Dasyuridae              | <i>Pseudantechinus macdonnellensis</i> |             |                          | +                     | ✓          |      |             |              |
| Dasyuridae              | <i>Sminthopsis macroura</i>            | +           | +                        |                       |            |      |             |              |
| Dasyuridae              | <i>Sminthopsis youngsoni</i>           | +           | +                        | +                     |            |      |             |              |
| <b>Diprotodontia</b>    |  |             |                          |                       |            |      |             |              |
| Macropodidae            | <i>Osphranter robustus</i>             |             |                          | +                     |            |      |             |              |
| Macropodidae            | <i>Osphranter rufus</i>                |             |                          | +                     |            |      |             |              |
| <b>Notoryctemorphia</b> |  |             |                          |                       |            |      |             |              |
| Notoryctidae            | <i>Notoryctes caurinus</i>             |             |                          | +                     |            |      | +           | +            |
| <b>Peremelemorphia</b>  |  |             |                          |                       |            |      |             |              |
| Thylacomyidae           | <i>Macrotis lagotis</i>                |             |                          | +                     |            |      | +           | +            |

| Family              | Species                               | IPA Records | Kiwirrkurra Area Records | BushBlitz Survey 2015 | New Record | Pest     | EPBC Listed | State Listed |
|---------------------|---------------------------------------|-------------|--------------------------|-----------------------|------------|----------|-------------|--------------|
| <b>Monotremata</b>  |                                       |             |                          |                       |            |          |             |              |
| Tachyglossidae      | <i>Tachyglossus aculeatus</i>         |             |                          | +                     |            |          |             |              |
| <b>Rodentia</b>     |                                       |             |                          |                       |            |          |             |              |
| Muridae             | <i>Mus musculus</i>                   | +           | +                        | +                     |            | +        |             |              |
| Muridae             | <i>Notomys alexis</i>                 | +           | +                        | +                     |            |          |             |              |
| Muridae             | <i>Pseudomys desertor</i>             | +           | +                        | +                     |            |          |             |              |
| Muridae             | <i>Pseudomys hermannsburgensis</i>    | +           | +                        | +                     |            |          |             |              |
| <b>Chiroptera</b>   |                                       |             |                          |                       |            |          |             |              |
| Emballonuridae      | <i>Saccolaimus flaviventris</i>       |             |                          | +                     | ✓          |          |             |              |
| Emballonuridae      | <i>Taphozous hilli</i>                |             |                          | +                     | ✓          |          |             |              |
| Molossidae          | <i>Austronomus australis</i>          | +           | +                        |                       |            |          |             |              |
| Molossidae          | <i>Mormopterus (Ozimops) beccarii</i> |             |                          | +                     | ✓          |          |             |              |
| Molossidae          | <i>Chaerephon jobensis</i>            |             |                          | +                     | ✓          |          |             |              |
| Vespertilionidae    | <i>Nyctophilus geoffroyi</i>          |             |                          | +                     | ✓          |          |             |              |
| Vespertilionidae    | <i>Scotorepens balstoni</i>           |             |                          | +                     | ✓          |          |             |              |
| Vespertilionidae    | <i>Vespadelus finlaysoni</i>          |             |                          | +                     | ✓          |          |             |              |
| <b>Artiodactyla</b> |                                       |             |                          |                       |            |          |             |              |
| Camelidae           | <i>Camelus dromedarius</i>            |             |                          | +                     |            | +        |             |              |
| <b>Carnivora</b>    |                                       |             |                          |                       |            |          |             |              |
| Canidae             | <i>Canis dingo</i>                    |             |                          | +                     |            |          |             |              |
| Canidae             | <i>Vulpes vulpes</i>                  |             |                          | +                     |            | +        |             |              |
| Felidae             | <i>Felis catus</i>                    |             |                          | +                     |            | +        |             |              |
| <b>Lagomorpha</b>   |                                       |             |                          |                       |            |          |             |              |
| Leporidae           | <i>Oryctolagus cuniculus</i>          |             |                          | +                     |            | +        |             |              |
| Frogs               | <b>2</b>                              | <b>2</b>    | <b>0</b>                 | <b>1</b>              | <b>0</b>   | <b>0</b> | <b>0</b>    | <b>0</b>     |
| Reptiles            | <b>64</b>                             | <b>60</b>   | <b>49</b>                | <b>48</b>             | <b>5</b>   | <b>0</b> | <b>1</b>    | <b>1</b>     |
| Native mammals      | <b>21</b>                             | <b>5</b>    | <b>5</b>                 | <b>18</b>             | <b>8</b>   | <b>0</b> | <b>2</b>    | <b>2</b>     |
| Introduced mammals  | <b>6</b>                              | <b>1</b>    | <b>1</b>                 | <b>6</b>              | <b>0</b>   | <b>5</b> | <b>0</b>    | <b>0</b>     |

