

A Preliminary Vertebrate Fauna Survey of Millstream
Chichester National Park Naturebank Envelopes-
Narrina Gorge and Ashburton

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Amphibolurus longirostris photo M.A. Cowan



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Executive Summary

A terrestrial vertebrate fauna survey was undertaken over a period of seven nights from the 4th September 2013 to the 11th of September 2013 at two potential NatureBank sites in the vicinity of Python Pool, Millstream Chichester National Park. Remote camera traps within the same area were established on the 7th August 2013 and remained in operation until the end of the survey in September 2013. Data collected from this work incorporating frogs, reptiles, mammals and birds is presented here along with records for the National Park extracted from reports and electronic database sources including those of the Western Australian Museum, the Department of Parks and Wildlife and Atlas of Living Australia.

This work identified a total of 110 species, including two frogs, 35 reptiles, 54 birds and nine mammals, within the survey area. Six of these species (five reptiles and one mammal) were the first documented occurrences within the National Park, although almost certainly most have been observed in the past but remain unrecorded in the literature or online databases. None of these species are range extensions, with all species occurring within the range of their known distributions.

Within the National Park there are records for at least 20 species of conservation significance including 13 species of birds, four species of mammals and three reptiles. Ten of these are priority-listed species, four are threatened and seven, all birds, are migratory. Of these conservation significant species only two were recorded during this survey and they were *Dasyurus hallucatus* (Northern Quoll) and *Merops ornatus* (Rainbow Bee-eater), with the former listed as threatened under state and national legislation and the latter protected under international treaties for migratory birds. Neither of these species were recorded within or utilising the primary areas proposed for infrastructure development and are unlikely to be adversely affected by the scope of the proposed developments at either site.

Of the two proposed development sites, Narrina Gorge and Ashburton, the Narrina Gorge site has the highest species richness although much of this was associated with Narrina Creek. The Narrina Creek area would provide considerably better opportunity for viewing native species, particularly for birds, than the relatively small creeks immediately adjacent and bordering parts of the Ashburton envelope.

1. Introduction

Naturebank sites are aimed at developing ecotourism accommodation opportunities in an environmentally sensitive manner within Western Australia's conservation estate. The identification of prospective locations is coordinated and managed by the Department of Parks and Wildlife in conjunction with Tourism WA. The Millstream Chichester National Park has been identified as a prospective location for such development opportunities, specifically within an area towards the northern perimeter of the National Park. Here two locations have been identified as being potentially suitable for a Naturebank development site and these are the Narrina Gorge and Ashburton envelopes. Locations for these within the National Park are identified in Figure 1. Both sites are within close proximity of the well known tourist attraction of Python Pool, with Narrina Gorge (21° 21' 5" S, 117° 15' 44") approximately 3 km to the southeast in a direct line and Ashburton (21° 21' 15" S, 117° 18' 0" E) approximately 6.5 km, slightly south of east. Both sites are within the Pilbara Bioregion of the Interim Biogeographic Regionalisation of Australia (IBRA) as defined by Thackway and Cresswell (1995). However the sites are situated in different subregions of the Pilbara IBRA with the Narrina Gorge site in the Chichester Subregion and the Ashburton site in the Roebourne Subregion.

The area of both envelope options are dominated by relatively open and flat spinifex (*Triodia* spp.) plain on sandy substrates. The Narrina Gorge area is the more complex of the two options, having a greater density of eucalypts, particularly towards the southern margin of the envelope, as well as being interspersed with shrubs (see Davis, 2013 for detailed vegetation descriptions) and having low rocky outcropping and a stony mantle primarily towards the western and eastern margins of the plain. The proposed Narrina Gorge envelope also includes a section of Narrina Creek with its steep banks of riparian vegetation comprising large eucalypts and dense grassy understorey. Rocky outcropping including large boulder piles of deep red iron rich rock occurs on the margins of the Creek at a number of locations but particularly on the north-eastern margin of the development envelope (see Figure 2a). The Ashburton area also borders a drainage line along the entire length of the north-western edge of the envelope, and while a much smaller system than that in the Narrina Gorge envelope, it still comprises a riparian zone with a more diverse and denser tree and shrub layer than the adjacent plain.

For sites to become available for development it is necessary to have pre-release clearances that meet environmental and cultural objectives. One of the environmental clearances required is that of a preliminary fauna assessment to 1) provide an inventory of species present within the development envelope and 2) identify species that occur or are likely to occur and have threatened, specially

protected, or priority conservation status under state and/or Commonwealth legislation and that may be adversely impacted on by any development of the area.

The work reported on here was targeted at terrestrial vertebrates and birds with a trapping program undertaken at both Narrina Gorge and Ashburton proposed development envelopes.

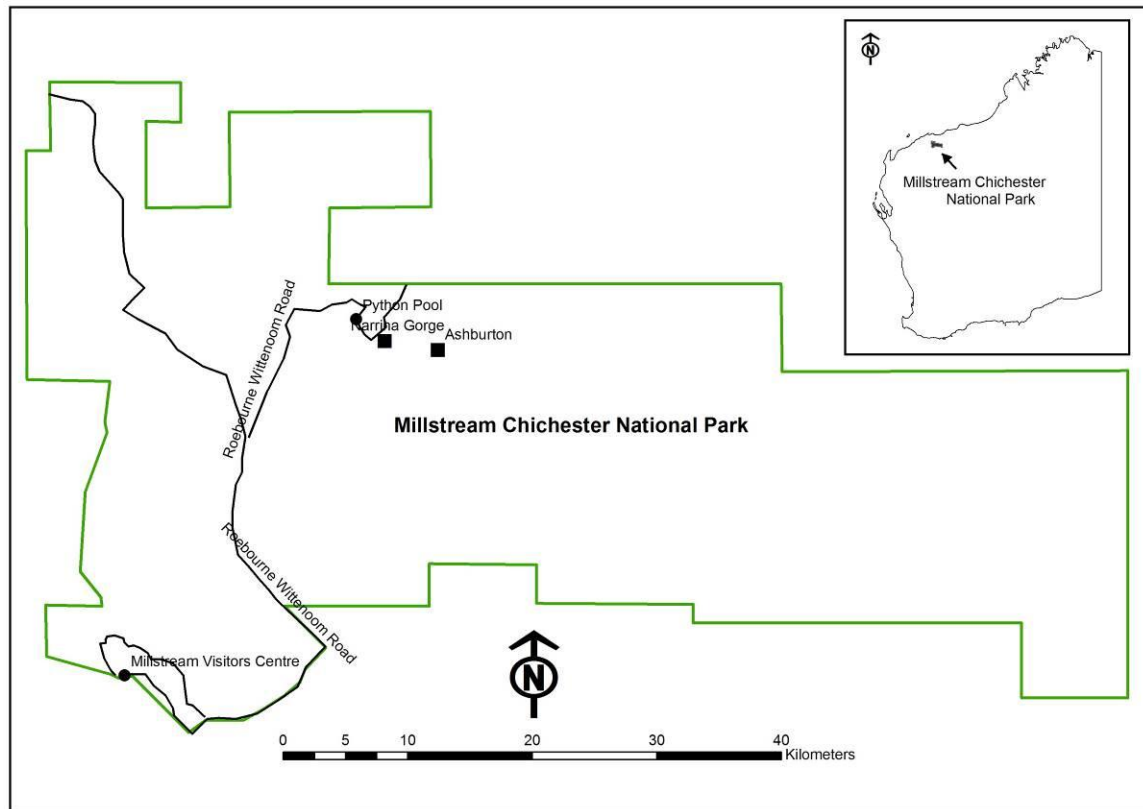


Figure 1. Map showing position of potential Naturebank locations (solid squares) within the Millstream Chichester National Park. Inset map shows position of the Park within Western Australia.

2. Desktop Assessment

Records were collated for the entire Park from Atlas of Living Australia (2013) along with the records from the WA Museum database (Western Australian Museum, 2012), from NatureMap (Department of Parks and Wildlife, 2013) and the Johnstone and Burbidge Pilbara bird database (Johnstone and Burbidge, 2013).

A number of written sources were also examined for additional records (Burbidge, 1971; Ecologia, 1999; Gibson and McKenzie, 2009; Doughty *et al*, 2011). An inventory from these sources is presented in Appendix B (frogs, reptiles and mammals) and Appendix E (birds).

The earliest records of collections in the Western Australian Museum (WAM) databases for reptiles, birds and mammals for the Millstream Chichester National Park area date back to 1958 when W.D.L. Ride led a Museum expedition to the Hamersley Range (Ride, 1959). While other expeditions to the area had occurred earlier (e.g. Gregory, 1884; Whitlock, 1923) there appears to be few collections from these; although, there are a number of observational records of birds in Atlas of Living Australia (ALA) database from the Historical Bird Atlas (Birds Australia, 2013) dating back to 1922 and presumably a result of the Whitlock expedition. In September of 1969 the Department of Fisheries and Fauna undertook a survey of the area (Burbidge, 1971) however the records from this work accounts for relatively few species of the known fauna (Appendix B). A number of other individuals and organisations have contributed additional species information through the fauna collections of the WAM over the ensuing years but post the Hamersley expedition the most significant collections appear to have been those made by the late G. M. Storr (Curator of Herpetology at the WA Museum, 1962-1986) between 1961 and 1962 followed by the Department of Parks and Wildlife's (DPaW) Pilbara Biological Survey between 2002 and 2007 (George *et al.*, 2009; Doughty *et al.*, 2011).

The focus of most of this historic work has been towards the south-western corner of the Park in relatively close proximity to the larger permanent waters of the Fortescue River such as at Deep Reach and Crossing Pool. Python Pool, which is close to the Naturebank envelopes (Figure 1), has been a focal point for more limited sampling while three of the thirteen Pilbara biological survey sites within the Park are within a few kilometres of the Naturebank sites. Ten sites along a linear transect closely aligned to the Dampier - Paraburdoo rail corridor were surveyed in September 1999 (Ecologia, 1999).

