

APPENDIX N

Terrestrial Fauna Assessment



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Vista Gold Australia Pty Ltd

Mt Todd Gold Project Fauna Impact Assessment

June 2013



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Executive Summary

Introduction and Project Background

Vista Gold Australia Pty Ltd (Vista Gold) proposes to re-open and operate the Mt Todd Gold Mine (north of Katherine, Northern Territory). Vista Gold commissioned GHD Pty Ltd (GHD) to assess the fauna of the mine, as part of an Environmental Impact Statement (EIS) required for the project by the NT Minister for Lands, Planning and the Environment (formerly Natural Resources, Environment and Heritage), under a bi-lateral agreement with the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). This report describes the methods, results and conclusions of the fauna assessment, and includes:

- ▶ Documentation of baseline wet-season and dry-season fauna surveys in areas in and surrounding the Project area;
- ▶ Identification of *Environmental Protection Biodiversity Conservation Act 1999* (EPBC) and NT listed fauna species present, or potentially present, in the Project area [including the Gouldian finch (*Erythrura gouldiae*)] that may be affected by the Project;
- ▶ Documentation of systematic fauna survey targeting EPBC and NT listed species in and adjacent to all areas proposed for development;
- ▶ Identification of the presence and potential presence of feral animals in the Project area; and
- ▶ Description of the distribution, ecology and habitat preferences of listed threatened and/or migratory species relevant to the project area.

The study area lies in the Yinberrie Hills (Pine Creek Bioregion), an area regarded by the Department of Land Resource Management (DLRM) as a site of conservation significance and which provides habitat for the largest known breeding population of the nationally threatened Gouldian finch (*Erythrura gouldiae*) (listed as *endangered* under the EPBC Act and *vulnerable* under the *Territory Parks and Wildlife Conservation Act 2006* [TPWC Act]).

Fauna at the Mt Todd mine area was assessed in a similar way more than 20 years ago as part of the approvals process for the construction of the original mine (Lane *et al.* 1990).

Vegetation Communities

Assessment of the vegetation in the project area (GHD 2013a) identified eight vegetation communities. Of those, three eucalypt woodland communities (*Eucalyptus tintinnans*, *E. spp.*, *Erythrophleum chlorostachys* woodland; *Eucalyptus tintinnans*, *Corymbia dichromophloia* woodland; and *Eucalyptus tectifica* woodland) are relatively widespread in large patches across the area, and two (*Eucalyptus bigalerita*, *E. spp.* open forest; and *Corymbia latifolia*, *Eucalyptus bigalerita* open woodland with areas of grassland) occur in smaller patches. Three communities are represented in the project area by one patch only [Melaleuca forest, with bare areas (Edith River); *Eucalyptus tectifica*, *Corymbia confertiflora* woodland; and *Eucalyptus tectifica* woodland / *E. tintinnans*, *E. spp.*, *Erythrophleum chlorostachys* woodland].



Survey Methods

Desktop Assessment

Desktop assessment of the Mt Todd mine area included reviews of the following:

- ▶ The DSEWPac Protected Matters Search Tool (PMST), which identifies matters of national environmental significance potentially occurring in the area of the mine;
- ▶ The Department of Land Resource Management (DLRM) Fauna Atlas database, which documents records of all fauna species in the search area; and
- ▶ Lane *et al.* (1990). The terrestrial vertebrate fauna of the Mt Todd-Yinberrie Hills area. Appendix 10 in 'Mt Todd Gold Project: Draft Environmental Impact Statement', NSP Environmental Consultants.

Following the desktop review, four field surveys were conducted as part of the assessment:

- ▶ Baseline dry season survey by six ecologists over six days and five nights (November 2011);
- ▶ Baseline wet season survey by nine ecologists over five days and four nights (February 2012);
- ▶ Targeted threatened species survey by two ecologists (with assistance from two Jawoyn Association Rangers) over five days and four nights (May 2011); and
- ▶ Targeted threatened species survey by two ecologists over two days and two nights (September 2012).

Baseline Surveys

For the baseline surveys, 16 sites were sampled, with two sites in each of the eight vegetation communities. Each site was focussed on a 50m x 50m area. Sites were chosen to maximise the likelihood of detecting fauna, including threatened species. The same sites were sampled in the dry and wet season surveys.

Survey methods for baseline surveys followed the NT Parks and Wildlife Commission's "*Draft survey methods used for fauna and flora on standard Biodiversity Unit survey sites*" (May 2011). Methods included: Habitat assessment, trapping using Elliot-type traps, cage traps, pitfall buckets, funnel (reptile) traps, Anabat® bat call detection, bird surveys (including Instantaneous Bird Count), active diurnal searches, nocturnal searches, scat/hair/bone/skin analysis, opportunistic observations and call playback. Survey techniques employed were consistent over the wet and dry season surveys, except where precluded by weather conditions.

Targeted Threatened Species Surveys

The targeted threatened species surveys considered the following species, which are known or considered most likely to occur in or near the project area:

- ▶ Gouldian finch (*Erythrura gouldiae*);
- ▶ northern quoll (*Dasyurus hallucatus*);
- ▶ crested shrike-tit (northern) (*Falcunculus frontatus whitei*);
- ▶ partridge pigeon (*Geophaps smithii smithii*);
- ▶ red goshawk (*Erythrotriorchis radiatus*);
- ▶ painted honeyeater (*Grantiella picta*);



- ▶ grey falcon (*Falco hypoleucos*);
- ▶ Australian bustard (*Ardeotis australis*) (formerly listed as *vulnerable* now listed as *near threatened*);
- ▶ masked owl (*Tyto novaehollandiae kimberli*);
- ▶ Mitchell's water monitor (*Varanus mitchelli*);
- ▶ Mertens' water monitor (*Varanus mertensi*); and
- ▶ yellow-spotted monitor (*Varanus panoptes*).

Other threatened fauna species were *not* targeted for the threatened species survey on the basis that those species were considered unlikely to occur in the project area [bare-rumped sheath-tail bat (*Saccolaimus saccolaimus nudiclunatus*), northern brush-tailed phascogale (*Phascogale pirata*), black-footed tree-rat (*Mesembriomys gouldii*) and brush-tailed rabbit-rat (*Conilurus penicillatus*). The northern leaf-nosed bat (*Hipposideros stenotis*) was not targeted either since at the time of survey it was not listed as being threatened. Survey methods were appropriate to detect these species if they were present.

Survey methods for targeted threatened species surveys included searches for northern quoll habitat, scat searches and deployment of baited motion-sensitive surveillance cameras to detect northern quoll, walked transects with active searching, call playback and listening for crested shrike-tit (northern) and masked owl, walked meandering transects with active searching and listening for all species including gouldian finch, partridge pigeon, painted honeyeater, grey falcon, Australian bustard, red goshawk and yellow-spotted monitor, vehicle-based searches for partridge pigeon and Australian bustard, active searches of wetlands and waterways for Mertens' water monitor and Mitchell's water monitor, active nocturnal searches for all species, and opportunistic observations.

Desktop Results

The desktop assessment revealed records of 300 indigenous terrestrial vertebrate fauna species relevant to the project area (36 mammals, 183 birds, 67 reptiles and 14 amphibians). Eight introduced fauna species are recorded (seven mammals and one amphibian).

Field Survey Results

Overview of Species Counts

Baseline surveys (dry and wet seasons) and targeted threatened species surveys resulted in records of a combined total of 245 fauna species (32 mammals, 145 birds, 48 reptiles and 20 amphibians). The species counts for the area generated by the DLRM (formerly NRETAS) Fauna Atlas (and thus the overall total species list) are significantly higher than those recorded during this survey or by Lane *et al.* (1990). The DLRM lists comprise observations recorded from multiple sources over a long period. Many of the species are likely to be recorded rarely, so would not be expected to be recorded in every survey.

Each sampling technique used in the baseline surveys resulted in the detection of different fauna, and in combination, all sampling techniques effectively sampled the fauna as a whole. Each of the seasonal surveys exhibited a species accumulation curve through time that was tending towards a plateau, indicating that the majority of species susceptible to the sampling techniques had been detected prior to the conclusion of each survey. Curves for mammals and amphibians during the wet season, however, deviated from that pattern.



More species were detected during the dry season survey (178 species) than during the wet season survey (146 species) or the threatened species surveys (122 species). Combining species accumulation across both seasonal baseline surveys (i.e., not including targeted surveys) indicates that most species were detected during the dry season survey, with relatively small numbers of species added over the course of the wet season survey. Wet season species counts may have been underestimated due to survey constraints, mainly caused by difficulties associated with inclement weather (e.g., failed anabat sampling, reduced site access, site flooding leading to ineffective traps). Continued survey effort at the mine site could be expected to result in a slow accumulation of relatively few additional species.

Thirty-five species detected during the surveys were new records for this area (i.e., within 10km of the mine site). These include six native species of mammal, twelve native species of bird, ten native species of reptile, and seven native species of amphibian.

Bats had the highest species richness of any mammalian group (19 of the 31 species), followed by small ground-dwelling mammals and non-native mammals (four each). One threatened species of mammal detected during the surveys is listed as *vulnerable* under NT legislation (pale field rat). Two species of mammal detected during the surveys are listed as *near threatened* under NT legislation (western chestnut mouse and Arnhem sheath-tailed bat). The large survey effort for mammals (2880 Elliot trap-nights and 576 cage trap-nights) resulted in the capture of only 10 individuals of four species, indicating very low diversity and abundance of small ground-dwelling mammals (e.g., rats, mice, dasyurids).

Birds showed the highest species richness (145 species) of all the taxonomic groups of vertebrate fauna. Two threatened species and four *near threatened* species of bird were detected during the surveys: crested shrike-tit (northern), painted honeyeater, bush stone-curlew, Australian bustard, hooded parrot and yellow-rumped manikin respectively. Detection of the crested shrike-tit (northern) was not confirmed. Nine species of bird detected during the surveys are listed as *migratory* under the EPBC Act: sharp-tailed sandpiper, marsh sandpiper, Gouldian finch, glossy ibis, white-bellied sea-eagle, rainbow bee-eater, eastern great egret, cattle egret and crested shrike-tit (northern).

Skinks and snakes were the most diverse reptilian groups with 15 and 12 species respectively of the total 48 species detected. One reptile detected is listed as *vulnerable* under NT legislation (Mertens' water monitor) and another monitor (northern ridge-tailed monitor) is listed as *near threatened*. Six reptiles detected are listed as *data deficient* under NT legislation (brown tree snake, Children's python, common tree snake, olive whipsnake, Papuan whipsnake and spotted tree monitor).

Amphibians had the highest relative abundance of all the vertebrate groups (mammals, birds, reptiles, amphibians) with 999 individuals of 20 species recorded over the course of the baseline surveys. Three amphibian species detected (northern dwarf tree frog, giant frog and ornate burrowing frog) are listed as *data deficient* under NT legislation.

The amphibian diversity recorded by GHD during the survey (20 species) exceeds the number of species recorded historically for the Pine Creek area (15 species; DLRM (formerly NRETAS) Fauna Atlas), suggesting that the area had not been adequately surveyed for amphibians. The twenty species includes the non-native, cane toad (*Rhinella marina*), which was not recorded during the original fauna survey at this mine site (Lane *et al.* 1990). It was the most commonly recorded amphibian in this survey. The cane toad is listed as 'invasive' and implicated in a Key Threatening Process under the EPBC Act.