### Appendix 3. List of mammals and reptiles caught at the two standard survey sites (SS1 and SS2)

| Species from SS1                   | Elliot | Hand Capture | Pitfall/Funnel* |
|------------------------------------|--------|--------------|-----------------|
| <i>Ctenotus pantherinus</i>        |        |              | 2               |
| <i>Gehyra variegata</i>            |        | 2            |                 |
| <i>Lerista bipes</i>               |        |              | 4               |
| <i>Liopholis striata</i>           |        | 1*           |                 |
| <i>Nephrurus levis</i>             |        | 1            |                 |
| <i>Pogona minor</i>                |        | 1            |                 |
| <i>Varanus gilleni</i>             |        | 1            |                 |
| <i>Notomys alexis</i>              | 1      |              |                 |
| <i>Pseudomys hermannsburgensis</i> | 8      |              | 1               |
| <b>Species from SS2</b>            |        |              |                 |
| <i>Ctenophorus isolepis</i>        |        | 1*           |                 |
| <i>Ctenotus nasutus</i>            |        |              | 1               |
| <i>Ctenotus pantherinus</i>        |        |              | 1               |
| <i>Diplodactylus laevis</i>        |        |              | 1               |
| <i>Diporiphora paraconvergens</i>  |        | 1            |                 |
| <i>Eremiascincus pallidus</i>      |        |              | 1               |
| <i>Lerista ips</i>                 |        |              | 1               |
| <i>Lucasium stenodactylum</i>      |        | 3            | 1               |
| <i>Nephrurus levis</i>             | 2      |              | 1               |
| <i>Rhynchoedura ornata</i>         |        | 2            |                 |
| <i>Simoselaps anomalus</i>         |        | 1            |                 |
| <i>Strophurus ciliaris</i>         |        | 2            |                 |
| <i>Varanus gouldii</i>             |        | 1*           |                 |
| <i>Ningui ridei</i>                | 1      |              | 1               |
| <i>Notomys alexis</i>              | 7      |              |                 |
| <i>Pseudomys desertor</i>          | 3      |              |                 |
| <i>Pseudomys hermannsburgensis</i> | 5      |              | 3               |

\* captures that were not part of the standard survey methodology.



***Appendix 4. Survey site images for where standard pit trapping and Elliott trapping was undertaken***



**SS1**



**SS2**



**V3**



**V4**



**V5**



**V6**



***Appendix 4. Survey site images for where standard pit trapping and Elliott trapping was undertaken (cont.)***



**V8**



**V9**



**V10**



**V12**



**V13**



**V14**

***Appendix 4. Survey site images for where standard pit trapping and Elliott trapping was undertaken (cont.)***



**V15**



**V30**

***Appendix 5. Financial Statement***

I hereby certify that all funds for this project have been spent in the manner and for the purposes specified by the contract.

Name: Mark Cowan

Signed: M. L. Cowan

Date: 21<sup>st</sup> December 2015