While a relatively comprehensive species list now exists for the Park, detailed knowledge of the spatial occurrence of species within the Park remains relatively poorly known. The collated historic data for frogs, reptiles and mammals is presented in Appendix B and for birds in Appendix E. For frog and reptile species the list comprises of four frogs, one turtle, 16 geckoes, four legless lizards, six dragons, 30 skinks, nine varanids and 18 snakes. This totals 88 species however at least four skinks, one gecko and four of the snake species remain unverified within any collections. These unverified taxa are: *Ctenopus robustus*, *C. serventyi*, *C. schomburgkii*, *Lerista jacksoni*, *Strophurus elderi*, *Acanthophis pyrrhus*, *Antaresia stimsoni*, *Demansia psammophis* and *Suta punctata*. While the presence of all of these species is possible it is also possible for a few (the skinks in particular) that they have been confused with other similar species that are known to be present in the Park. Without confirmation through photographs or specimens lodged with the

WA Museum these will remain unresolved. For birds there are observational and specimen records totaling more than 156 species from 52 families. Many of these are associated with permanent water in the south-western part of the Park and therefore will likely be only occasional visitors to ephemeral water in other areas. For mammals there are records of one monotreme, ten marsupials, eight rodents, 14 bats and two introduced carnivores, *Canis lupus dingo* (Dingo) and *Felis catus* (Cat). Two of the marsupials are large macropods- *Macropus robustus* (Hills Kangaroo or Euro) and *M. rufus* (Red Kangaroo).

Of these species of fauna a number have special conservation status with, *Liasis olivaceus barroni* (Pilbara olive python), *Falco hypoleucos* (Grey Falcon), and *Rhinonicteris aurantius* (Pilbara Leaf-nosed Bat) listed as vulnerable under both State (Wildlife Conservation Act 1950) and Commonwealth (Environment Protection and Biodiversity Conservation Act 1999) legislation. Under the same legislation, *Dasyurus hallucatus* (Northern Quoll) and *Rostratula benghalensis* (Painted Snipe) are listed as endangered. Others given priority listing under State legislation are the reptiles *Notoscincus butleri* (Lined Soil-crevice Skink) (P4), *Ramphotyphlops ganei* (species of blind snake) (P1), the birds *Ixobrychus flavicollis* (Black Bittern) (P3), *Ardeotis australis* (Australian Bustard) (P4), *Burhinus grallarius* (Bush Stone-curlew) (P4), *Neochmia ruficauda subclarescens* (Star Finch)(P4) and *Amytornis striatus* (Striated Grasswren) (P4); the rodents *Leggadina lakedownensis* (P4) and *Pseudomys chapmani* (Western Pebble-mound Mouse) (P4); the bat *Macroderma gigas* (Ghost Bat) (P4). A number of birds are also listed under international treaties for migratory birds (schedule 3) and these include *Vanellus tricolor* (Banded Lapwing), *Numenius phaeopus* (Whimbrel), *Philomachus pugnax* (Ruff), *Ardea alba* (Great Egret), *A. ibis* (Cattle Egret), *Merops ornatus* (Rainbow Bee-eater) and *Haliaeetus leucogaster* (White-bellied Sea-Eagle).

3. Methodology

Pit trap lines were established at the Narrina Gorge and Ashburton envelopes to sample the broad habitat types. Thus at each site there was a pit trap line established on the spinifex dominated plain and another site established within the riparian vegetation associated with the drainage lines. Figure 2a shows the layout of traps relative to the footprint at the Narrina Gorge site with Figure 2b showing the layout at the Ashburton site. Sites P1 and P3 are the spinifex plain pit trap lines at Narrina Gorge and Ashburton respectively and sites P2 and P4 are the riparian vegetation pit trap lines at Narrina Gorge and Ashburton, respectively.

Each pit trap line consisted of an aluminium flywire fence approximately 50-60 m long and 30 cm high with the bottom few centimetres buried in the soil. At approximately five metres in from either end of the fence, and then at around 10 metre intervals, a pitfall trap was positioned with its opening centrally located under the fence and flush to the ground. The pitfall traps used were 250 mm wide by 400 mm deep plastic buckets (20 L) with six established along each trap line. Insulating material in the form of small polystyrene packing trays, along with

small amounts of soil and litter, were placed in the bottom of buckets to provide protection for trapped animals from both weather and predation. At each site six funnel traps were also established. These were set in pairs on either side of the aluminium fence line and located approximately centrally between two pit traps (Figure 3).

Associated at each pit trapping site was a line of Elliot traps (E1 to E4) consisting of 25 medium sized traps (type A). These were placed in lines (Figure 2a and 2b) with a spacing of 10 to 15 metres between each trap. Two additional Elliot trap lines (E5 and E6) were established at the Narrina Gorge envelope due to its larger extent and to ensure reasonable spatial coverage for this preliminary survey (Figure 2a). Due to the potential for species such as *Dasyurus hallucatus* to occupy or utilise Narrina Creek, four cage traps (C1-C4) were established (Figure 2a). Each Elliot trap and cage trap was baited with a small ball of universal bait-a combination of oats and peanut butter with the addition of finely chopped bacon. Bait was replenished as required and all traps were re-baited after three days. All traps were checked and cleared early each morning.

All pit trapping sites, including funnel traps, were established on the 4th of September 2013 and then operated for seven days/nights through to the 11th of September 2013. Elliot trap lines E3, E4 and E5 were established on the 5th September while sites E1 and E2 along with cages C1-C4 were established the following day, 6th September, and finally E6 on the 8th September 2013. All traps were closed on the 11th September. Coordinate details traps at each site are given in Appendix D while a general habitat photo for each of the pit and Elliot trapping sites is provided in Appendix F.

Captured animals were identified to species level and had body mass (g), sex and reproductive status recorded. For reptiles, snout-vent length (mm) was also recorded with a plastic ruler, and for mammals additional measurements taken were cranium (mm) and pes length (mm) with a set of vernier callipers. A small mark from a paint pen or marker pen (xylene free) was applied to the outside of one ear for mammals and to the abdomen of reptiles so it was possible to determine recaptures over the trapping period.

During the course of each day and during the process of checking traps a list of bird species seen and heard was collated for both the Narrina Gorge and Ashburton sites.

Prior to the trapping survey, on the 7th of August 2013, 25 motion sensitive cameras were established across the two survey envelopes with 15 of these at Narrina Gorge and 10 at Ashburton. Their positions across the two envelopes are identified in Figures 2a and 2b. Each camera was attached to a 450mm tall plastic tent peg with the camera facing south to minimise optical aberrations from direct sunlight. The lens was directed at a slight angle towards the ground 1.5 to 2 m in front of the camera and a small amount of tuna oil was placed on the ground at this

position to act as an attractant for animals. These were left in situ until the final day of the field survey on the 11th September 2013 and were thus in position for 35 days.

Species nomenclature for amphibians, reptiles, birds and mammals followed that of the Western Australian Museum. The Western Australian Museum field guides were the primary source used for reptile species identification (Storr et al. 1983, 1990, 1999 and 2002) although natural history information was also sought from ‘A Complete Guide to Reptiles of Australia’ (Wilson and Swan 2008). Reference material for mammals was from ‘The Mammals of Australia’ (Van Dyck and Strahan 2008) and ‘A Field Guide to the Mammals of Australia’ (Menkhorst and Knight 2004). Bird identification was through a ‘Field Guide to Australian Birds’ (Morcombe 2004).

Species accumulation data was analysed for vertebrate captures from the pit-fall trapping survey only in Primer-E (Clarke and Gorley 2006) using the Jackknife 1 and Chao1 richness estimators, which are considered two of the best performers for analysing abundance data (Magurran 2004).

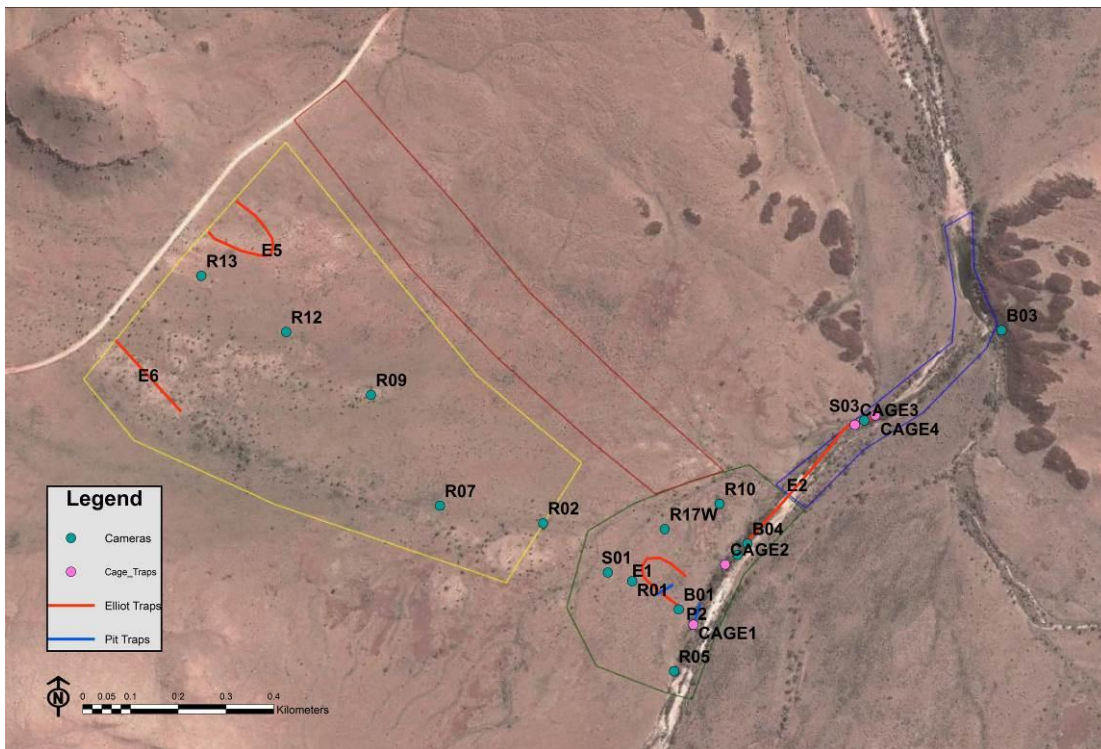


Figure 2a. Layout of both pit trap lines and Elliot trap lines along with cage traps and the position of the camera traps for Narrina Gorge envelope. The different coloured polygons outline proposed use areas: Green- NatureBank envelope, Red-

Access corridor, Yellow-Public camp ground, ~~and, and~~ Blue- Narrina Gorge river envelope.