Fauna Diversity – Variation among Sites, Habitats and Seasons

Fauna richness varied across the 16 sites and the eight vegetation communities. Sites in *Eucalyptus* and *Melaleuca* forest/woodland in riparian habitats tended to have higher richness than other sites, particularly during the dry season survey. The lowest diversity was recorded at sites in open *Eucalyptus tintinnans*, *E. spp.*, *Erythrophleum chlorostachys* woodland and *E. tectifica*/*E. tintinnans*, *E. spp.*, and *Erythrophleum chlorostachys* woodland.

Fauna species richness tended to be more even among sites during the wet season than during the dry season. This was influenced largely by high species richness of birds in the riparian forest/woodland habitats during the dry season. The *E. bigalerita*, *E. spp.* open forest had the highest species richness (>60 bird species in total). Species richness in this habitat differed by approximately one third between the dry and wet season surveys. Reptile species richness also varied among sites. Sites in *E. tectifica* woodland had the highest richness, with richness declining during the wet season survey. Sites in *E. tectifica*/*E. tintinnans* woodland had the lowest number of reptile species overall. Reptile diversity patterns tended to be influenced by diversity of varanids (monitors). Species richness of amphibians varied between seasons with six sites having greater richness in the dry season than in the wet season. The reverse pattern occurred at two sites. Sites that had the highest wet-season amphibian species richness (*E. tectifica*, *C. confertiflora* woodland and *E. tectifica*/*E. tintinnans* woodland) had the lowest species richness during the dry season.

The relationship between Habitat Characteristics and Fauna Species Richness

Fauna species richness (all species) corresponded strongly with period since fire. Sites with evidence of more recent fire tended to have significantly lower species richness. Canopy height was the next most influential habitat variable. Sites with taller trees tended to have higher species richness.

Species richness of birds and amphibians exhibited patterns similar to the fauna as a whole with higher species richness in areas with less recent fire and taller canopy height. There were no significant relationships between habitat features and the species richness of mammals or reptiles.

Records of Threatened Species

Five threatened species were recorded during the baseline surveys and/or targeted threatened species surveys [gouldian finch, pale field-rat, painted honeyeater, Mertens' water monitor, and crested shrike-tit (northern)].

- ▶ Gouldian finch – This species was recorded six times during the threatened species survey in May 2011, but not during the dry or wet season baseline surveys or the subsequent threatened species survey in September 2012. Five observations of Gouldian finches (12 birds in total, and potential nesting activity observed) immediately west of the Batman Pit, and ≥40 individuals observed near the Edith River just outside the mine lease area (but within the Yinberrie Hills).

The observation of ~50 Gouldian finches during the survey represents approximately 20% of the total estimated Yinberrie Hills population (250 birds; O'Malley 2005). Observing this number during a brief survey in May 2011 suggests that at the time of the survey the Yinberrie Hills supported a breeding population. Several sub-adult finches were observed with adult finches. Our results suggest that the Gouldian finch continues to breed in close proximity to the Batman Pit (within 100 to 200m).



- ▶ Pale field-rat – This species was recorded on six occasions during the dry and wet season baseline surveys in *Eucalyptus bigalerita*, *E. spp.* open forest and *Melaleuca* forest with bare areas. Of the ten individual small terrestrial mammals recorded during the wet and dry season surveys, this species was the most abundant. This species similar to other small mammal species across the Top End has undergone significant decline, including three national parks such as Kakadu where it has been monitored over a long-term period.
- ▶ Painted honeyeater – This species was recorded once during the dry season survey in *Eucalyptus tintinnans*, *Corymbia dichromophloia* woodland, This record was new for the area and some distance from where previous records are documented for the NT.
- ▶ Australian bustard (formerly listed as vulnerable under NT legislation and part of the May 2011 survey) – There were 11 observations (19 birds) recorded during the threatened species and baseline surveys, mostly from vehicles during vehicle-based surveys or incidental observations. Most individuals were detected in and around the Waste Rock Dump and Heap Leach Pad. This species is known to respond favourably to fire and is often located in recently burnt habitats, including woodlands. It is possible that the relatively large number of bustards recorded may have been a response to recent fire.
- ▶ Mertens' water monitor - Three records in the project area were made during the surveys. One monitor was observed at the Tollis Pit during the May 2011 threatened species survey, one was observed near the Mt Todd mine workshop during the wet season baseline survey, and another was observed in the Raw Water Dam during the September 2012 threatened species survey. This species is reported as having undergone significant declines in abundance across the Top End following the arrival of the cane toad. There is a large area of suitable habitat in and beyond the mine site. It is likely that continued monitor/toad evolutionary interactions will determine the persistence of the Mertens' water monitor population in the study area, rather than impacts resulting from the proposed development.
- ▶ Crested shrike-tit (northern) – There were two unconfirmed detections of the shrike-tit during the dry season surveys. Both birds were heard and not seen. Historical records and the presence of potentially suitable habitat in lower lying areas and in the Yinberrie Hills suggest that this species may visit occasionally or be a rare resident of the study area.

Seven of the targeted threatened species were not recorded during this survey (northern quoll, partridge pigeon, grey falcon, red goshawk, masked owl, Mitchell's water monitor and yellow-spotted monitor). Of these, neither the partridge pigeon, masked owl, nor the red goshawk was recorded in 1990 by Lane *et al.* The partridge pigeon has never been recorded at the mine site. The yellow-spotted monitor and grey falcon was observed in the mine area once more than 20 years ago by Lane *et al.* (1990). This is the only record of the species in the mine area in the DLRM (formerly NRETAS) Fauna Atlas. As for Mertens' water monitor, it is likely that continued monitor/toad evolutionary interactions will determine the persistence of the yellow-spotted monitor population in the study area rather than impacts resulting from the proposed development.

Results of This Survey Compared with Lane *et al.* (1990)

Lane *et al.* (1990) surveyed the fauna of the Mt Todd site before the mine was constructed and operated, and before the arrival of the cane toad. That assessment provides an important benchmark for comparison with this study. General survey effort for the two studies was broadly similar, but perhaps



higher for this study than for Lane *et al.* (1990). Lane *et al.* (1990) recorded 219 terrestrial vertebrate fauna species, while GHD recorded 245 species during four visits.

A number of small mammal species recorded by Lane *et al.* (1990) were not recorded by GHD. This may be largely because GHD's survey focussed on a smaller area and did not include the diversity of habitats that the 1990 survey did. Two species of small mammal should have been recorded in the study area sampled by GHD. Their apparent absence may reflect a reported decline in the NT's Top End small mammal fauna, or be due to low probabilities of capture possibly associated with low population sizes. Lane *et al.* (1990) captured only one individual of each of the two species.

There is little evidence to suggest that cane toads have had profound effects on the diversity and abundance of native fauna species. The northern quoll (which is the only mammal demonstrated to be impacted by the cane toad invasion; Woinarski *et al.* 2008), was not recorded in this survey, having been recorded as widespread and common in 1990. Similarly, the yellow-spotted monitor (*Varanus panoptes*) and Goulds' monitor (*Varanus gouldii*) were reported in Lane *et al.* (1990). These were not detected by GHD in 2011/12.

Assessment of Potential Impacts on Fauna

Evaluations of the significance of potential impacts are based on the Commonwealth's *Significant Impacts Guidelines: Matters of National Environmental Significance* (the guidelines) as applied to critically endangered and endangered species (DEWHA 2009).

In the absence of a generally recognised set of criteria for assessing potential impacts on local fauna as a whole, potential impacts on the community of fauna at the Yinberrie Hills are assessed according to the guidelines on significance of impacts on biological and ecological values of National Heritage places (DEWHA 2009).

Identified potential sources of impact are presented in detail and risk assessments of these potential impacts on each threatened species are provided in Appendix H. In all cases the assessments assume a standard set of mitigation and management measures has been imposed. Assessments were made of the risk of impacts on each threatened species population, or the fauna as a whole in the Yinberrie Hills site of conservation significance.

There was no risk to any of the threatened species or the fauna as a whole that was Extreme. The majority of sources of impact generate "Very Low" or "Low" levels of risk. This means that either zero or one source of impact individually constitutes at most a "High" level of risk for the Guidelines' consequences. In no case is it thought that the impacts are additive or synergistic. In some cases a "Very Low" level of risk stemming from land clearing seems to be rendered irrelevant by its potential spatial overlap with the higher risk posed by dust.

The greatest threat that the project has to fauna is associated with a High risk from the potential impacts of dust on the Gouldian finch, and possibly other fauna.

Identified potential sources of impact are summarised below:

- ▶ Clearing of breeding and/or foraging habitat - The proposed re-opening of the mine is likely to cause a cumulative loss (including previous loss of 884.54ha and proposed mining loss of 608.72ha) of 1497.26ha of breeding/foraging habitat (all habitats) or 2.09% of these habitats in the Yinberrie site of conservation significance. This equates to small areas of habitat loss for Gouldian finch, crested shrike-tit (northern), partridge pigeon and Australian bustard. The affected vegetation types are E. tintinnans hillside woodlands, all lowland woodland types present in the Mineral leases, i.e. all



habitats present in the Mineral Leases other than riparian areas which will remain untouched. Clearing seems unlikely to have any significant direct impact on any of the threatened species or populations.

- Dust levels generated by mining and processing activities - Levels of predicted ground-level dust concentration greater than $50\mu\text{gm}^{-3}$ are predicted to encompass all of the Mineral Leases, extending well to the south and well outside the Mineral Leases to the west and northwest. Dust is expected to cover 7,162ha of Gouldian finch breeding habitat in the Yinberrie Hills, or a minimum of 10.0% of the breeding habitat in the Yinberrie Hills site of conservation significance (the area of breeding habitat affected will actually be greater than 10.0% as this is only representative of the breeding habitat present within the 1:50,000 vegetation mapping extent. Additional Gouldian finch breeding habitat exists outside of this mapping extent but still within the Yinberrie Hills).

The GHD air quality assessment has also found that the Gouldian finch habitat in the Yinberrie Hills (to the west of the Batman Pit) has the potential to be exposed to predicted maximum 24-hour ground level concentrations of PM₁₀ of greater than $200\mu\text{g}/\text{m}^3$, including background of $20.8\mu\text{g}/\text{m}^3$ (GHD 2013).

A dust level of $50\mu\text{gm}^{-3}$ is a criterion for Total Suspended Particles (TSP) for human exposure. There is no applicable criterion for fauna. Small birds like the Gouldian finch would be expected to require a lower dust criterion, because they have higher relative rates of inhalation than do humans. The Gouldian finch population seems to have been unaffected by the previous mining and its dust levels, whatever they may have been. The population as a whole appears to have remained relatively stable during previous mining. It is recommended that a precautionary approach be taken to the possible impacts of dust on the Gouldian finch population.

- Noise levels generated by mining and processing activities - Levels of mining activity and anticipated noise levels are similar to those described in the initial EIS for the Mt Todd Gold Mine (GHD 2013b). The fauna as a whole, and the threatened species and populations, are considered unlikely to suffer significant impacts from noise generated by mining activities. Any impact would likely be negligible, and not amenable to detection at the population level.
- Wildfire - The Yinberrie Hills have a seemingly long history of possibly excessive late dry season hot fires. It is not known whether habitats in the study area or Yinberrie Hills as a whole are experiencing and/or have experienced negative impacts as a result of this fire regime. Early dry season control fires have been used to manage fire in the area of the mine since the initiation of mining at Mt Todd. This continues today and is planned to continue during the proposed mining.