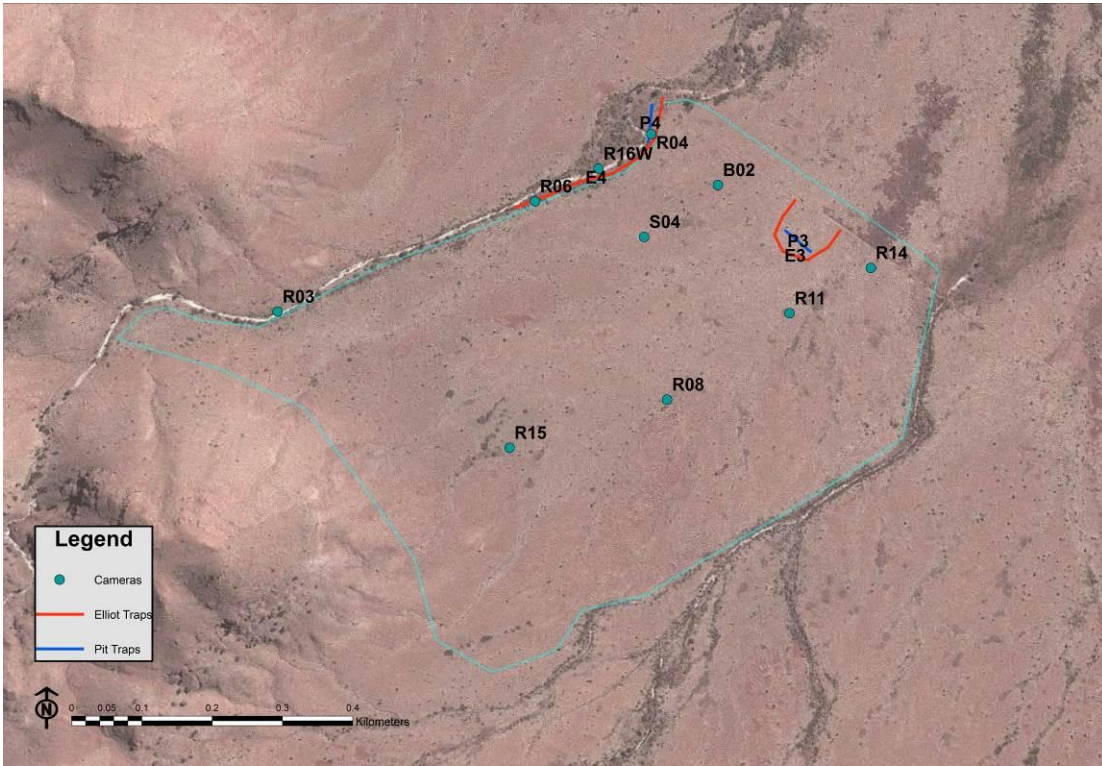


Figure 2b. Layout of both pit trap lines and Elliot trap lines along with the position of camera traps for the Ashburton envelope (light green line).

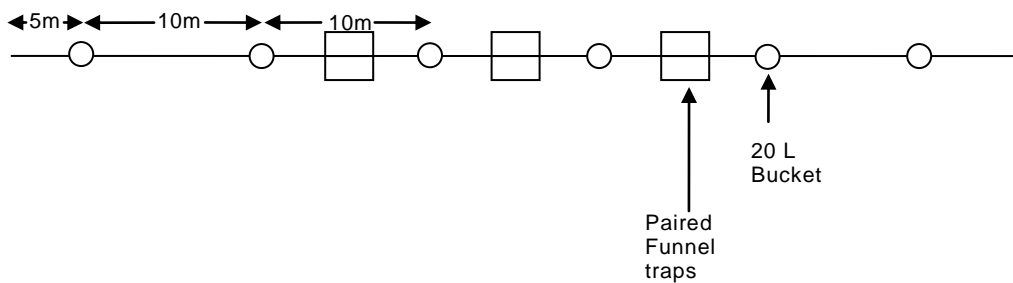


Figure 3. Drift fence and trap layout showing spacing and arrangement of each of the traps types. Spacing between each of the buckets was approximately 10 m with a pair of funnel traps positioned in between all but one pair of buckets.

4. Field Investigation

The timing of the survey was targeted for early spring as temperatures are generally high enough to promote good reptile activity. Temperatures data are

presented in Figure 4 and were warm - hot throughout the survey with maximum daytime temperature ranging from 32.6 to 40.1 °C (mean 36.1, SD 2.6) and minimum temperatures ranging from 17.4 to 23.4°C (mean 20.2, SD 2.6). There was no precipitation during the survey period.

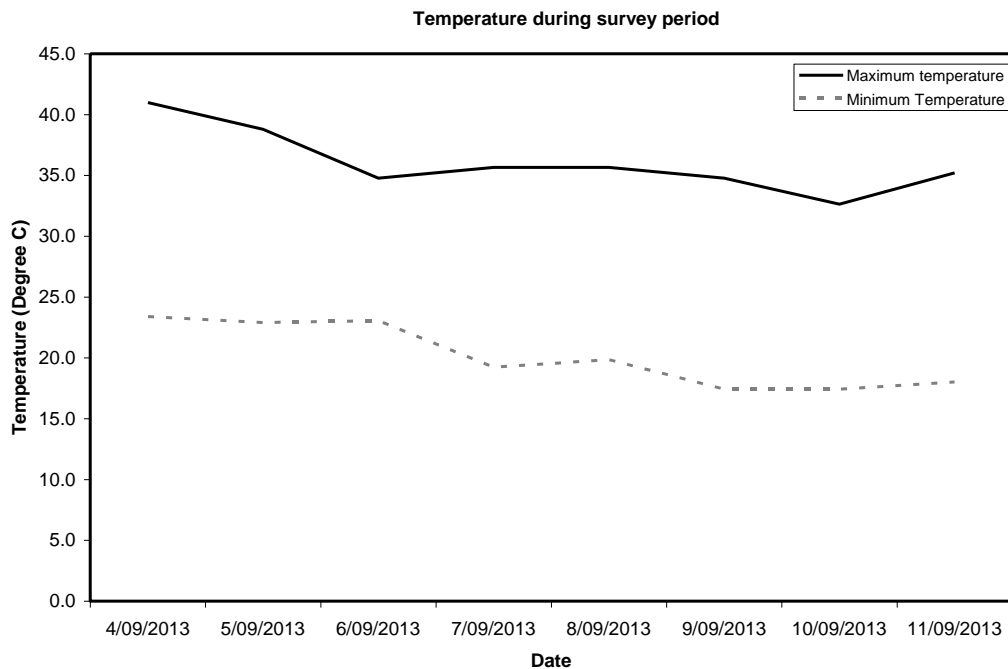


Figure 4. Climate data from the 4th of September to 11th of September 2013 was recorded with temperature data loggers set up at our camp site within 3.5km of both survey areas.

Over the course of the survey there were 265 captures of frogs, reptiles and mammals, with 149 individuals caught in pits, 44 in funnel traps, 46 in Elliot traps, four in cages and the remainder were camera detections. The total number of species of ground vertebrates recorded for the survey was 46, with 39 of these identified through trapping and another seven recorded by motion sensitive cameras only. Captures in the different types of survey methods are as follows: pits recorded 32 species; funnels: 19 species; Elliot traps: eight species; cage traps: two species; and camera traps: 15 species. Many species were detected with multiple methods. However, funnel traps only accounted for a single species not detected by other methods while camera traps accounted for seven species and pit traps for 11 species exclusively. Between the two envelopes there were 18 species at Narrina Gorge not detected at Ashburton while only eight species at Ashburton were not detected at Narrina Gorge.

For the birds, 54 species from 30 families were recorded with six of these species detected only by remote camera. Bird species richness was again significantly

higher at the Narrina gorge site, with 51 species present while there were only 24 species at Ashburton. There were 30 species of bird identified at Narrina Gorge not recorded at Ashburton while only three species recorded at Ashburton not at Narrina Gorge. These three Ashburton records were only made by motion sensitive cameras.

Of the mammals, only two species were relatively abundant and these were *Pseudomys desertor* (Desert Mouse) and *Dasykaluta rosamondae* (Kaluta) with 24 and 13 detections respectively. For both species, abundance was greatest at the Narrina Gorge site and primarily in association with the spinifex plain. For the reptiles, the most common species were *Diplodactylus conspicilatus* (Fat-tailed Gecko, n =42) followed by *Lucasium stenodactylum* (Sand-plain Gecko, n = 25), *Ctenotus grandis* (Grand Ctenotus, n = 22), *Ramphotyphlops ammodytes* (a Blind Snake, n = 12) and *Ctenotus pantherinus* (Leopard Skink, n = 10). All these species were common at both sites other than *R. ammodytes* which was only detected once at one of the Ashburton sites. Again these species are primarily associated with the spinifex sandplain, apart from *C. grandis* which had a greater association with tussock grass areas of the riparian vegetation found in Site P2 and Site P4. Species regularly sighted were *Ctenophorus isolepis* (Military Dragon) observed at both envelopes on the spinifex sandplain, *Amphibolurus longirostris* (Long-nosed Dragon) was particularly common along Narrina Creek while *Ctenophorus caudicinctus* (Ring-tailed Dragon) was regularly sighted towards the north western extent of the Narrina Gorge envelope where low rocky outcropping occurs.

For three species of monitor lizards, *V. giganteus* (Perentie), *V. eremius* (Pygmy Desert Monitor) and *V. panoptes* (Yellow-spotted Monitor), this is the first time their presence has been documented at Millstream Chichester National Park. The known distribution for these species includes the Park, and their occurrence here is expected. These species have probably been anecdotally observed previously, but not officially recorded. Other species which had not been recorded prior to this survey are the skink *Ctenotus hanloni* (Nimble Ctenotus) , the snake *Pseudonaja mengdeni* (Gwardar) as well as *Petrogale rothschildi* (Rothschild's Rock-wallaby), with the latter two species again likely to have been observed in the past. Introduced species present include *Mus musculus* (House Mouse), *Felis catus* (Cat) and *Canis lupus dingo* (Dingo), with the former two detected at both sites, primarily in the riparian vegetation, while *Canis lupus dingo* was only recorded on the one occasion by camera at the Ashburton site.

The conservation significant species, *Dasyurus hallucatus* (Northern Quoll), was caught in cage traps at Narrina Gorge and detected on six separate cameras (Appendix D) with four of these at Narrina Gorge and the other two at Ashburton. All of these detections were within the creek lines associated with each site. Only two birds of conservation significance were detected and these were *Burhinus grallarius* (Bush Stone-curlew) which is a Priority species and *Merops ornatus* (Rainbow Bee-eater) which is protected through international migratory bird agreements.