The fauna and the threatened species and populations are unlikely to suffer significant impacts from wildfire associated with the proposed mine. Any impact would likely be negligible, and not amenable to detection at the population level. The existing fire regime does not appear to have had a negative impact on the population of Gouldian finches in recent times (although fire regimes may have contributed to previous declines). The fire regime maintains a diversity of grasses providing a year-round source of food for the Gouldian finch which breeds in the western side of the mineral lease.



- ▶ Exotic plants and animals – The proposed mining activity is unlikely to result in enhanced feral animal populations or increases in the number of feral animal species. Weed concentrations along disturbed edges to vegetation are the object of a long-term weed management plan. Weeds in the area, especially Gamba grass¹, have the potential to significantly alter the structure and species composition of vegetation. The fauna and the threatened species and populations are unlikely to suffer significant impacts from additional or existing exotic animals or plants. Any impact would likely be negligible, and not amenable to detection at the population level. Virtually all the species of feral animal and exotic plant species capable of causing significant habitat change are present in or have ready access to the mine site without intervention from the proposed mining.
- ▶ Poisoning from drinking tailings dam water - Bird mortalities from drinking tailings water may increase when levels of weak-acid-dissociable (WAD) cyanide peak (e.g., rise to 100mg/L). Tailings dam operation during previous mining, and recent maintenance of large surface volumes of metal (especially copper) contaminated water in the Batman Pit and other water bodies, do not appear to have resulted in a decline in bird populations, including the Gouldian finch population.

The fauna and the threatened species and populations are considered unlikely to suffer significant impacts from consumption of tailings dam water. Impact would likely be negligible and not amenable to detection at the population level.

- ▶ Lowering or contamination of the water table - The impermeable nature of the hornfels in the western portion of the mine sites, and the hornfels basement rock to the south and east are expected to cause a localised drawdown of the water table. The fauna and threatened species and populations are unlikely to suffer significant impacts from groundwater changes. Impacts on the Gouldian finch from groundwater draw down and/or contamination is expected to be unlikely and of very limited extent should it occur. Any impact would likely not be amenable to detection at the population level.

Mitigation and Monitoring

A range of mitigation measures are suggested to reduce the likelihood of impacts on fauna caused by the re-opening of the mine. These are relatively standard and have been assumed in assessing risks of impacts. Mitigation measures developed and planned for implementation will be detailed in full in the site's Environmental Management Plan (Operational) under the NT Mining Authorisation process.

The EIS Guidelines for this Project call for the establishment of “mechanisms to determine the long-term impact of environmental impacts associated with key environmental issues (monitoring and reporting)”.

Monitoring should focus on dealing with uncertainties surrounding the highest recorded risk to the Yinberrie Hills fauna. There is the potential impact of dust on the Yinberrie Hills Gouldian finch population. This is also the highest risk to the fauna as a whole. The uncertainties are:

- ▶ The levels of near ground dust concentration and dust deposition in the suspected breeding habitat adjacent to the Mt Todd mine before and during mine operation;
- ▶ The effects of dust levels on intensity of Gouldian finch nesting and nesting success;
- ▶ The future population levels of the Gouldian finch in the Yinberrie Hills;

¹One incidence of Gamba Grass was noted during the surveys and subsequently immediately eradicated.



- ▶ The status of other potential breeding areas in the Yinberrie Hills and the Mt Todd to Pine Creek region; and
- ▶ Fire management in the whole of the Yinberrie Hills.

Suggested monitoring includes:

- ▶ Monitoring of dust in the Gouldian finch breeding habitat using a carefully constructed and appropriate statistical design to allow assessment of the effects of distance from the mine and habitat features on dust levels;
- ▶ Monitoring of Gouldian finch nesting intensity and success in relation to dust levels using artificial nest boxes; and
- ▶ Expansion of the long-term DLRM monitoring of the Gouldian finch population to allow location and assessment of adjacent large areas of suitable breeding habitat in the Yinberrie Hills and/or Mt Todd to Pine Creek region, preceded by desk-top examination of the attributes of the other possible breeding areas in comparison with the known area adjacent to the mine.



Abbreviations and Glossary

CAMBA	China – Australia Migratory Bird Agreement
DLRM	Northern Territory Department of Land Resource Management
EIS	Environmental Impact Statement
EPA	Northern Territory Environment Protection Authority
EPBC	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
GHD	GHD Pty Ltd
JAMBA	Japan – Australia Migratory Bird Agreement
MNES	Matters of National Environmental Significance
NRETAS	Northern Territory Department of Natural Resources, Environment, The Arts and Sport
PMST	EPBC Act Protected Matters Search Tool
ROKAMBA	Korea – Australia Migratory Bird Agreement
sp.	Species (one species)
spp.	Species (more than one species)
subsp.	Subspecies
TPWC	<i>Territory Parks and Wildlife Conservation Act 2006</i>



1. Introduction

1.1 Background

Vista Gold Australia Pty Ltd (Vista Gold) proposes to re-establish and operate the Mt Todd Gold Mine, located approximately 55km north of Katherine, Northern Territory (NT) (Figure 1-1).

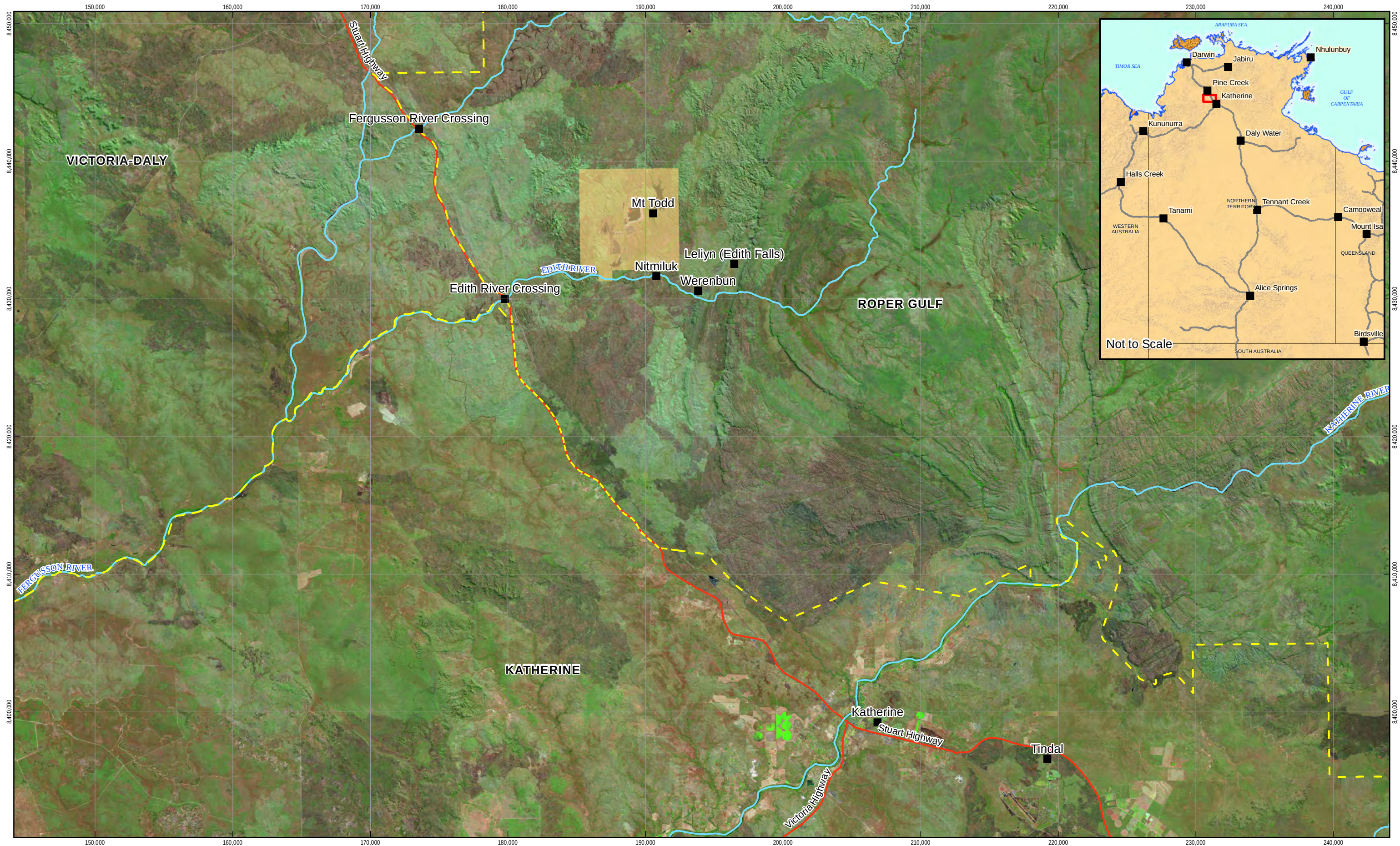
The Mt Todd Gold Project (the Project) includes mining for gold within the existing Mt Todd Gold Mine - Batman Pit, which has been mined previously but is currently in care and maintenance. For the purposes of this assessment, the mine site refers to areas of previous or proposed disturbance within the mine leases. Mine leases/study area refers to the broader area defined by MLN 1070, MLN 1071 and MLN 1127 (Figure 2-2).

The NT Minister for Lands, Planning and the Environment (formerly Natural Resources, Environment and Heritage) determined that an Environmental Impact Statement (EIS) is required for the Project. The NT EPA (formerly NRETAS) subsequently issued '*Guidelines for the Preparation of an Environmental Impact Statement – Mt Todd Gold Project Katherine Region NT, Vista Gold Australia Pty Ltd, September 2011*'. The Project was referred to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) and was determined to be a "Controlled Action" requiring assessment under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Therefore, the EIS is being assessed under an accredited assessment arrangement between the Commonwealth and NT governments.

This report presents the methods, results and implications of a fauna assessment at the site, and provides information to be used in the preparation of the EIS. This report addresses the requirements of the EIS including the following:

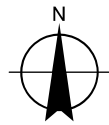
- documentation of baseline fauna surveys of areas both within and surrounding the Project area;
- identification of EPBC and NT listed fauna species that are present, or potentially present, within the Project area [including the Gouldian finch (*Erythrura gouldiae*)] and that may be affected by the Project directly or indirectly;
- documentation of systematic fauna surveys targeting EPBC and NT listed species in areas of native vegetation that the proponent proposes to develop, and areas that lie adjacent to areas proposed for development. This includes all areas of vegetation or potential habitat that are proposed to be cleared to accommodate new roads and other infrastructure;
- identification of the presence and potential presence within the Project area of feral animals;
- identification of all listed threatened and/or migratory species that could be affected directly or indirectly as a consequence of the proposed Project; and
- description of the distribution, ecology and habitat preferences of listed threatened and/or migratory species relevant to the project area.

Legislation and licencing requirements related to fauna are summarised in Appendix A.