During the course of the survey and in the process of establishing cameras a number of foot traverses of the primary habitat types in both proposed development areas were made. During these any observed species or their sign was recorded. A particular target was any evidence of the priority listed species *Pseudomys chapmani* (Western Pebble-mound Mouse) however it remained undetected during the course of this field investigation.

When species accumulation data were plotted for the entire survey trapping captures, the graph was beginning to approach an asymptote (Figure 5). This permuted data was then compared against the Chao1 and Jackknife1 indicators, which are considered amongst the most robust species accumulation indices (Magurran, 2004). The results suggest that this work detected a high proportion of species likely to be present with 80% for Jackknife1 and 85% for Chao1 indices. At the individual Narrina Gorge or Ashburton site scale the predicted species proportion was generally a little lower with Ashburton having a predicted percentage of 65% for the Jackknife1 and 100% for the Chao1 while for Narrina Gorge it was 72% for the Jackknife1 and 74% for the Chao1 estimator.

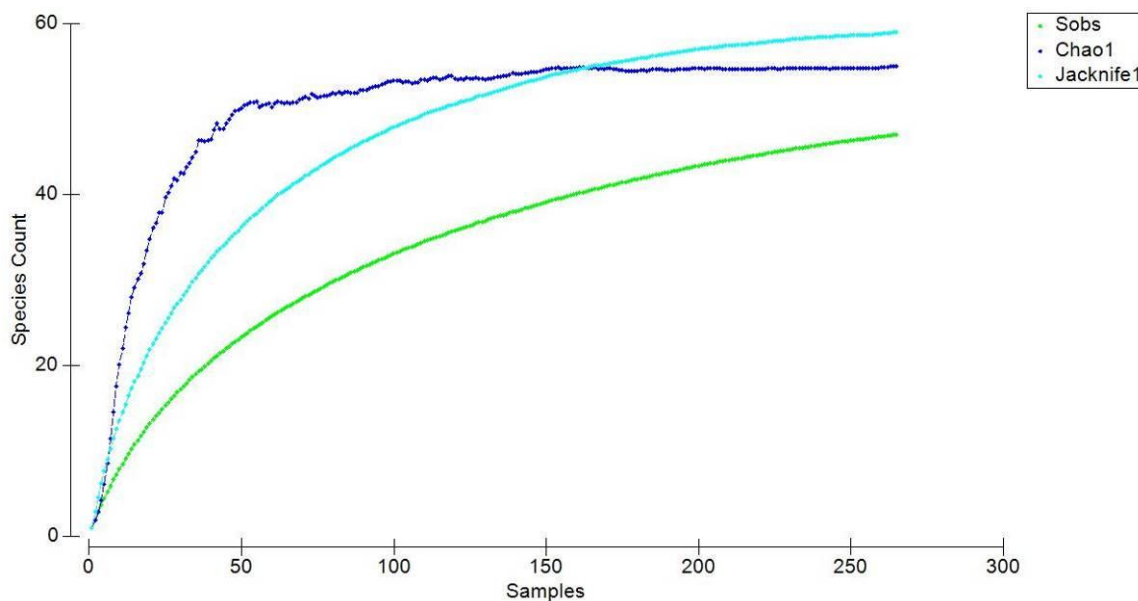


Figure 5. Species accumulation curves for species observed (Sobs) in green, for the Chao1 species richness estimator in dark blue and, for the first order Jackknife1 estimator in light blue.

5. Discussion

Of the two primary habitat types (spinifex sandplain and riparian vegetation) existing in the potential development envelopes the sandplain is the more homogeneous and widespread across the landscape. The creekline areas contain more habitat complexity with greater variability in topography, vegetation structure and floristic diversity and, at certain times of the year the presence of water. This is particularly the case for the Narrina Gorge which is significantly larger than the drainage lines associated with the Ashburton site and still contained standing pools of water during this survey.

The fauna caught within both envelopes was typical of what would be expected in these types of habitats within the Pilbara with the riparian areas of the creeklines having greater species richness than the adjacent spinifex sandplains. The fauna at both sites was comparatively rich with more than 42% of the total reptile fauna, 50% of the mammal fauna (excluding bats) and 35% of the bird faunas known for the Millstream Chichester National Park identified. These species richness results for reptiles and mammals compare favourably with those of other earlier surveys in the area with none documenting more species than were identified here, other than for bats during in the Pilbara Biological Survey (Appendix B).

For a number of the specially protected species identified as existing within the broader area of the Millstream Chichester National Park there is only limited suitable habitat present within either the Narrina Gorge or Ashburton envelopes. Of the vulnerable and endangered species, *Liasis olivaceus barroni* and *Dasyurus hallucatus* are the most likely species to make any significant use of the available habitat and this would be focused along the riparian zones associated with drainage lines, particularly that of Narrina Creek due to its greater complexity and size when compared with that of the Ashburton envelope. Rock piles, again along the periphery of Narrina Creek, could form core habitat for these two species and indeed *D. hallucatus* was detected in the riparian areas of the creeks at both sites as well as within these rock piles at the Narrina Gorge site. How many individuals this represents is not possible to determine but is probably very few due to the small extent of these habitats within either envelope. For the wading bird *Rostratula benghalensis* and the raptor *Falco hypoleucos*, while there are records of both species within the Millstream Chichester National Park, given the small footprint containing common habitat types along with neither species observed during our survey they should not be considered as a risk. Similarly *Rhinonictoris aurantius*, which may forage along creek lines, only roosts in caves of which there are none within the immediate proximity of either envelope.

Of the priority species *Ramphotyphlops ganei* is only recorded from the south-western corner within the Park and little is known of its habitat requirements other than it may be associated with moist gorges and gullies (Wilson and Swan, 2008). The skink *Notoscincus butleri* is generally associated with rocky substrates with spinifex, often along creek lines or watercourses (Wilson and Swan, 2008) and this species was recorded at three of the Pilbara Biological Survey sites within close proximity of the Naturebank envelopes. While the broad spinifex plains are unlikely to support this species there are areas along Narrina Creek that may. All five priority bird species recorded from the Park could potentially make occasional use of areas within the envelopes although only

Burhinus grallarius was recorded during our survey, and this was only in Narrina Creek at the Narrina Gorge Site. This species is considered at greatest risk in the more southern parts of its range where its abundance has likely been affected by habitat clearing and it remains vulnerable to fox predation (Johnstone and Storr, 1998). Widespread nomadic species like *Ardeotis australis* may forage on spinifex plains as may *Amytornis striatus* but this habitat has a massive extent throughout Australia's interior. For *Neochmia ruficauda* it is frequently associated with creek lines but is likely to forage in areas adjacent or in close proximity to permanent water. *Ixobrychus flavicollis* prefers areas of permanent water, often incorporating reed beds. For mammals, both rodents, *Leggadina lakedownensis* and *Pseudomys chapmani*, have the potential to occur within the foot prints although there are no records within the immediate vicinity of the envelopes and there were no detections of these species from the three Pilbara Biological Survey sites within close proximity of the survey sites. The last priority mammal, the bat *Macroderma gigas*, much like *R. aurantius* is dependent on caves or old mine shafts for roosting sites. It forages over broad areas and could not be considered likely to be impacted by development within either of the envelopes due to the distance from any potential roost sites and the wide availability of the habitat types.

Seven species of bird recorded from the Millstream Chichester National Park are protected under international treaties for migratory species (Schedule 3) and these species are identified in Appendix E. Of these only one was recorded during the survey and this was *Merops ornatus* (Rainbow Bee-eater) where a pair were recorded within the creekline area of the Narrina Gorge site. This species migrates towards southern areas of Australia from as far north as Indonesia from around September and October to breed (Johnstone and Storr, 1998).

There were a few records of *Felis catus* as well as a single record of *Canis lupus dingo* on remote cameras and these were always associated with the drainage tracts. This probably results from the relative ease of movement through these areas (open vegetation when compared to the dense spinifex) along with greater prey abundance and in the case of Narrina Gorge, the presence of water.

6. Conclusions and Recommendations

Both the Narrina Gorge site and the Ashburton site have relatively rich faunas, although the majority of species identified are common and widespread in the sampled habitat types. Only two species of conservation significance were identified (*Dasyurus hallucatus* and *Merops ornatus*) and both of these were within the broad drainage tract of Narrina Creek at the Narrina Gorge site. *Dasyurus hallucatus* was also recorded by remote camera in the creek line at the Ashburton site. The records of *D. hallucatus* at the Ashburton site probably represent foraging activity and or a movement corridor as individuals disperse through the landscape as there appears to be no suitable refuge habitat within that proposed development envelope. The Narrina Gorge area however has two areas associated with the creek that may form more permanent habitat for *D. hallucatus*: the large rugged boulder hills at the northern end of

the Narrina River envelope as well as a smaller rocky outcropping midway along the same envelope (Camera S03 in Figure 2a). Similarly to the Ashburton site this creek line would likely support some foraging and general movement of the species as evidenced by our camera detections and cage trapping. While a pair of *Merops ornatus* were observed, also within the Narrina River envelope, they did not appear to be nesting and the sites where they were heard and seen perching were primarily on the opposite bank to the development site and towards the northern extent of the river envelope.

The sandplain sites had lower overall species richness than the riparian zones associated with each of the envelopes, particularly for reptiles, with only around half the number of species recorded. Birds also had greatest diversity in and around the riparian vegetation associated with the creeklines and this was particularly the case at the Narrina Gorge site as the size of the system, prevalence of taller vegetation, including large eucalypts, and nature of the creek bed ensures water will persist for more extended periods than at the Ashburton site.

Primary development within the alluvial outwash plain sites at either location could not be considered likely to have any significant detrimental effect on fauna we have been able to identify in this survey, beyond the immediate disturbance zone, and given the wide extent of this habitat type and the relative commonality of the species within it, this would not be considered of either local or regional significance at the proposed development scale. While the riparian zones are the more speciose areas and include the two conservation significant species identified, the limitation of proposed development within this to a walk trail within the Narrina River envelope would be unlikely to affect the prevalence or continued persistence of these species.

With further work and as part of a formal site environmental impact assessment process it will be necessary to undertake a review and risk assessment in relation to both formally listed invertebrate species as well as those groups considered short range endemics although there is no evidence to suggest that there are species likely to be adversely impacted present within either envelope.

To maintain the broadest natural biodiversity values at either of these locations it is recommend that primary developments focus on the spinifex alluvial outwash plain and provide a non-building buffer between it and the riparian zones of the creeklines. Obviously it will be important to minimise any effects to drainage within these areas and to ensure the continued naturalness of vegetation and water quality within the creeks.

Due to the prevalence of feral cats within both envelopes, the fact that they can have a significant negative impact on a range of native species and evidence suggesting that they often increase in abundance around development sites, it would be advisable for any site development to monitor numbers and implement some control actions. These same sorts of actions may also be necessary for *Mus musculus*, although care would have to be taken to ensure that this species was not

confused with several species of native rodent known to occupy the areas. A management program to address *M. musculus* would also make any development site less attractive to snakes.

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9. Appendices

9.1 Appendix A- Table of survey trapping results for terrestrial vertebrates.

TAXON	Narrina Gorge		Ashburton		Narrina Gorge	
	Site 1	Site 2	Site 3	Site 4	Site 5*	Site 6*
Hylidae						
<i>Litoria rubella</i>	-	+	-	-	-	-
Myobatrachidae						
<i>Uperoleia russelli</i>	-	+	-	-	-	-
Agamidae						
<i>Amphibolurus longirostris</i>	-	+	-	-	-	-
<i>Ctenophorus caudicinctus</i>	-	-	-	-	+	+
<i>Ctenophorus isolepis</i>	+	-	+	-	+	+
<i>Pogona minor</i>	-	-	+	+	-	-
Diplodactylidae						
<i>Diplodactylus conspicillatus</i>	+	-	+	+	-	-
<i>Lucasium stenodactylum</i>	+	+	+	+	-	-
<i>Strophurus elderi</i>	-	+	-	+	-	-
Gekkonidae						
<i>Gehyra pilbara</i>	-	-	-	+	-	-
<i>Gehyra variegata</i>	-	+	+	+	-	-
<i>Heteronotia binoei</i>	-	+	-	-	-	-
Pygopodidae						
<i>Delma pax</i>	-	+	+	-	-	-
<i>Lialis burtonis</i>	-	-	+	+	-	-
Scincidae						
<i>Ctenotus duricola</i>	+	-	-	+	-	-
<i>Ctenotus grandis</i>	-	+	-	+	+	-
<i>Ctenotus hanloni</i>	+	-	-	+	-	-
<i>Ctenotus pantherinus</i>	+	-	+	-	+	-
<i>Ctenotus saxatilis</i>	-	+	-	-	-	-
<i>Egernia formosa</i>	-	+	-	-	-	-
<i>Glaphyromorphus isolepis</i>	-	+	-	-	-	-
<i>Lerista verhmens</i>	-	-	-	+	-	-
<i>Menetia greyii</i>	-	+	-	+	-	-
<i>Morethia ruficauda</i>	+	+	-	-	-	-
<i>Tiliqua multifasciata</i>	-	-	+	+	-	-

TAXON	Narrina Gorge		Ashburton		Narrina Gorge	
	Site 1	Site 2	Site 3	Site 4	Site 5*	Site 6*
Varanidae						
<i>Varanus acanthurus</i>	-	+	-	-	-	-
<i>Varanus eremius</i>	+	-	+	-	-	-
<i>Varanus giganteus</i>	-	-	-	+	-	-
<i>Varanus gouldii</i>	+	-	-	-	-	-
<i>Varanus panoptes</i>	-	-	-	+	-	-
<i>Varanus tristis</i>	-	+	-	-	-	-
Elapidae						
<i>Furina ornata</i>	-	+	-	-	-	-
<i>Pseudechis australis</i>	-	+	-	-	+	-
<i>Pseudonaja mengdeni</i>	-	+	-	+	-	-
<i>Vermicella snelli</i>	-	-	-	+	-	-
Typhlopidae						
<i>Ramphotyphlops ammodytes</i>	+	+	-	+	-	-
<i>Ramphotyphlops grypus</i>	+	+	-	-	-	-
Dasyuridae						
<i>Dasykaluta rosamondae</i>	+	-	+	+	-	-
<i>Dasyurus hallucatus</i>	-	+	-	-	-	-
<i>Ningauai timealeyi</i>	+	-	-	-	-	-
Macropodidae						
<i>Macropus robustus</i>	-	+	-	+	-	-
<i>Petrogale rothschildi</i>	-	+	-	-	-	-
Muridae						
<i>Mus musculus</i>	-	+	-	+	-	-
<i>Pseudomys desertor</i>	+	-	+	+	+	+
<i>Pseudomys hermannsburgensis</i>	+	-	+	-	-	-
<i>Zyzomys argurus</i>	-	+	-	-	-	-
Species of Frogs	0	2	0	0	0	0
Species of Reptiles	11	19	10	18	5	2
Species of Mammals	4	5	3	4	1	1
Individuals of Frogs	0	8	0	0	0	0
Individuals of Reptiles	65	54	32	50	7	2
Individuals of Mammals	20	7	7	7	7	1

* designates sites where only Elliot traps were used.

9.2 Appendix B- Terrestrial vertebrates recorded in Millstream Chichester National Park.

Taxon	Museum Records	Fisheries and Wildlife	Ecologia Fauna Survey 1999	Pilbara Biological Survey	Adjacent Pilbara Biological Survey Sites	NatureBank Survey	Conservation Code
Hylidae							
<i>Cyclorana maini</i>	+						
<i>Litoria rubella</i>	+		+			+	
Myobatrachidae							
<i>Pseudophryne douglasi</i>	+						
<i>Uperoleia saxatilis</i>	+		+			+	
Cheluidae							
<i>Chelodina steindachneri</i>	+	+					
Agamidae							
<i>Ctenophorus caudicinctus</i>	+	+	+	+	+	+	
<i>Ctenophorus isolepis</i>	+	+		+		+	
<i>Ctenophorus nuchalis</i>	+			+			
<i>Amphibolurus longirostris</i>	+	+	+	+		+	
<i>Pogona minor</i>	+		+	+	+	+	
<i>Tympanocryptis cephalus</i>	+						
Diplodactylidae							
<i>Diplodactylus conspicillatus</i>	+		+	+	+	+	
<i>Diplodactylus elderi</i>			+				
<i>Diplodactylus galaxias</i>	+			+	+		
<i>Diplodactylus mitchelli</i>	+			+			
<i>Lucasium stenodactylum</i>	+		+	+	+	+	
<i>Lucasium wombeyi</i>	+			+	+		
<i>Oedura marmorata</i>	+						
<i>Rhynchoedura ornata</i>	+		+	+			
<i>Strophurus elderi</i>	+	+		+		+	
Gekkonidae							
<i>Gehyra pilbara</i>	+		+			+	
<i>Gehyra punctata</i>	+			+	+		
<i>Gehyra purpurascens</i>	+						
<i>Gehyra variegata</i>	+	+	+	+	+	+	
<i>Heteronotia binoei</i>	+	+	+	+	+	+	
<i>Heteronotia spelea</i>	+						
<i>Nephurus wheeleri</i>	+						

Taxon	Museum Records	Fisheries and Wildlife	Ecologia Fauna Survey 1999	Pilbara Biological Survey	Adjacent Pilbara Biological Survey Sites	NatureBank Survey	Conservation Code
Pygopodidae							
<i>Delma elegans</i>	+	+	+				
<i>Delma nasuta</i>	+						
<i>Delma pax</i>	+		+			+	
<i>Lialis burtonis</i>	+	+				+	
Scincidae							
<i>Carlia munda</i>	+		+	+			
<i>Carlia triacantha</i>				+			
<i>Cryptoblepharus buchananii</i>	+	+		+			
<i>Cryptoblepharus plagiocephalus</i>	+						
<i>Cryptoblepharus ustulatus</i>	+						
<i>Ctenotus duricola</i>	+		+	+	+	+	
<i>Ctenotus grandis</i>	+		+	+	+	+	
<i>Ctenotus hanloni</i>							+
<i>Ctenotus helenae</i>	+		+	+			
<i>Ctenotus pantherinus</i>	+	+	+	+	+	+	
<i>Ctenotus robustus</i> *							
<i>Ctenotus rubicundus</i>	+		+	+			
<i>Ctenotus saxatilis</i>	+		+	+	+	+	
<i>Ctenotus serventyi</i> *							
<i>Ctenotus schomburgkii</i> *			+				
<i>Cyclodomorphus melanops</i>	+	+	+	+			
<i>Egernia cygnitos</i>	+						
<i>Egernia formosa</i>	+					+	
<i>Egernia pilbarensis</i>	+						
<i>Eremiascincus isolepis</i>	+	+	+	+		+	
<i>Lerista bipes</i>	+						
<i>Lerista flammicauda</i>	+			+			
<i>Lerista jacksoni</i> *				+			
<i>Lerista muelleri</i>	+	+	+	+			
<i>Lerista verhmens</i>	+			+		+	
<i>Menetia greyii</i>	+			+	+	+	
<i>Menetia surda</i>	+			+			
<i>Morethia ruficauda</i>	+		+	+	+	+	
<i>Notoscincus butleri</i>	+		+	+	+		P4
<i>Tiliqua multifasciata</i>	+		+			+	
Varanidae							
<i>Varanus acanthurus</i>	+		+			+	
<i>Varanus brevicauda</i>	+		+	+	+		
<i>Varanus bushi</i>	+						
<i>Varanus eremius</i>						+	
<i>Varanus giganteus</i>						+	

Taxon	Museum Records	Fisheries and Wildlife	Ecologia Fauna Survey 1999	Pilbara Biological Survey	Adjacent Pilbara Biological Survey Sites	NatureBank Survey	Conservation Code
<i>Varanus gouldii</i>	+	+				+	
<i>Varanus panoptes</i>						+	
<i>Varanus pilbarensis</i>	+						
<i>Varanus tristis</i>	+	+				+	
Boidae							
<i>Antaresia perthensis</i>	+		+				
<i>Antaresia stimsoni</i> *			+				
<i>Liasis olivaceus</i> subsp. <i>barroni</i>		+					Threatened
Elapidae							
<i>Acanthophis pyrrhus</i> *			+				
<i>Brachyuropsis approximans</i>	+						
<i>Demansia psammophis</i> *							
<i>Demansia rufescens</i>	+						
<i>Furina ornata</i>	+					+	
<i>Parasuta monachus</i>	+						
<i>Pseudechis australis</i>	+					+	
<i>Pseudonaja mengdeni</i>						+	
<i>Suta fasciata</i>	+						
<i>Suta punctata</i> *		+					
<i>Vermicella snelli</i>	+					+	
Typhlopidae							
<i>Ramphotyphlops ammodytes</i>	+					+	
<i>Ramphotyphlops ganei</i>	+			+			P1
<i>Ramphotyphlops grypus</i>	+			+		+	
<i>Ramphotyphlops pilbarensis</i>	+		+				
Tachyglossidae							
<i>Tachyglossus aculeatus</i>	+						
Dasyuridae							
<i>Dasykaluta rosamondae</i>	+	+	+	+		+	
<i>Dasyurus hallucatus</i>	+					+	Threatened
<i>Ningai timealeyi</i>	+		+		+	+	
<i>Planigale kendricki</i>	+		+	+	+		
<i>Planigale tealei</i> *			+	+			
<i>Pseudantechinus roryi</i>	+						
<i>Pseudantechinus woolleyae</i>	+						
<i>Sminthopsis macroura</i>	+		+	+	+		
Macropodidae							
<i>Macropus robustus</i>	+	+	+			+	