1:250,000 (at A3)
0 2.5 5 7.5 10
Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 53



LEGEND

- Place Names
- Major Roads
- Rivers
- LGA Boundaries
- Mt Todd Mineral Leases



Vista Gold Australia Pty Ltd
Mt Todd Gold Project

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Location of Mt Todd Gold Project

Figure 1-1



1.2 Objectives of the Assessment

The main objective of the fauna assessment is to meet the EIS guideline requirements (EPA (formerly NRETAS) 2011) for documentation and assessment of the fauna of the study area. This is achieved by:

- ▶ Undertaking wet and dry season fauna surveys of the mine site and adjacent areas using a range of sampling techniques designed to gain as complete a description as possible of:
 - the fauna and its seasonal changes; and
 - the relationships between fauna and the available habitats.
- ▶ Undertaking fauna surveys targeted specifically on locating and assessing the presence of fauna species listed as threatened/migratory under the *Territory Parks and Wildlife Conservation Act 2006* (TPWC Act) and/or the EPBC Act;
- ▶ Undertaking a desktop analysis of potential breeding habitat for the endangered Gouldian finch in the area, from the mine north-northwest to a location close to Pine Creek;
- ▶ Assessing the regional and national significance of the fauna and its populations of threatened species;
- ▶ Determining ways in which the re-establishment and proposed expansion and operation of the mine might impact on the fauna and its threatened species;
- ▶ Assessing the levels of risk to the fauna and threatened species posed by sources of potential impact;
- ▶ Proposing mitigation measures to reduce the risk of impacts that may be significant; and
- ▶ Determining the residual risks to fauna including threatened species.



2. The Mt Todd Project Area

The Mt Todd study area is located east of the Stuart Highway and north of Edith Falls Road, approximately 55km north of Katherine, and 250km south-east of Darwin, NT, Australia. Access is via the Edith Falls Road.

The study area lies towards the south-western end of the Yinberrie Hills; an area which was listed in the Interim List for the Register of National Estate until 2007 when the register was closed. The hills provide habitat for the largest known breeding population of the nationally threatened Gouldian finch (*Erythrura gouldiae*) (*endangered* under the EPBC Act and *vulnerable* under the TPWC Act). Background information to the National Recovery Plan for the Gouldian finch (O'Malley 2007) defines the Yinberrie Hills population as an '*important breeding population*'. The Northern Territory Department of Land Resource Management (DLRM) regards the hills as a site of conservation significance.

2.1 Climate

The climate of the Katherine region is typically characterised by hot, humid wet seasons lasting from November to April followed by a hot, dry season from May to October. Transition periods occur between the wet and dry seasons, typically lasting one month or longer.

The Bureau of Meteorology records the Katherine region as having an average annual rainfall of approximately 1,100mm, with most rain falling in the wet season. Rainfall is highly seasonal, with long-term monthly average totals ranging from 0.4mm in June to 269.4mm in January (BoM 2011). Actual rainfall totals can be far more (e.g. 913mm recorded in January 1998) (BoM 2011).

Temperatures have average daily maxima of 37.7°C in October and 30.1°C in June, and average daily minima of 12.9°C in July and 24.6°C in November. Mean relative humidity at 0900 hours ranges from 83% in February to 52% in August, with respective monthly values of 60% and 24% at 1500 hours. Mean daily evaporation rates range from 7.9mm in October to 4.9mm in June, with an annual average of 6.2mm per day (BoM 2011).

2.2 Pine Creek Bioregion

The study area occurs in the Pine Creek bioregion, which is characterised as follows (Baker *et al.* 2005):

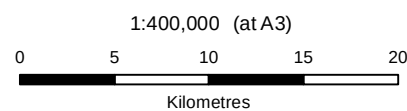
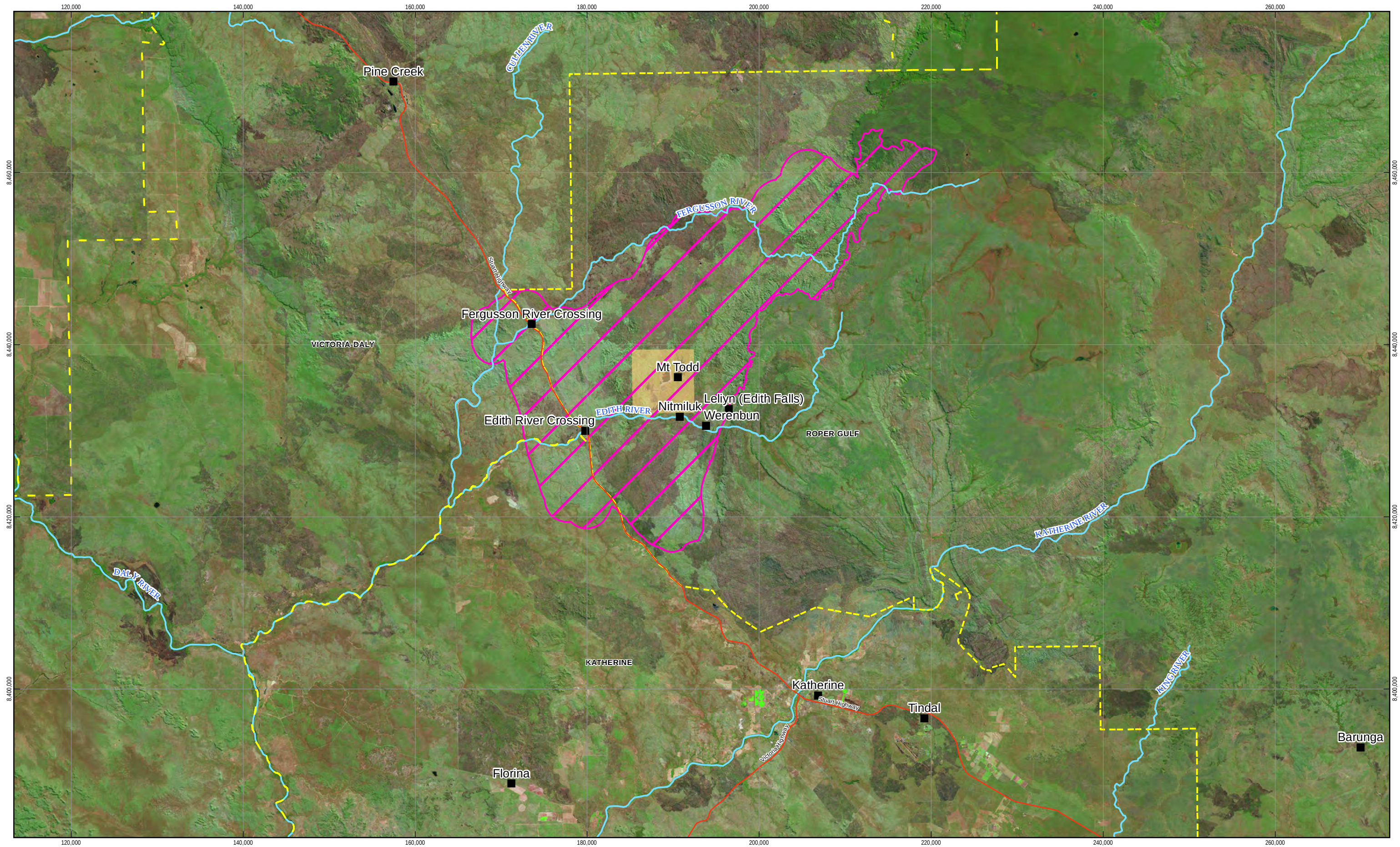
- The Pine Creek bioregion occurs entirely in the NT, encompassing an area of 28,456km²;
- The bioregion is comprised of foothills south and west of the western Arnhem Land sandstone massif;
- It supports the highly mineraliferous Pine Creek Geosyncline, comprising archaean granite and gneiss overlain by Palaeoprotozoic sediments;
- Vegetation types include tall open eucalypt forests, typically dominated by Darwin woollybutt (*Eucalyptus miniata*) and Darwin stringybark (*E. tetrodonta*) and eucalypt woodlands, with smaller patches of monsoon rainforest, *Melaleuca spp.* woodlands, riparian vegetation and tussock grasslands;
- The climate is monsoonal with rainfall occurring between the months of November and April, varying from 1,000mm inland to 1,600mm in areas closer to the coast;

- ▶ According to the DLRM Fauna Atlas, ten of the terrestrial vertebrate fauna species known from the bioregion are listed as threatened (*critically endangered*, *endangered*, or *vulnerable*) under Commonwealth or NT legislation. These include four mammals, three birds and three reptiles. An additional 32 vertebrate fauna species are listed as *near threatened* (17 species) or *data deficient* (15 species) under NT legislation. Eight vertebrate fauna species (all birds) known from the bioregion are listed as *migratory* under the Commonwealth EPBC Act; and
- ▶ A range of exotic fauna species exists in the bioregion, including water buffalo, cane toad, cat, cattle, dog, donkey, honey bees and pig. Each of these species has the potential to impact adversely on native fauna and their habitats, through direct and indirect processes such as predation, resource competition, and erosion causing sedimentation of wetlands/waterways. The cane toad has the potential to poison predators that attempt to consume it.

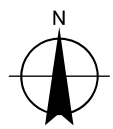
2.3 The Yinberrie Hills

The Mt Todd Mine Site is located in the south-western end of the Yinberrie Hills (Figure 2-1); a key area in northern Australia for the Gouldian finch (*Erythrura gouldiae*). The following information (obtained from http://lrm.nt.gov.au/_data/assets/pdf_file/0015/13911/30_yinberrie.pdf on 19 February 2013) provides a general description of the area:

- ▶ The Yinberrie Hills are characterised by rolling hills, rising from the extensive plains to the north, east and south and are distinct from the Arnhem Land escarpment to the east and north-east. The hills encompass an area of 1,025km² and are dominated by sandstone hills and rises;
- ▶ The hills are dominated by grassy open woodland, but provide habitat attributes that are scarce in the broader landscape including an understorey of perennial native grasses, retention of water in small rocky pools throughout the dry season and smooth-barked eucalypts with hollows. The hills support grassy eucalypt woodlands with a mixed over-storey of snappy or salmon gums (including *Eucalyptus tintinnans*), *E. tectifica*, *Corymbia confertiflora* and an understorey dominated by tall annual spear-grasses;
- ▶ The hills are predominantly aboriginal freehold, with small portions of freehold and crown leasehold land. The main land use is for indigenous purposes. Around 8% of the Yinberrie Hills area is managed as a conservation reserve (Nitmiluk National Park). Significant tourism and mining occur and/or have occurred in the area;
- ▶ Ecological values include persistent use of the area by relatively large numbers of the endangered Gouldian finch (i.e. 150 to 250 finches; O'Malley 2006), and the presence of the largest known breeding population of the species. The hills provide permanent water and foraging habitat during the dry season. Hollow-bearing trees provide nesting habitat during the late wet season and early dry season. The lowlands adjacent to the hills support perennial grasses used by finches for feeding during the wet season. Other threatened species that inhabit the Hills include Australian bustard (formerly listed as threatened, now *near threatened*), crested shrike-tit (northern), partridge pigeon, northern quoll, Mertens' water monitor and yellow-spotted monitor; and
- ▶ The main management consideration in the Yinberrie Hills is a fire regime typified by large-scale, late dry-season fires that encourage fire-tolerant plant species and reduce the availability of grass seed favoured by the Gouldian finch during the wet season. Other management concerns include large numbers of feral pigs and cattle.



Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 53



LEGEND

- | | |
|---------------|---|
| ■ Place Names | --- LGA Boundaries |
| — Roads | ▨ Yinberrie Hills Site of Conservation Significance |
| — Rivers | ■ Mt Todd Mineral Leases |



Vista Gold Australia Pty Ltd
Mt Todd Gold Project

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Yinberrie Hills

Figure 2-1



2.4 Vegetation Communities of the Study Area

The GHD flora assessment identified eight vegetation communities in the mineral leases area (GHD 2013a). The vegetation types are listed in Table 2-1, with a brief description of their occurrence and habitat attributes.