Taxon	Museum Records	Fisheries and Wildlife	Ecologia Fauna Survey 1999	Pilbara Biological Survey	Adjacent Pilbara Biological Survey Sites	NatureBank Survey	Conservation Code
<i>Macropus rufus</i>		+	+				
<i>Petrogale rothschildi</i>						+	
Muridae							
<i>Leggadina lakedownensis</i>	+		+	+	+		P4
<i>Mus musculus</i>	+	+	+			+	
<i>Rattus rattus</i>	+						
<i>Pseudomys chapmani</i>	+		+	+	+		P4
<i>Pseudomys delicatulus</i>	+		+				
<i>Pseudomys desertor</i>				+		+	
<i>Pseudomys hermannsburgensis</i>	+		+	+		+	
<i>Zyzyomys argurus</i>	+		+			+	
Emballonuridae							
<i>Saccolaimus flaviventris</i>				+			
<i>Taphozous georgianus</i>	+			+			
Hipposideridae							
<i>Rhinonicteris aurantius</i>							Threatened
Megadermatidae							
<i>Macroderma gigas</i>				+			P4
Molossidae							
<i>Chaerephon jobensis</i>				+			
<i>Mormopterus beccarii</i>				+			
<i>Tadarida australis</i>				+			
Pteropodidae							
<i>Pteropus alecto</i>	+	+					
Vespertilionidae							
<i>Chalinolobus gouldii</i>	+			+			
<i>Nyctophilus bifax daedalus</i>	+			+			
<i>Nyctophilus geoffroyi</i>				+			
<i>Nyctophilus timoriensis</i>	+						
<i>Scotorepens greyii</i>	+			+			
<i>Vespadelus finlaysoni</i>	+			+			
Canidae							
<i>Canis lupus dingo</i>	+	+				+	
Felidae							
<i>Felis catus</i>						+	

Taxon	Museum Records	Fisheries and Wildlife	Ecologia Fauna Survey 1999	Pilbara Biological Survey	Adjacent Pilbara Biological Survey Sites	NatureBank Survey	Conservation Code
No. Reptiles and Amphibians from all sources =88	72	18	34	37	17	37	
% Reptiles and Amphibians recorded	82	20	39	42	19	42	
% of WA Museum records for Reptiles and Amphibians	100	25	47	51	24	51	
No. of Frogs from all sources=4	4	0	2	0	0	2	
No. of Turtles from all sources= 1	1	1	0	0	0	0	
No. of Lizards from all sources= 65	55	15	28	35	17	29	
No. of Snakes from all sources=18	12	2	4	2	0	6	
No. of Mammals recorded from all sources =36	24	6	13	19	5	11	
% of Mammals recorded	67	17	36	53	14	31	
% of WA Museum records for Mammals	100	25	54	79	21	46	
No. of Monotremes from all sources=1	1	0	0	0	0	0	
No. of Dasyurids from all sources=8	7	1	5	4	3	3	
No. of Macropods from all sources=3	1	2	2	0	0	2	
No. of Rodents from all sources=8	7	1	6	4	2	4	
No. of Bats from all sources=14	7	1	0	11	0	0	
No. of Carnivores from all sources= 2	1	1	0	0	0	2	

* Species that are unconfirmed.

9.3 Appendix C- Table of survey results for birds.

Order	Scientific Name	Vernacular	Narrina Gorge	Ashburton	Comment / Conservation Code
ANSERIFORMES	Anatidae				
	<i>Anas superciliosa</i>	Pacific Black Duck	x		
CHARADRIIFORMES	Burhinidae				
	<i>Burhinus grallarius</i>	Bush Stone Curlew	x		P4
	Charadriidae				
	<i>Elseyornis melanops</i>	Black-fronted Dotterel	x		
CICONIIFORMES	Ardeidae				
	<i>Ardea novaehollandiae</i>	White-faced Heron	x		
	<i>Ardea pacifica</i>	White-necked Heron	x		
	<i>Nycticorax caledonicus</i>	Rufous Night Heron	x		
	Pelecanidae				
	<i>Pelecanus conspicillatus</i>	Australian Pelican	x		
COLUMBIFORMES	Columbidae				
	<i>Geopelia cuneata</i>	Diamond Dove	x	x	
	<i>Geopelia striata</i>	Zebra Dove	x	x	
	<i>Eremiornis carteri</i>	Spinifexbird	x	x	
	<i>Ocyphaps lophotes</i>	Crested Pigeon	x	x	
CORACIIFORMES	Halcyonidae				
	<i>Dacelo leachii</i>	Blue-winged Kookaburra	x		
	<i>Todiramphus sanctus</i>	Sacred Kingfisher	x		
	Meropidae				
	<i>Merops ornatus</i>	Rainbow Bee-eater	x		Schedule 3. Migratory bird protected under an international agreement.
CUCULIFORMES	Cuculidae				
	<i>Cacomantis pallidus</i>	Pallid Cuckoo	x		
	<i>Centropus phasianinus</i>	Pheasant Coucal	x		
	<i>Chrysococcyx basalis</i>	Horsefield's Bronze-Cuckoo	x	x	
FALCONIFORMES	Accipitridae				
	<i>Accipiter cirrhocephalus</i>	Collared Sparrowhawk		x	
	<i>Aquila audax</i>	Wedge-tailed Eagle	x		(within 1 km)

Order	Scientific Name	Vernacular	Narrina Gorge	Ashburton	Comment / Conservation Code
	<i>Circus assimilis</i>	Spotted Harrier		x	
	<i>Elanus caeruleus</i>	Black-shouldered Kite	x	x	
	Falconidae				
	<i>Falco berigora</i>	Brown Falcon	x		
	<i>Falco cenchroides</i>	Australian Kestrel	x		
GALLIFORMES	Phasianidae				
	<i>Coturnix ypsilophora</i>	Brown Quail	x		
PASSERIFORMES	Acanthizidae				
	<i>Smicrornis brevirostris</i>	Weebill	x		
	Artamidae				
	<i>Artamus personatus</i>	Masked Woodswallow	x	x	
	<i>Cracticus nigrogularis</i>	Pied Butcherbird	x	x	
	<i>Cracticus tibicen</i>	Australian Magpie	x		
	Campephagidae				
	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike	x	x	
	Corvidae				
	<i>Corvus orru</i>	Toressian Crow	x	x	
	Estrildidae				
	<i>Emblema pictum</i>	Painted Finch	x		
	<i>Taeniopygia guttata</i>	Zebra Finch	x	x	
	Hirundinidae				
	<i>Petrochelidon ariel</i>	Fairy Martin	x		(nests observed)
	Maluridae				
	<i>Malurus lamberti</i>	Varigated Fairy-wren	x	x	
	Megaluridae				
	<i>Geophaps plumifera</i>	Spinifex Pigeon	x	x	
	Meliphagidae				
	<i>Gavicalis virescens</i>	Singing Honeyeater	x		
	<i>Ptilotula keartlandi</i>	Grey-headed Honeyeater	x		
	<i>Lichmera indistincta</i>	Brown Honeyeater	x	x	
	<i>Manorina flavigula</i>	Yellow-throated Miner	x	x	
	<i>Ptilotula penicillatus</i>	White-plumed Honeyeater	x	x	(Breeding)
	Monarchidae				
	<i>Grallina cyanoleuca</i>	Magpie-lark	x	x	
	Motacillidae				
	<i>Anthus australis</i>	Australian Pipit	x		
	Pachycephalidae				

Order	Scientific Name	Vernacular	Narrina Gorge	Ashburton	Comment / Conservation Code
	<i>Colluricincla harmonica</i>	Grey Shrike-thrush	x		
	<i>Oreoica gutturalis</i>	Crested Bellbird		x	
	<i>Pachycephala rufiventris</i>	Rufous Whistler	x		
	Pardalotidae				
	<i>Pardalotus rubricatus</i>	Red-browed Pardalote	x		
	Ptilonorhynchidae				
	<i>Ptilonorhynchus maculatus</i>	Western Bowerbird	x		
	Rhipiduridae				
	<i>Rhipidura leucophrys</i>	Willie Wagtail	x	x	(Breeding)
PHALACROCORACIFORMES	Phalacrocoracidae				
	<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant	x		
PSITTACIFORMES	Psittacidae				
	<i>Cacatua roseicapilla</i>	Galah	x	x	
	<i>Cacatua sanguinea</i>	Little Corella	x	x	
	<i>Melopsittacus undulatus</i>	Budgerigar	x	x	
	<i>Platycercus zonarius</i>	Australian Ringneck	x		(Likely)
STRIGIFORMES	Strigidae				
	<i>Ninox novaeseelandiae</i>	Boobook Owl	x		

9.4 Appendix D- List of species recorded with motion sensitive cameras

Group	Vernacular	Species	Camera Number	
Reptiles	Long-nosed Dragon	<i>Ampibilourus longirostris</i>	R16W	
	Giant Desert Skink	<i>Ctenotus grandis</i>	R04	
	Giant Desert Skink	<i>Ctenotus grandis</i>	R06	
	Leopard Skink	<i>Ctenotus pantherinus</i>	R02	
	Leopard Skink	<i>Ctenotus pantherinus</i>	R04	
	Leopard Skink	<i>Ctenotus pantherinus</i>	R17W	
	Crevice Skink	<i>Egernia formosa</i>	R05	
	Bearded Dragon	<i>Pogona minor</i>	R04	
	Bearded Dragon	<i>Pogona minor</i>	R08	
	Bearded Dragon	<i>Pogona minor</i>	R16W	
	Bluetongue Skink	<i>Tiliqua miltifasciata</i>	R04	
	Bluetongue Skink	<i>Tiliqua miltifasciata</i>	R06	
	Bluetongue Skink	<i>Tiliqua miltifasciata</i>	R07	
	Pygmy Desert Monitor	<i>Varanus eremius</i>	R04	
	Perentie	<i>Varanus giganteus</i>	R03	
	Gould's Goanna	<i>Varanus gouldii</i>	R09	
	Gould's Goanna	<i>Varanus gouldii</i>	R17W	
	Yellow-spotted Monitor	<i>Varanus panoptes</i>	R03	
	Yellow-spotted Monitor	<i>Varanus panoptes</i>	R16W	
	Black Tree Monitor	<i>Varanus tristis</i>	B03	
	Birds	Collared Sparrowhawk	<i>Accipiter cirrhocephalus</i>	R03
		Pacific Black Duck	<i>Anas superciliosa</i>	S02
White-faced Heron		<i>Ardea novaehollandiae</i>	B04	
White-faced Heron		<i>Ardea novaehollandiae</i>	S02	
White-necked Heron		<i>Ardea pacifica</i>	B04	
White-necked Heron		<i>Ardea pacifica</i>	S02	
Bush Stone-curlew		<i>Burhinus grallarius</i>	B04	
Pheasant Coucal		<i>Centropus phasianinus</i>	S02	
Western Bowerbird		<i>Ptilonorhynchus maculatus</i>	B04	
Western Bowerbird		<i>Ptilonorhynchus maculatus</i>	R03	
Western Bowerbird		<i>Ptilonorhynchus maculatus</i>	S02	
Western Bowerbird		<i>Ptilonorhynchus maculatus</i>	S03	
Spotted Harrier		<i>Circus assimilis</i>	R11	
Torresian Crow		<i>Corvus orru</i>	B04	
Torresian Crow		<i>Corvus orru</i>	R04	
Torresian Crow		<i>Corvus orru</i>	R13	
Torresian Crow		<i>Corvus orru</i>	S02	

Group	Vernacular	Species	Camera Number
	Pied Butcherbird	<i>Cracticus nigrogularis</i>	S02
	Diamond Dove	<i>Geopelia cuneata</i>	B04
	Diamond Dove	<i>Geopelia cuneata</i>	R03
	Diamond Dove	<i>Geopelia cuneata</i>	R06
	Diamond Dove	<i>Geopelia cuneata</i>	R16W
	Diamond Dove	<i>Geopelia cuneata</i>	S02
	Spinifex Pigeon	<i>Geophaps plumifera</i>	R03
	Spinifex Pigeon	<i>Geophaps plumifera</i>	R16W
	Spinifex Pigeon	<i>Geophaps plumifera</i>	R17W
	Magpie-Lark	<i>Grallina cyanoleuca</i>	B04
	Magpie-Lark	<i>Grallina cyanoleuca</i>	S02
	Rufous Night Heron	<i>Nycticorax caledonicus</i>	B04
	Rufous Night Heron	<i>Nycticorax caledonicus</i>	S02
	Willie Wagtail	<i>Rhipidura leucophrys</i>	B04
	Willie Wagtail	<i>Rhipidura leucophrys</i>	R11
	Willie Wagtail	<i>Rhipidura leucophrys</i>	R16W
	Willie Wagtail	<i>Rhipidura leucophrys</i>	S02
Mammals	Dingo	<i>Canus lupus</i>	R03
	Kaluta	<i>Dasykaluta rosamondae</i>	R02
	Kaluta	<i>Dasykaluta rosamondae</i>	R06
	Kaluta	<i>Dasykaluta rosamondae</i>	R11
	Kaluta	<i>Dasykaluta rosamondae</i>	R15
	Kaluta	<i>Dasykaluta rosamondae</i>	R17W
	Kaluta	<i>Dasykaluta rosamondae</i>	S04
	Quoll	<i>Dasyurus hallucatus</i>	B03
	Quoll	<i>Dasyurus hallucatus</i>	R03
	Quoll	<i>Dasyurus hallucatus</i>	R05
	Quoll	<i>Dasyurus hallucatus</i>	R16W
	Quoll	<i>Dasyurus hallucatus</i>	S02
	Quoll	<i>Dasyurus hallucatus</i>	S03
	Cat	<i>Felis catus</i>	B01
	Cat	<i>Felis catus</i>	B04
	Cat	<i>Felis catus</i>	R03
	Cat	<i>Felis catus</i>	R04
	Cat	<i>Felis catus</i>	R05
	Cat	<i>Felis catus</i>	R09
	Cat	<i>Felis catus</i>	R12
	Cat	<i>Felis catus</i>	R16W
	Cat	<i>Felis catus</i>	S02
	Cat	<i>Felis catus</i>	S03

Group	Vernacular	Species	Camera Number
Euro		<i>Macropus robustus</i>	B01
Euro		<i>Macropus robustus</i>	B04
Euro		<i>Macropus robustus</i>	R03
Euro		<i>Macropus robustus</i>	R06
Euro		<i>Macropus robustus</i>	R11
Euro		<i>Macropus robustus</i>	S02
Euro		<i>Macropus robustus</i>	S03
Euro		<i>Macropus robustus</i>	S04
Mouse		<i>Mus musculus</i>	R05
Mouse		<i>Mus musculus</i>	R11
Rothschild's Rock Wallaby		<i>Perogale rothschildi</i>	B03
Desert Mouse		<i>Pseudomys desertor</i>	R04
Desert Mouse		<i>Pseudomys desertor</i>	R12
Desert Mouse		<i>Pseudomys desertor</i>	R17W
Sandy Inland Mouse		<i>Pseudomys hermannsburgensis</i>	R16W
Common Rock Rat		<i>Zyomys argurus</i>	R05

9.5 Appendix E- List of birds recorded from Millstream Chichester National Park.

Order	Scientific Name	Vernacular	Comment
Anseriformes	Anatidae		
	<i>Anas gracilis</i>	Grey Teal	
	<i>Anas superciliosa</i>	Pacific Black Duck	
	<i>Anseranas semipalmata</i>	Magpie Goose (Pied Goose)	
	<i>Aythya australis</i>	Hardhead	
	<i>Cygnus atratus</i>	Black Swan	
	<i>Dendrocygna eytoni</i>	Plumed Whistling Duck	
Caprimulgiformes	Aegothelidae		
	<i>Aegotheles cristatus</i>	Australian Owlet-nightjar	
	Caprimulgidae		
	<i>Eurostopodus argus</i>	Spotted Nightjar	
	Podargidae		
	<i>Podargus strigoides</i>	Tawny Frogmouth	
Charadriiformes	Burhinidae		
	<i>Burhinus grallarius</i>	Bush Stone-curlew	P4
	Charadriidae		
	<i>Charadrius melanops</i>	Black-fronted Dotterel	
			Schedule 3. Migratory bird protected under an international agreement.
	<i>Charadrius veredus</i>	Oriental Plover	
	<i>Erythrogonys cinctus</i>	Red-kneed Dotterel	
	<i>Vanellus tricolor</i>	Banded Lapwing	
	Haematopodidae		
	Laridae		
	<i>Larus novaehollandiae</i>	Silver Gull	
	Recurvirostridae		
	<i>Himantopus himantopus</i>	Black-winged Stilt	
	Rostratulidae		
	<i>Rostratula benghalensis</i>	Painted Snipe	Schedule 1. Endangered
Scolopacidae			
		Schedule 3. Migratory bird protected under an international agreement.	
<i>Numenius phaeopus</i>	Whimbrel		
		Schedule 3. Migratory bird protected under an international agreement.	
<i>Philomachus pugnax</i>	Ruff		
<i>Tringa hypoleucos</i>	Common Sandpiper		

Order	Scientific Name	Vernacular	Comment	
Ciconiiformes	Ardeidae		Schedule 3. Migratory bird protected under an international agreement.	
	<i>Ardea alba</i>	Great Egret		
	<i>Ardea garzetta</i>	Little Egret	Schedule 3. Migratory bird protected under an international agreement.	
	<i>Ardea ibis</i>	Cattle Egret		
	<i>Ardea intermedia</i>	Intermediate Egret		
	<i>Ardea novaehollandiae</i>	White-faced Heron		
	<i>Ardea pacifica</i>	White-necked Heron		
	<i>Ixobrychus flavicollis</i>	Black Bittern		P3
	<i>Nycticorax caledonicus</i>	Rufous Night Heron		
	Threskiornithidae			
	<i>Platalea flavipes</i>	Yellow-billed Spoonbill		
	<i>Threskiornis molucca</i>	Australian White Ibis		
	<i>Threskiornis spinicollis</i>	Straw-necked Ibis		
	Columbiformes	Columbidae		
<i>Geopelia cuneata</i>		Diamond Dove		
<i>Geopelia striata</i>		Zebra Dove		
<i>Geophaps plumifera</i>		Spinifex Pigeon		
<i>Ocyphaps lophotes</i>		Crested Pigeon		
<i>Phaps chalcoptera</i>		Common Bronzewing		
<i>Phaps histrionica</i>		Flock Bronzewing (Flock Pigeon)		
Coraciiformes	Coraciidae			
	<i>Eurystomus orientalis</i>	Dollarbird		
	Halcyonidae			
	<i>Dacelo leachii</i>	Blue-winged Kookaburra		
	<i>Todiramphus pyrrhopygius</i>	Red-backed Kingfisher		
	<i>Todiramphus sanctus</i>	Sacred Kingfisher		
	Meropidae			
	<i>Merops ornatus</i>	Rainbow Bee-eater	Schedule 3. Migratory bird protected under an international agreement.	
	Centropodidae			
	<i>Centropus phasianinus</i>	Pheasant Coucal		
	Cuculidae			
	<i>Chrysococcyx basalus</i>	Horsfield's Bronze Cuckoo		
	<i>Chrysococcyx osculans</i>	Black-eared Cuckoo		
<i>Cuculus pallidus</i>	Pallid Cuckoo			