Table 2-1 Description of Vegetation Communities in the Project area

Vegetation Community (Fauna survey sites)	Description	Photo – dry season	Photo – wet season
1 (5, 6)	<i>Melaleuca forest, with bare areas (Edith River).</i> Tall Melaleuca and Eucalypt forest along the banks of the Edith River, containing shrub layer and tall tussock grass ground-layer. Subject to seasonal flooding with deep fast-flowing water to mid-storey layers. Floods potentially long-lasting due to large catchment size. Sandy, sedimentary soils. Occasional hollow-bearing trees, some with multiple hollows. Lots of woody debris. Presence of exotic weeds (~5%). Bare ground abundant (~50% in wet), and small amounts of leaf litter. No exposed or embedded rocks, or gravel present. No evidence of recent fire activity. This vegetation type covers approximately 15.01ha (0.28%) of the investigation area.	 Site 6 (186936, 8431384) – dry season	 Site 6 (186936, 8431384) – wet season



Vegetation Community (Fauna survey sites)	Description	Photo – dry season	Photo – wet season
2 (3, 9)	<i>Eucalyptus bigalerita</i>, <i>E. spp.</i> open forest Open eucalypt forest/woodland containing sparse shrub layer and seasonal dense tall tussock grass ground-layer. Groundcover very sparse during the dry season. Habitat follows moderately-sized seasonal watercourses (larger tributaries of the Edith River). Tall forest generally, but in narrow strips only along the watercourses. Subject to seasonal flooding but mainly at lower structural levels (Site 3 partially inundated during wet season survey). Wet-season floods likely to be frequent but of relatively short duration due to small catchment size. Occasional hollow-bearing trees. Standing dead timber present. Sandy, sedimentary soils near watercourse, with red-brown clay loam soil higher on the banks. During the wet, inter-tussock space dominated by bare ground, with small amounts of litter. No exposed rocks present on site. Small amounts of gravel between grass tussocks. Woody debris present. Presence of exotic weeds (~5%). No evidence of recent fire. This vegetation type covers approximately 367.09ha (6.75%) of the investigation area.	 Site 3 (188942,8432614)– dry season	 Site 3 (188942,8432614) – wet season



Vegetation Community (Fauna survey sites)	Description	Photo – dry season	Photo – wet season
4 (4, 13)	<i>Eucalyptus tintinnans</i>, <i>E. spp.</i>, <i>Erythrophleum chlorostachys</i> woodland Eucalypt woodland containing sparse shrub layer with seasonal tall tussock grass ground-layer. Groundcover is sparse during the dry season and subject to fire. Site is on eastern rocky mid-slope of undulating hills, which are the foothills of the Yinberrie Hills which support Gouldian finch breeding. Many hollow-bearing trees, some with multiple hollows. Standing dead timber present. In the wet, inter-tussock space is dominated by gravel and bare ground. Small areas of outcropping rocks, and embedded rock surfaces. Small amounts of woody debris and litter present. Brown sandy skeletal soil. The vegetation species composition and structure of these areas are influenced by fire disturbance. This vegetation type occurs only in small patches in the assessed area (but is more prevalent to the west and north of the study area), and those patches are likely to be influenced by edge effects and include some species from neighbouring habitats. This vegetation type covers approximately 1,690.48ha (31.10%) of the investigation area.	 Site 13 (187759, 8436243) – dry season	 Site 13 (187759, 8436243) – wet season



Vegetation Community (Fauna survey sites)	Description	Photo – dry season	Photo – wet season
6 (12, 14)	<i>Eucalyptus tintinnans</i>, <i>Corymbia dichromophloia</i> woodland Open eucalypt woodland containing sparse shrub layer with seasonal dense tall tussock grass ground-layer. This vegetation type occurs in a similar landscape position as vegetation type 4, differing mostly in the presence of <i>C. dichromophloia</i> as a co-dominant tree with <i>E. tintinnans</i> and a lesser dominance of <i>Erythrophleum chlorostachys</i>. Groundcover is sparse during the dry season and subject to fire. In the wet, inter-tussock space dominated by gravel, with small amounts of litter, bare ground and exposed rock. Many hollow-bearing trees. Standing dead timber present. Sites on eastern mid-slope of undulating hills, which are the foothills of the Yinberrie Hills which support Gouldian finch breeding. Red-brown rock-sand soil. Evidence of recent fire, perhaps within previous 1-2 years. This vegetation type covers approximately 734.33ha (13.51%) of the investigation area.	 Site 14 (188641, 8438512) – dry season	 Site 14 (188641, 8438512) – wet season



Vegetation Community (Fauna survey sites)	Description	Photo – dry season	Photo – wet season
9 (7, 11)	<i>Eucalyptus tectifica</i> woodland Eucalypt and Corymbia woodland containing sparse shrub layer and seasonal dense tall tussock grass ground-layer. This vegetation type occurs on the valleys and hillsides lower down the rocky hills than vegetation types 4 and 6. Groundcover is sparse during the dry season and subject to fire. In the wet, inter-tussock spaces dominated by gravel, with small amounts of litter, bare ground and exposed rock present. Many hollow-bearing trees. Small amounts of woody debris present. Dark brown loam soil. Evidence of fire, but not within previous 1 – 2 years. This vegetation type covers approximately 1385.13ha (25.48%) of the investigation area.	 Site 11 (190583, 8435243)– dry season	 Site 11 (190583, 8435243) – wet season



Vegetation Community (Fauna survey sites)	Description	Photo – dry season	Photo – wet season
10 (1, 2)	<i>Eucalyptus tectifica</i>, <i>Corymbia confertiflora</i> woodland This community differs from vegetation type 9 in its landscape position and more open structure. Eucalypt and Corymbia woodland containing sparse shrub layer with seasonal tall tussock grass ground-layer. Groundcover is sparse during the dry season and subject to fire. Few hollow-bearing trees present in site. In the wet, inter-tussock space dominated by bare ground, with small amounts of litter. No exposed rock, or gravel present. Evidence of feral pig activity (diggings). Light-brown/red clay to sandy soil. Evidence of recent fire, probably within previous 1 – 2 years. This vegetation type occurs in only one patch along the entry road at the southern extent of the mine site, and covers approximately 42.39ha (0.78%) of the investigation area.	No photo available.	 Site 2 (189064, 8432396) – wet season



Vegetation Community (Fauna survey sites)	Description	Photo – dry season	Photo – wet season
11 (8, 10)	<i>Corymbia latifolia</i>, <i>Eucalyptus bigalerita</i> open woodland with areas of grassland Eucalypt and <i>Corymbia</i> open woodland with areas of grassland. Sparse shrub layer with seasonal dense tall tussock grass ground-layer. Groundcover is very sparse during the dry season and subject to fire. In the wet, inter-tussock spaces dominated by bare ground, with exposed rocks absent. Small amounts of litter and gravel present. Few hollow-bearing trees. Minimal coarse woody debris present. Brown clay-loam soil. Evidence of light cattle grazing. Evidence of fire, but not within previous 1 – 2 years in most areas. This vegetation type is found growing on clay in seasonally inundated drainage lines that lack perennial water. This vegetation type occurs in the centre and east of the mine leases and covers approximately 171.11ha (3.15%) of the investigation area.	 Site 10 (191238, 8435306) – dry season	 Site 8 (189410, 8434251) – wet season



Vegetation Community (Fauna survey sites)	Description	Photo – dry season	Photo – wet season
16 (15, 16)	<i>Eucalyptus tectifica</i> woodland / <i>E. tintinnans</i>, <i>E. spp.</i>, <i>Erythrophleum chlorostachys</i> woodland Open Eucalypt woodland containing sparse shrub layer with seasonal tall tussock grass ground-layer. Shrub and groundcover is very sparse during the dry season and subject to fire. Recently burned prior to dry season survey. In the wet, inter-tussock space dominated by gravel, with a small amount of litter. Many hollow-bearing trees, some with multiple hollows. Standing dead timber present. Brown sandy soil. Sites near crest of undulating hills. This vegetation type occurs as a mixed woodland on a rocky hillside with skeletal soils, and is represented by one patch in the far south east of the mine leases [approximately 58.33ha (1.07%) of the investigation area].	 Site 16 (191804, 8432305) – dry season	 Site 16 (191804, 8432305) – wet season



2.5 Previous Disturbance and Mining History

The study area has been a centre of human activity and associated disturbance of habitats for possibly as long as 35,000 years or more. It is not a pristine site.

The Mt Todd area is the location of numerous Aboriginal archaeological sites, including a large (at least 2 by 2.5km) quarry site occupying the *E. tintinnans* woodland habitat (Gouldian finch breeding area) to the west and south of the Batman Pit. Significant numbers of camp sites, other quarry sites and artefact scatters have been recorded from the area (Earth Sea Heritage Surveys 2012). There has been no assessment of the nature or area of disturbance attributable to Aboriginal activities or the nature of implications for habitats in the area today.

European exploration led to additional disturbance of the site (Earth Sea Heritage Surveys 2012). The Overland Telegraph Line transected the site in 1872, and was soon followed by mining for gold. From then until the 1980s the study area was the site for intermittent mining for gold, tin and wolfrum. Much of the disturbance was overgrown by the early 1990s. Wilson and Clark (1990) estimated the area of disturbed land to be approximately 24ha.

Gold mining from the 1990s through to the early 2000s resulted in the clearing of 888.54ha of habitat and disturbance of an additional 110.15ha (total habitat disturbance of 998.69ha) (GHD 2013a).

2.6 Mt Todd Mine Project Description

Gold mining will be an open-pit truck and shovel operation, using large haul trucks, hydraulic shovels and front end loaders to transport materials to the crusher, stockpiles, Run of Mine (ROM) pad and waste dump. Extracted ore, approximately 17.8 million tonnes per annum (Mtpa), will be processed in an ore processing plant where it will be crushed, milled and then carbon in leach (CIL) leached followed by adsorption, desorption and recovery leading to gold dore (unrefined gold). Gold dore will be transported for onward secure shipment to a refinery.

Mining and associated operations will occur on primarily on Mineral Leases MLN 1070, MLN 1071 and MLN 1127, covering 5,365ha. A small portion of EL 29886 will be inundated due to a raising of the raw water dam and a Special Purpose Licence will be applied for to accommodate this (Figure 1-3).

The Project, based on current known data, will have a life of around 19 years inclusive of construction, operations and closure. Construction is anticipated to commence in the first quarter of 2014 and take two years, including 6 months pre-production. The mine is scheduled to operate for a further 13 years. Closure and rehabilitation of the mine is expected to take four years.

The key elements of the Project are outlined below and depicted in Figure 2-3.