Order	Scientific Name	Vernacular	Comment	
Falconiformes	Accipitridae			
	<i>Accipiter cirrocephalus</i>	Collared Sparrowhawk		
	<i>Accipiter fasciatus</i>	Brown Goshawk		
	<i>Aquila audax</i>	Wedge-tailed Eagle		
	<i>Aquila morphnoides</i>	Little Eagle		
	<i>Circus approximans</i>	Swamp Harrier		
	<i>Circus assimilis</i>	Spotted Harrier		
	<i>Elanus caeruleus</i>	Black-shouldered Kite		
	<i>Elanus scriptus</i>	Letter-winged Kite		
				Schedule 3. Migratory bird protected under an international agreement.
		<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	
		<i>Haliastur indus</i>	Brahminy Kite	
		<i>Haliastur sphenurus</i>	Whistling Kite	
		<i>Hamirostra isura</i>	Square-tailed Kite	
		<i>Hamirostra melanosternon</i>	Black-breasted Buzzard	
		<i>Milvus migrans</i>	Black Kite	
		<i>Pandion haliaetus</i>	Osprey	
		Falconidae		
		<i>Falco berigora</i>	Brown Falcon	
		<i>Falco cenchroides</i>	Australian Kestrel	
	<i>Falco hypoleucos</i>	Grey Falcon		
	<i>Falco longipennis</i>	Australian Hobby		
Galliformes	Phasianidae			
	<i>Coturnix ypsilophora</i>	Brown Quail		
Gruiformes	Gruidae			
	<i>Grus rubicunda</i>	Brolga		
	Otididae			
	<i>Ardeotis australis</i>	Australian Bustard	P4	
	Rallidae			
	<i>Fulica atra</i>	Eurasian Coot		
	<i>Gallinula ventralis</i>	Black-tailed Native-hen		
	<i>Gallirallus philippensis</i>	Buff-banded Rail		
	<i>Porphyrio porphyrio</i>	Purple Swamphen		
	<i>Porzana fluminea</i>	Australian Spotted Crake		
	<i>Porzana tabuensis</i>	Spotless Crake		
Passeriformes	Acanthizidae			
	<i>Gerygone fusca</i>	Western Gerygone		

Order	Scientific Name	Vernacular	Comment
	<i>Smicrornis brevirostris</i>	Weebill	
	Alaudidae		
	<i>Mirafra javanica</i>	Horsfield's Bushlark (Singing Bushlark)	
	<i>Artamus cinereus</i>	Black-faced Woodswallow	
	<i>Artamus leucorhynchus</i>	White-breasted Woodswallow	
	<i>Artamus minor</i>	Little Woodswallow	
	<i>Artamus personatus</i>	Masked Woodswallow	
	Campephagidae		
	<i>Coracina maxima</i>	Ground Cuckoo-shrike	
	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike	
	<i>Lalage tricolor</i>	White-winged Triller	
	Climacteridae		
	<i>Climacteris melanura</i>	Black-tailed Treecreeper	
	Corvidae		
	<i>Corvus bennetti</i>	Little Crow	
	<i>Corvus orru</i>	Torresian Crow	
	Cracticidae		
	<i>Cracticus nigrogularis</i>	Pied Butcherbird	
	<i>Cracticus tibicen</i>	Australian Magpie	
	<i>Cracticus torquatus</i>	Grey Butcherbird	
	Dicaeidae		
	<i>Dicaeum hirundinaceum</i>	Mistletoebird	
	<i>Grallina cyanoleuca</i>	Magpie-lark	
	<i>Rhipidura fuliginosa</i>	Grey Fantail	
	<i>Rhipidura leucophrys</i>	Willie Wagtail	
	Estrildidae		
	<i>Emblema pictum</i>	Painted Finch	
	<i>Neochmia ruficauda</i>	Star Finch	P4
	<i>Taeniopygia guttata</i>	Zebra Finch	
	Hirundinidae		
	<i>Cheramoeca leucosternus</i>	White-backed Swallow	
	<i>Hirundo ariel</i>	Fairy Martin	
	<i>Hirundo neoxena</i>	Welcome Swallow	
	<i>Hirundo nigricans</i>	Tree Martin	
	Maluridae		
	<i>Amytornis striatus</i>	Striated Grasswren	P4
	<i>Malurus lamberti</i>	Variiegated Fairy-wren	
	<i>Malurus leucopterus</i>	White-winged Fairy-wren	
	<i>Stipiturus ruficeps</i>	Rufous-crowned Emu-wren	
	Meliphagidae		
	<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater	

Order	Scientific Name	Vernacular	Comment
	<i>Sugomel niger</i>	Black Honeyeater	
	<i>Certhionyx variegatus</i>	Pied Honeyeater	
	<i>Epthianura tricolor</i>	Crimson Chat	
	<i>Ptilotula keartlandi</i>	Grey-headed Honeyeater	
	<i>Ptilotula penicillatus</i>	White-plumed Honeyeater	
	<i>Ptilotula plumulus</i>	Grey-fronted Honeyeater	
	<i>Lacustroica whitei</i>	Grey Honeyeater	
	<i>Lichenostomus virescens</i>	Singing Honeyeater	
	<i>Lichmera indistincta</i>	Brown Honeyeater	
	<i>Manorina flavigula</i>	Yellow-throated Miner	
	<i>Melithreptus gularis</i>	Black-chinned Honeyeater	
	Motacillidae		
	<i>Anthus Australia</i>	Australian Pipit	
	Neosittidae		
	<i>Daphoenositta chrysoptera</i>	Varied Sittella	
	Pachycephalidae		
	<i>Colluricincla harmonica</i>	Grey Shrike-thrush	
	<i>Oreoica gutturalis</i>	Crested Bellbird	
	<i>Pachycephala rufiventris</i>	Rufous Whistler	
	Pardalotidae		
	<i>Pardalotus rubricatus</i>	Red-browed Pardalote	
	<i>Pardalotus striatus</i>	Striated Pardalote	
	<i>Petroica cucullata</i>	Hooded Robin	
	<i>Petroica goodenovii</i>	Red-capped Robin	
	Pomatostomidae		
	<i>Pomatostomus superciliosus</i>	White-browed Babbler	
	<i>Pomatostomus temporalis</i>	Grey-crowned Babbler	
	Ptilonorhynchidae		
	<i>Ptilonorhynchus maculatus</i>	Western Bowerbird	
	Sylviidae		
	<i>Acrocephalus australis</i>	Australian Reed Warbler	
	<i>Cincloramphus cruralis</i>	Brown Songlark	
	<i>Cincloramphus mathewsi</i>	Rufous Songlark	
	<i>Cisticola exilis</i>	Golden-headed Cisticola	
	<i>Eremiornis carteri</i>	Spinifex-bird	
	Zosteropidae		
	<i>Zosterops luteus</i>	Yellow White-eye	
Pelecaniformes	Anhingidae		
	<i>Anhinga melanogaster</i>	Darter	
	Pelecanidae		

Order	Scientific Name	Vernacular	Comment
	<i>Pelecanus conspicillatus</i>	Australian Pelican	
	Phalacrocoracidae		
	<i>Phalacrocorax carbo</i>	Great Cormorant	
	<i>Phalacrocorax melanoleucos</i>	Little Pied Cormorant	
	<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant	
	<i>Phalacrocorax varius</i>	Pied Cormorant	
Podicipediformes	Podicipedidae		
	<i>Tachybaptus novaehollandiae</i>	Australasian Grebe (Black-throated Grebe)	
	<i>Podiceps cristatus</i>	Great Crested Grebe	
	<i>Poliiocephalus poliocephalus</i>	Hoary-headed Grebe	
Psittaciformes	Psittacidae		
	<i>Cacatua roseicapilla</i>	Galah	
	<i>Cacatua sanguinea</i>	Little Corella	
	<i>Calyptorhynchus banksii</i>	Red-tailed Black Cockatoo	
	<i>Melopsittacus undulatus</i>	Budgerigar	
	<i>Nymphicus hollandicus</i>	Cockatiel	
	<i>Platycercus varius</i>	Mulga Parrot	
	<i>Platycercus zonarius</i>	Australian Ringneck (Ring-necked Parrot)	
Strigiformes	Strigidae		
	<i>Ninox connivens</i>	Barking Owl	
	<i>Ninox novaeseelandiae</i>	Boobook Owl	
	<i>Tyto alba</i>	Barn Owl	
Struthioniformes	Casuariidae		
	<i>Dromaius novaehollandiae</i>	Emu	
Turniciformes	Turnicidae		
	<i>Turnix velox</i>	Little Button-quail	

9.6 Appendix F- Site coordinates from trapping locations and remote cameras.

Trap site	Datum	Latitude	Longitude
Pit 1 & Elliot Line 1	WGS84	-21.3521	117.2630
Pit 2	WGS84	-21.3526	117.2636
Elliot Line 2	WGS84	-21.3489	117.2669
Pit 3 & Elliot Line 3	WGS84	-21.3539	117.3013
Pit 4 & Elliot Line 4	WGS84	-21.3523	117.2992
Elliot Line 5	WGS84	-21.3446	117.2545
Elliot Line 6	WGS84	-21.3471	117.2524
Cage 1	WGS84	-21.3527	117.2636
Cage 2	WGS84	-21.3516	117.2642
Cage 3	WGS84	-21.3490	117.2666
Cage 4	WGS84	-21.3488	117.2670

Remote Camera sites	Datum	Latitude	Longitude
Camera B01	WGS84	-21.3524	117.2633
Camera B02	WGS84	-21.3532	117.3003
Camera B03	WGS84	-21.3472	117.2694
Camera B04	WGS84	-21.3512	117.2646
Camera R01	WGS84	-21.3519	117.2624
Camera R02	WGS84	-21.3508	117.2607
Camera R03	WGS84	-21.3548	117.2947
Camera R04	WGS84	-21.3525	117.2994
Camera R05	WGS84	-21.3536	117.2632
Camera R06	WGS84	-21.3534	117.2979
Camera R07	WGS84	-21.3505	117.2588
Camera R08	WGS84	-21.3559	117.2996
Camera R09	WGS84	-21.3484	117.2575
Camera R10	WGS84	-21.3505	117.2641
Camera R11	WGS84	-21.3548	117.3012
Camera R12	WGS84	-21.3472	117.2559
Camera R13	WGS84	-21.3462	117.2543
Camera R14	WGS84	-21.3542	117.3022
Camera R15	WGS84	-21.3565	117.2976
Camera R16W	WGS84	-21.3530	117.2988
Camera R17W	WGS84	-21.3509	117.2630
Camera S01	WGS84	-21.3518	117.2620
Camera S02	WGS84	-21.3514	117.2644
Camera S03	WGS84	-21.3489	117.2668
Camera S04	WGS84	-21.3538	117.2993

9.7 Appendix G



Site P1/E1



Site P2/E2



Site P3/E3



Site P4/E4



Site E5



Site E6