Mining and Mining Infrastructure

- ▶ extension of the existing Batman Pit from its current depth of 114m to approximately 588m (RL - 400m) and surface area of 40 hectares (ha) to approximately 137ha;
- ▶ expansion of the existing waste rock dump (WRD) from a height of 24m above ground level to approximately 350m above ground level (RL 470m), and a footprint of 70ha to approximately 217ha;
- ▶ construction of a Run of Mine (ROM) pad and ore stockpile;
- ▶ construction of an Ammonium Nitrate and Fuel Oil (ANFO) Facility;



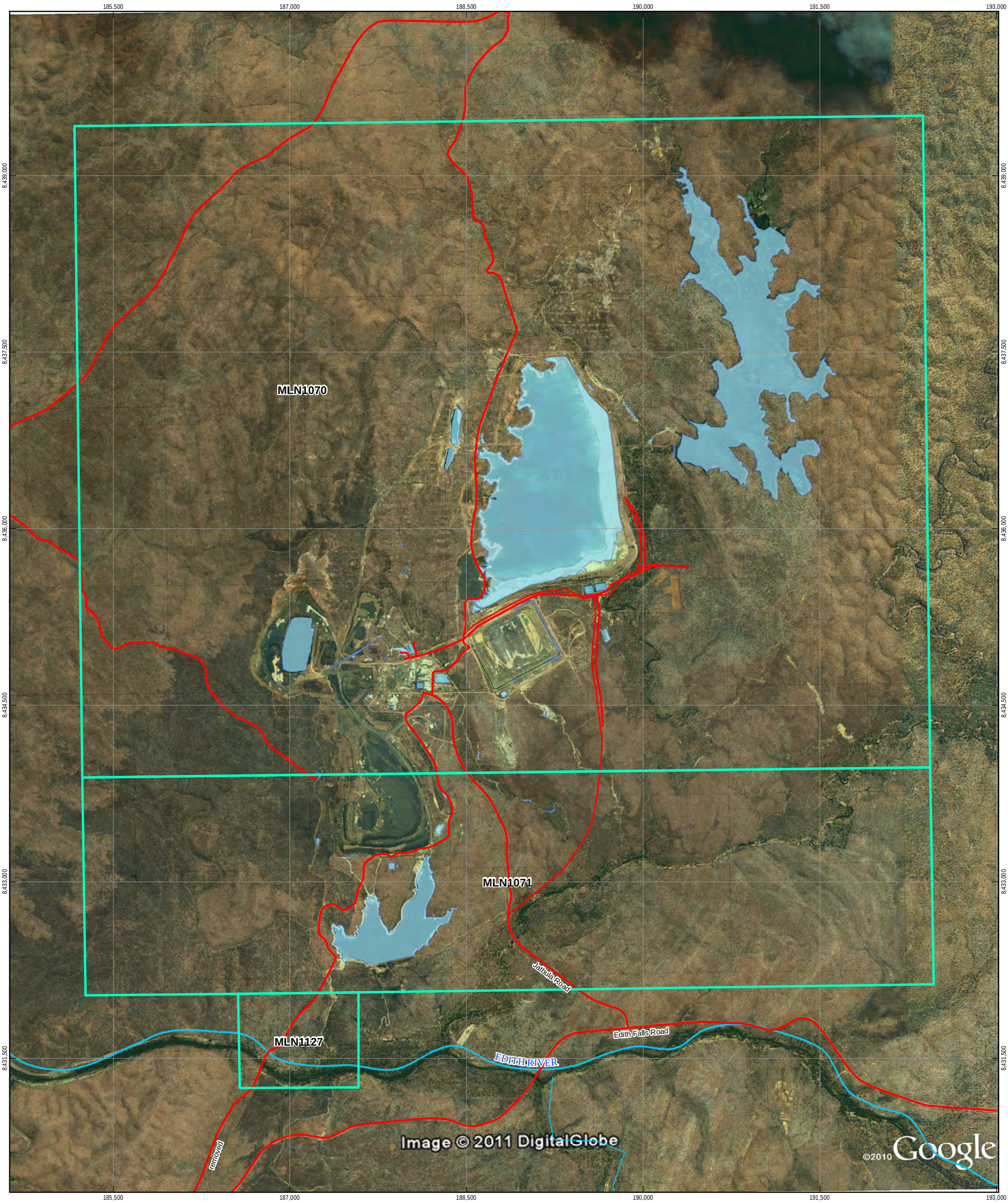
- construction of heavy and light vehicle workshop and administration offices, and facilities comprising wash down area, tyre change facility, lube storage facility etc; and
- construction of haul roads and access roads.

Process Plant and Associated Facilities

- Ore Processing Plant capable of processing approximately 50,000 tonnes per day (tpd) of ore;
- processing and / or reclamation of the existing low grade ore (LGO) stockpile and scats stockpile, and construction and processing of new LGO stockpile with a footprint of approximately 47ha;
- raising the existing tailings storage facility (TSF1) from 16m to 34m above ground level;
- construction of a new TSF2, approximately 300ha in area and up to 60m high (RL 175m);
- diversion of Horseshoe Creek and Stow Creek adjacent to TSF2 to provide flood protection;
- rehabilitation of the existing heap leach pad (HLP), if residual HLP material is not processed through the new plant;
- chemical and reagent storage and handling facility; and
- process plant workshops, administration offices, control room etc.

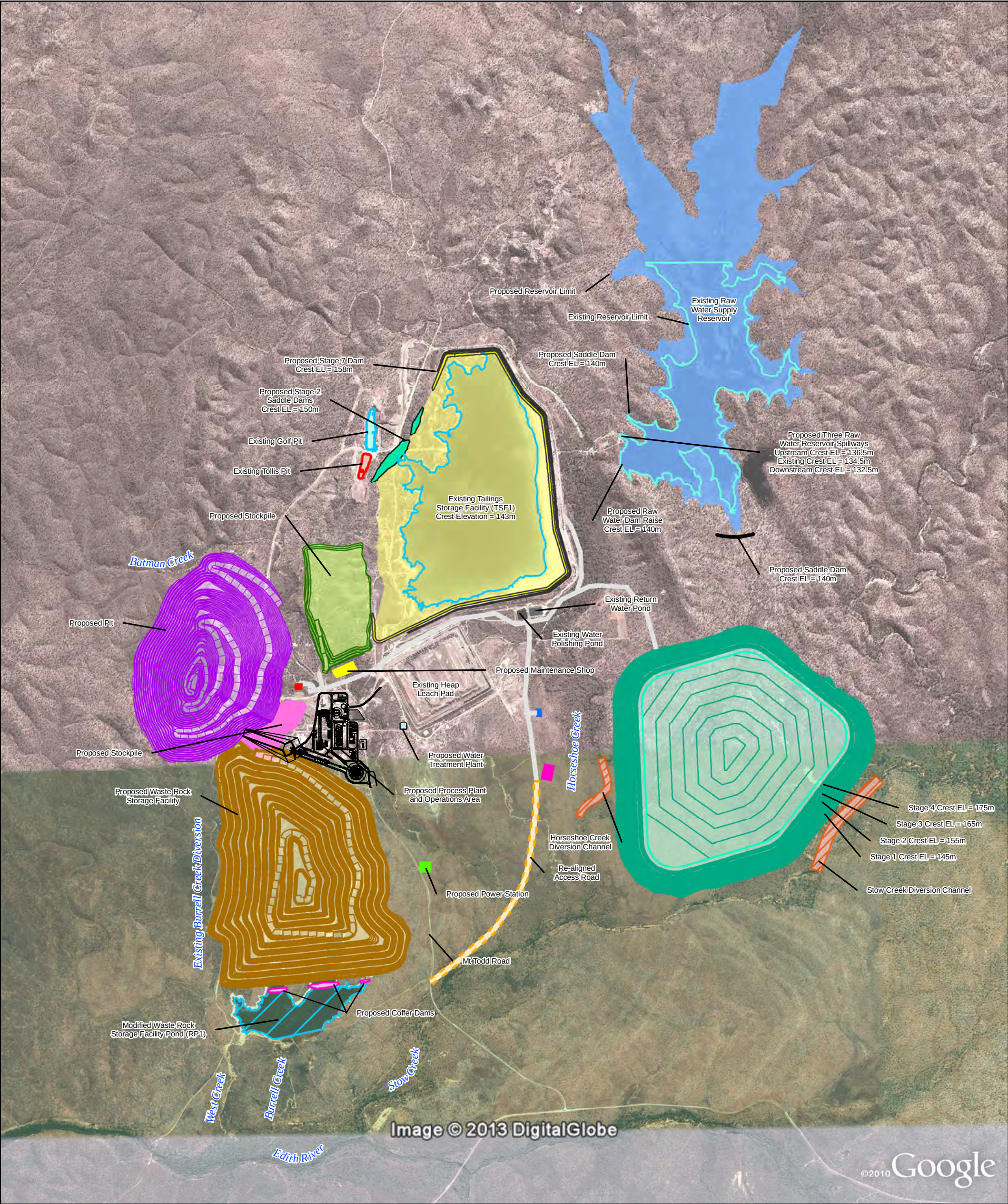
Other Infrastructure

- gas fired Power Station, including re-routing of the existing gas pipeline;
- anaerobic treatment wetlands, approximately 10ha in area;
- a 2m high raising of the raw water dam (RWD) and an increase in the area of inundation;
- construction of saddle dams at the RWD and TSF1;
- construction of three coffer dams at Retention Pond 1 (RP1) and deepening of RP1;
- water treatment plant;
- security gate house;
- potential re-alignment of access roads;
- site wide drainage, sediment traps; and
- modification to existing fuel storage and distribution facility.



LEGEND

	Mineral Lease Boundary		Water bodies
	Access Roads		Waterways



LEGEND					
Process Plant	Power Plant	Explosives Magazine	TSF1 Existing Water Body	TSF2 Impounded Surface Area (Year 12)	Proposed Saddle Dam (Raw Water Dam)
Golf Pit	Proposed Haul Road	Diversion Channels	Proposed Saddle Dam	TSF2 Contours (Year 12)	Retention Pond 1
Tollis Pit	Re-aligned Access Road	Raw Water Dam Existing Water Body	TSF1	TSF2 Footprint (Year 12)	Batman Pit Footprint (Year 12)
Fuel Bays	Coffer Dams	Indicative Raw Water Dam	Low Grade Ore Stockpile Contours	Water Treatment Plant	Waste Rock Dump Contours (Year 10)
Proposed Maintenance Shop	ANFO Facility	TSF1 Contours	Low Grade Ore Stockpile	Batman Pit Contours (Year 12)	Waste Rock Dump Footprint (Year 10)



3. Methods

Four field surveys were conducted as part of the assessment:

- ▶ Two seasonal baseline surveys (November 2011 and February 2012); and
- ▶ Two targeted threatened species survey (May 2011 and September 2012).

A desktop review, relevant to all field surveys, was conducted and is described within the methods presented for the baseline surveys.

3.1 Baseline Fauna Surveys

3.1.1 Desktop Assessment of Past Records

A desktop review of past fauna records included the following:

- ▶ The Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPac) PMST was used to identify matters of national environmental significance potentially occurring in the area of the mine (Appendix B). The PMST only considers flora and fauna species and communities listed in one or more provisions of the EPBC Act, and is based on the predicted distributions of flora and fauna species and communities and/or their habitat, rather than known records. The PMST may predict the occurrence of a species or community in an area when there are no documented records from the area. The PMST was used to identify matters of national environmental significance up to a distance of 10 kilometres beyond the proposed study area. Information was downloaded in September 2011 in the form of an Environmental Report from the website <http://www.environment.gov.au/erin/ert/epbc/index.html>;
- ▶ The DLRM Fauna Atlas database documents records of all fauna species in the search area (in this case, in the Pine Creek bioregion). This database identifies fauna species known to occur rather than predicted to occur; and
- ▶ Lane *et al.* (1990). The terrestrial vertebrate fauna of the Mt Todd-Yinberrie Hills area. Appendix 10 in 'Mt Todd Gold Project: Draft Environmental Impact Statement', NSP Environmental Consultants for Zapopan NL.

3.1.2 Scheduling

Two baseline field surveys were conducted by GHD ecologists across the proposed development area. These were to capture baseline fauna data during the two distinct climatic seasons of the Katherine region, the dry and wet seasons. The surveys were conducted in accordance with a *Territory Parks and Wildlife Conservation Act 2006* permit issued to GHD by the NT Parks and Wildlife Commission (Permit number 40623, expiry date 30 April 2014). Fauna survey techniques used in the baseline surveys conform to the *Environmental Assessment Guidelines: Terrestrial Fauna Survey* promulgated by DLRM.

Dry Season

Six GHD ecologists conducted dry season baseline fauna surveys in the mine leases over a period of six days and five nights (Wednesday 2 November to Monday 7 November 2011).



Wet Season

Nine GHD ecologists conducted wet season baseline fauna surveys in the mine leases over a period of five days and four nights (Friday 24 February 2012 to Tuesday 28 February 2012).

3.1.3 Weather

Dry Season

Weather (taken from the Bureau of Meteorology RAAF Tindal weather station: 014932) during the dry season fauna survey was generally warm to hot, sunny and dry, with patchy light rain and occasional thunderstorms with heavy rain. The daily average maximum temperature during the survey period was 36.1°C (range 29.7°C to 37.9°C) with an overnight average minimum of 23.8°C (range 21.4°C to 26.5°C). Wind strength and direction were highly variable but generally light and from the north. Cloud cover varied. A total of 25.6mm of rain was recorded during the dry-season survey period at the RAAF Tindal weather station. Rainfall in this part of the NT is often localised. There were patchy showers over the mine site during the survey period that may not have registered at Tindal and vice versa. Rainfall during the preceding wet season (from November 2010 to the end of April 2011) totalled 1142.6mm at Katherine, which was 117.3mm higher than the long-term (30-year) average for that period.

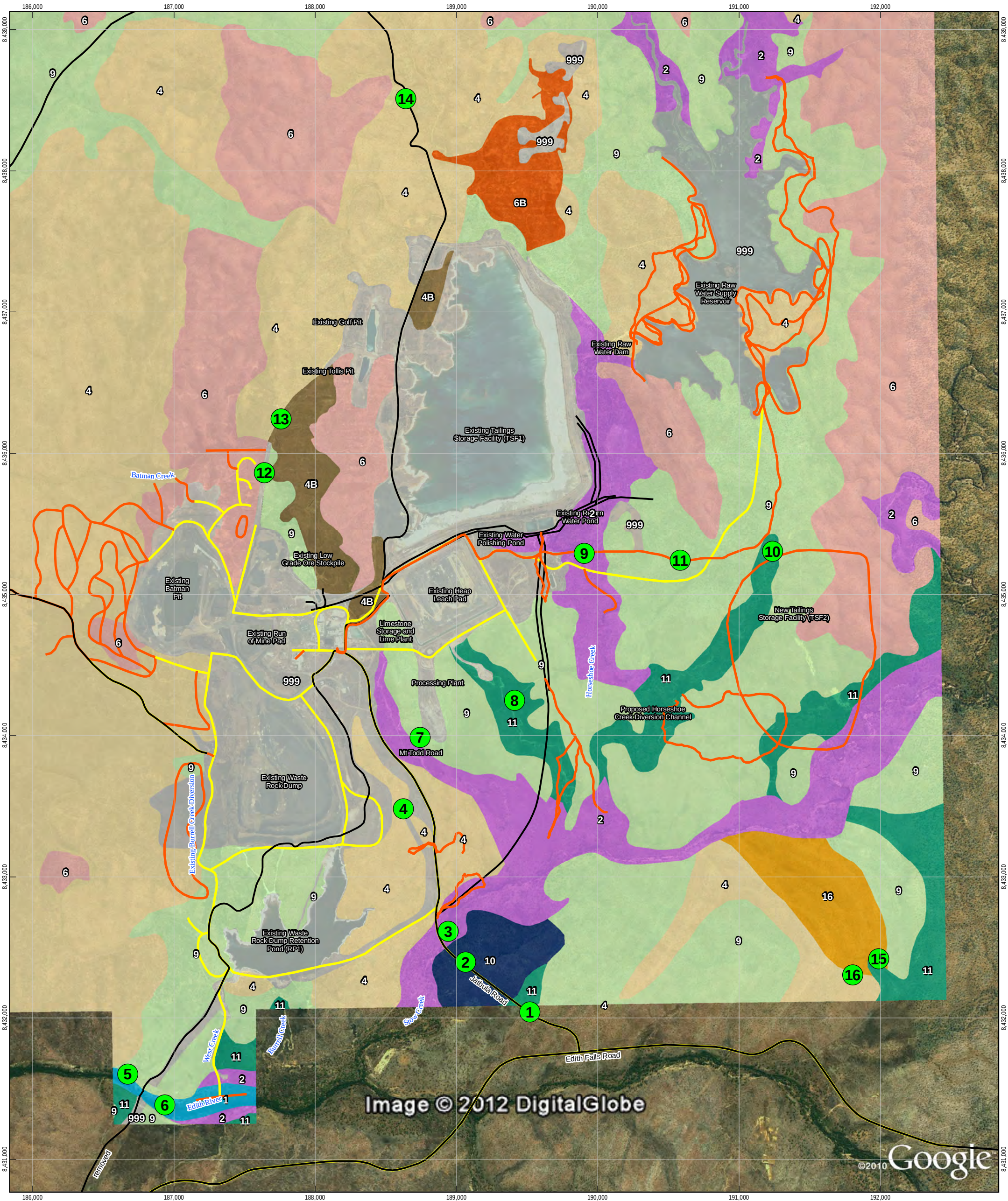
Wet Season

Weather (taken from the Bureau of Meteorology RAAF Tindal weather station) during the wet season fauna survey was generally warm to hot and humid, with wet evenings. Daily average maximum temperature over the period of survey was 34.1°C (range 32.2°C to 35.9°C) with an overnight average minimum of 23.4°C (range 23.3°C to 24.8°C). Wind strength and direction were variable but generally light and from the north. Cloud cover varied. Heavy rain fell at Tindal on two of the four survey days, with 20.0mm and 44.2mm falling on consecutive nights (25-26 February). Rainfall in this part of the NT is often localised. There were patchy showers over the mine site during the survey period that may not have registered at Tindal and vice versa.

3.1.4 Selection of Sample Sites

GHD botanists had previously surveyed the vegetation of the mine leases (GHD 2013b). Results from that survey, including vegetation maps, were provided to the fauna survey team to provide a basis for selection of sites for fauna survey. This allowed selection of sites in a representative range of vegetation/habitat types. Sixteen survey sites were established across the eight main vegetation types represented in the mine leases. Each survey site was focussed on a 50m x 50m area. Figure 3-1 shows the locations of the fauna survey sites and the vegetation types as mapped/verified during GHD's flora impact assessment (GHD 2013b). Two survey sites were established in each of the vegetation communities (Table 2-1). The same sites were sampled in the dry and wet season surveys.

Areas declared as aboriginal sacred sites were avoided. Areas selected were those considered to provide higher quality habitat for fauna, based upon vegetation structure, topographic location, and habitat features (e.g. presence of rock outcrops, hollow-bearing trees, long grass, leaf litter). The choices of site were made in an effort to maximise the likelihood of detecting fauna, including threatened species.



LEGEND		Vegetation Community	
	Fauna Survey Sites	1	<i>Melaleuca</i> forest, with bare areas
	Routes Driven and Surveyed from Vehicle	2	<i>E. bigalerita</i> <i>Eucalyptus</i> spp. open-forest
	Routes Walked	4	<i>E. tintinnans</i> <i>Eucalyptus</i> spp. <i>Erythrophleum chlorostachys</i> woodland
	Access Roads	4B	<i>E. tintinnans</i> <i>Eucalyptus</i> spp. <i>Erythrophleum chlorostachys</i> woodland (Disturbed)
		6	<i>E. tintinnans</i> <i>C. dichromophloia</i> woodland
		6B	<i>E. tintinnans</i> <i>C. dichromophloia</i> woodland (Disturbed)
		9	<i>E. tectifica</i> woodland
		10	<i>E. tectifica</i> <i>C. confertiflora</i> woodland
		11	<i>E. latifolia</i> <i>E. bigalerita</i> open-woodland with areas of grassland
		16	<i>E. tectifica</i> woodland \ <i>E. tintinnans</i> <i>Eucalyptus</i> spp. <i>Erythrophleum chlorostachys</i> woodland
		999	Disturbance

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Vista Gold Australia Pty Ltd

Mt Todd Gold Project

Job Number

43-21801

Revision

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Date

28 May 2013

Location of Fauna Survey Sites and Vegetation Communities

Figure 3-1



3.1.5 Survey Techniques

Survey methods followed the NT Parks and Wildlife Commission's "Draft survey methods used for fauna and flora on standard Biodiversity Unit survey sites". Survey techniques employed were consistent over the wet and dry season surveys, except where weather conditions precluded this. Table 3-1 provides a summary of survey effort in each site (focussed on a 50m x 50m area). Additional explanatory notes are provided below.

1. *Habitat assessment* – Vegetation characteristics across the mine site were assessed by GHD botanists (GHD 2013b). Information collected by the botanists was augmented during the fauna surveys with assessments of the fauna habitat features of each site.
2. *Baited Elliot-type traps* – Twenty Elliot-type box traps (size A) were placed approximately 8m apart along the perimeter of the quadrat boundary at each site. Each trap was placed in a suitable microhabitat (e.g. with suitable cover and shade) and marked with a labelled piece of flagging tape attached to a nearby tree or shrub to assist with finding traps during the period of the survey. Traps were baited with a suitably moist mixture of rolled oats, honey and peanut butter (widely used recipe for attracting mammals), with a small amount of tuna oil added to attract carnivores. Traps remained open for four days and four nights (which exceeds the minimum period of three nights/days required by DLRM). Traps were checked once each morning and once each mid-late afternoon, except where this was precluded by conditions (e.g. inundation of sites during wet season surveys (Section 3.1.7)). Bait was refreshed once during the dry season survey period.
3. *Baited cage traps* – One cage trap was placed at each corner of the quadrat boundary of each site (four cage traps per site). Traps were placed in suitable microhabitats (e.g. in suitable cover and shade). Each trap was individually marked with a labelled piece of flagging tape attached to a nearby tree or shrub to assist with finding traps. Traps were baited as for Elliot traps. Traps remained open for four days and four nights (which exceeds the minimum period of three nights/days required by DLRM). Traps were checked once each morning and once each mid-late afternoon, except where this was precluded by conditions (e.g. inundation of sites during wet season surveys (Section 3.1.7)). Bait was refreshed once during the dry season survey period.
4. *Pitfall buckets* – Four pitfall traplines were established in the quadrat at each site. Each pitfall trap comprised a single 20-litre bucket dug into the ground such that its lip was flush with ground-level, and bisected by a fly-wire 'drift fence' (10m long and 35cm high) to direct animals into pits (see Photo 3-1). Each bucket was supplied with 3cm of soil, a damp sponge, a piece of bark and some leaf litter to provide protection for animals while in the trap. Traps remained open for four days and four nights (which exceeds the minimum period of three nights/days required by DLRM). Pits were scattered through the different microhabitats in the quadrat (e.g. in open ground; in dense grass; close to trees; in rocky areas). Traps were checked once each morning and once each mid-late afternoon, except where precluded by conditions (e.g. inundation of sites during wet season surveys (Section 3.1.7)).
5. *Funnel traps* - Two funnel traplines were established in the quadrat at each site. Each funnel trapline consisted of a fly-wire 'drift fence' (10m long and 35cm high) to direct animals into traps. Traps were placed mid-way along and on each side of the fence (two funnel traps per trapline) (see Photo 3-1). Each funnel trap contained a damp sponge and was covered with grass and bark to protect and shade animals while in the trap. Traps remained open for four days and four nights (which exceeds the minimum period of three nights/days required by DLRM). Funnel lines were placed in different microhabitats in the quadrat (e.g. in open ground; in dense grass; close to trees; in rocky areas).



Traps were checked once each morning and mid-late afternoon, except where precluded by conditions (e.g. inundation of sites during wet season surveys (Section 3.1.7)).

6. *Anabat® bat call detection* – Anabat® bat call detection units were used to collect the high frequency calls of micro-chiropteran bats. Anabat® units were deployed for one night at each site, and placed in an open area (i.e. devoid of nearby vegetation to avoid interference and non-bat noise) with the microphone oriented upwards at 45°. Recordings were downloaded and referred to a bat specialist for analysis.
7. *Bird surveys (including Instantaneous Bird Count)* – Bird survey counts involved one zoologist compiling a complete list of all birds seen, heard or otherwise detected in the vicinity of the survey quadrat. GHD ecologists incorporated the standard NT 'instantaneous' bird count method from a single point, but then increased the survey effort by moving gradually around the 50m x 50m quadrat area (also covering a width of around 25m on all sides of the transect) to survey a 1 ha area (approximately) over a time period ranging from 15 minutes to 25 minutes. Notes were kept on whether birds were inside or outside the quadrat, and whether species were detected during the 'instantaneous' count or during the period that followed. Where possible, numbers of individuals were noted, along with any detected breeding activity, unusual habitat use or other specific interactions (e.g. potential predation). The surveys were mostly completed early in the morning (within two hours of sunrise) and in the late afternoon when birds were most active (i.e. not during the heat of the day). The numbers of bird surveys conducted varied among the survey sites because of time constraints during the establishment of 16 sites, and site access e.g. following heavy rain). At least three bird surveys were conducted at each site during the dry season, and at least five at each site during the wet season surveys (Table 3-1).
8. *Active search* – Generally, active searches involved two zoologists (but sometimes one) thoroughly searching in daylight for the presence or signs of animals for a period of approximately 20 minutes. Two active searches were conducted during the day at each site during the dry season. One active search was done at each site during the wet season due to time constraints. Active searching is generally useful for detecting cryptic ground and tree-dwelling fauna, particularly reptiles. Ground, rock and tree surfaces were scanned, and under surfaces of rocks, logs, bark, clumps of vegetation and other debris examined for reptiles and other animals. All vertebrate fauna detected were noted. Where possible, reptiles were captured or photographed for identification. Some species were identifiable without the need for capture. Indirect evidence of fauna species was documented or collected for later identification (i.e. tracks, scats, bones, sloughed skin and hair samples).
9. *Nocturnal survey* – During the dry season, two nocturnal surveys were conducted at each site by two ecologists for at least 20 minutes, using strong headtorches to aid the capture and identification of fauna species. All vertebrate fauna detected were noted. During the wet season, nocturnal surveys were conducted on two nights. Sites were surveyed on the first night, but weather conditions (i.e. heavy rain) hampered nocturnal searches on the second night, so searches were instead conducted by teams of two or three ecologists from vehicles along tracks adjacent to fauna sites.
10. *Scat / hair / bone / skin analysis* – Hair, bones, sloughs (shed reptile skin), scats (animal faeces) and pellets (e.g. regurgitated material from owls) can be used to determine the presence of an animal at a site or in a nearby area. Scats and pellets can be used to identify the animals that produced them, and animals that were eaten. Where possible, the species responsible for the signs were determined immediately. Where that was not possible, the material was collected for later analysis and



identification. More than 10 scat samples and two bone samples were collected and sent to a specialist for analysis and identification.

11. *Opportunistic observations* – Opportunistic observations of fauna across the entire mine site were documented, whether or not the observations were made at the 16 sites. These observations involved single or multiple species recorded from a single location, or over a small area, on one particular day. Where possible, numbers of individuals of each species were noted, along with other relevant details (e.g. breeding activity, habitat type, unusual habitat use).
12. *Call playback* – Call playback was done for two threatened species of birds. Call-playback for masked owl (northern) (*Tyto novaehollandiae kimberli*) was done at night at each site during the dry season and at Sites 5 and 6 during the wet season survey. Call-playback for crested shrike-tit (northern) (*Falcunculus frontatus whitei*) was done during the daytime at all sites during the dry season and wet season surveys. Methods and results of call playback are described in Section 3.2.5.

Table 3-1 Summary of Fauna Survey Effort during Baseline Surveys in the Project Area

Survey type	Dry season survey effort	Wet season survey effort
Habitat assessment	Approximately two person-hours per site, investigating quadrat area through various survey methods.	Habitat and vegetation characteristics at sites assessed by botanists and zoologists.
Elliot trapping	20 baited Elliot traps (type A) per site, checked twice daily for four days and nights. 1280 trap-nights in total; 80 trap-nights per site.	20 baited Elliot traps (type A) per site, checked twice daily for four days and nights. 1280 trap-nights in total; 80 trap-nights per site.
Cage trapping	Four baited cage traps per site, checked twice daily for four days and nights. 256 trap-nights in total; 16 trap-nights per site.	Four baited cage traps per site, checked twice daily for four days and nights. 256 trap-nights in total; 16 trap-nights per site.
Pitfall trapping	Four 10m pit-fall traplines (each with one bucket) per site, checked twice daily for four days and nights. 256 trap-nights in total; 16 trap-nights per site.	Four 10m pit-fall traplines (each with one bucket) per site, checked twice daily for four days and nights. 256 trap-nights in total; 16 trap-nights per site.
Funnel trapping	Two 10m traplines (each with two funnel traps) per site, checked twice daily for four days and nights. 128 trap-nights in total; 8 trap-nights per site.	Two 10m traplines (each with two funnel traps) per site, checked twice daily for four days and nights. 128 trap-nights in total; 8 trap-nights per site.
Anabat	One survey-night at each site; 16 survey-nights in total.	One survey night at 14 sites (two sites rained out, with no access). On two occasions, one Anabat survey night sampled two sites. 12 survey-nights in total.
Bird surveys	At least three (and up to seven) 20 minute diurnal surveys at each site, incorporating 'instantaneous bird counts'. 87 bird counts in total;	At least five (and up to nine) 20 minute diurnal surveys at each site, incorporating 'instantaneous bird counts'. 103 bird counts in total:

Survey type	Dry season survey effort	Wet season survey effort
	Site 15 – 7 surveys; Sites 1, 8, 9, 10, 11, 12, 13 and 16 – 6 surveys; Sites 2, 3, 5, 6, 7 – 5 surveys; Site 4 – 4 surveys; Site 14 – 3 surveys.	Site 1 – 9 surveys; Sites 2, 3, 4, 12, 13, 14, 15, and 16 – 7 surveys; Sites 9, 10 and 11 - 6 surveys; Sites 5, 6, 7 and 8 – 5 surveys.
Active searches	Two 20-minute (or more) diurnal searches by two ecologists at each site. Minimum of 21 person-hours active searching in total; 1.33 person-hours per site.	One 20-minute diurnal search by one or more ecologists at each site. Minimum of 3.66 person-hours active searching in total.
Nocturnal searches	Two 20-minute (or more) nocturnal searches by two ecologists at each site. Nocturnal surveys supplemented by road spotlighting through the mine site. Minimum of 21 person-hours active searching in total; 1.33 person-hours per site.	Up to two 20-minute (or more) nocturnal surveys by three ecologists at ten sites. Six sites (8-11, 15-16) were not surveyed at night due to safety concerns with access. Nocturnal surveys supplemented by road spotlighting through the mine site. Minimum of 22 person-hours active searching (15 at sites, 7 along roadways).
Scat / hair / bone / skin / pellet analysis	Assessed / Collected opportunistically.	Assessed / Collected opportunistically.
Opportunistic observations	Six ecologists over the entire survey period, including five 12 hour days during set-up and survey. Minimum of 432 person-hours of opportunistic observation.	Nine ecologists over five 12 hour days during set-up and survey. Minimum of 540 person-hours of opportunistic observation.
Call playback	Crested Shrike-tit – all sites at least once, for at least 15 minutes. Masked Owl – All sites on one night only.	Crested Shrike-tit – all sites at least once, for at least 15 minutes. Masked Owl - Sites 5 and 6 on one night only.





Photo 3-1 Examples of a pitfall trap line (left) and a funnel trap line (right) used in the survey

3.1.6 Exploration of Patterns in Fauna Diversity and Habitats

Canonical Discriminant Functions Analysis (CDA)

Canonical discriminant function analysis (CDA) can be used to investigate patterns in multiple and often unrelated variables (e.g. tree height, numbers of frogs, distance to water, size of rocks) that are measured for a group of entities (e.g. sites). CDA examines the data for patterns (e.g. differences in variables x , y and z among sites), then identifies 'functions' that best explain the patterns in the data. A 'function' is a theoretical axis drawn through the data in multidimensional space, to explain as much of the variation in those data as possible. The first function (Function 1) always explains most of the variance in the data, the second (Function 2) explains the next most variation in the data, and so on (i.e. subsequent 'functions' continue to define the next most variation in the data). Together, all functions identified by the analysis explain 100% of the variance in the data. Wilks' Lambda tests of significance for each function show which of the functions are significant at the $\alpha < 0.10$ level. This level of significance is accepted because of the relatively few sites sampled in each vegetation type.

CDA also produces standardised canonical discriminant function coefficients, which show the relationships of individual variables (e.g. numbers of frogs, size of rocks) with each of the functions. Structure matrices then correlate each variable against each function, thereby identifying the variables (e.g. numbers of frogs) that are most important to the patterns found in the data. Plots of Function 1 against Function 2 for function scores (often plotted as Centroid values) from each entity graphically show groupings and overlap among entities.

In an effort to understand patterns of fauna diversity among vegetation communities, CDA was performed on various sets of fauna diversity data collected at sites (that is, which faunal groups had the biggest influence on differences in diversity among vegetation communities). As stated in Section 3.1.4, the 16 survey sites were chosen to represent the range of vegetation communities that occurred in the study area, with two sites representing each of the eight communities. Data obtained at each site can be considered one of two replicates for the purposes of discriminant function analysis of vegetation communities. Descriptions of sites and vegetation communities are provided in Section 2.4. Vegetation communities are reported in more detail in a separate report (GHD 2013b).

CDA were run on all fauna groups combined (species counts of mammals, birds, reptiles and frogs in the different communities), then on faunal sub-groups within each group separately (e.g., species counts of skinks, dragons, snakes etc). Because there were fewer variables than groups, variables were entered together, with all groups given equal probabilities for the analysis. Some sub-groups were excluded from CDA because there were few observations of each of those sub-groups (e.g. pygopods [legless lizard], one individual detected).

Linear Regression

Multiple linear regression was used to investigate which habitat characteristics had the strongest relationship with fauna species richness (all species) at sites. Characteristics were entered into the model using the forward stepwise method. Using this method, the data are examined to identify the habitat characteristic that has the greatest influence on the dependent variable (fauna species richness, in this case), then the next most influential characteristic is determined, then the next, and so on until addition of further characteristics has no bearing on the outcome of the model. The model is run and results produced after each step.



Ten habitat characteristics were included in the CDA analysis: canopy height (m), proportional canopy cover, proportional cover of vegetation greater than 3m in height, proportional cover of vegetation less than 3m in height, proportional cover of ground layer vegetation, proportional cover of litter, proportional cover of bare ground, proportional cover of gravel, period since fire (yrs), and numbers of hollows observed. For sites where there was no evidence of recent fire, period since fire was set at once every 10 years.

Other variables were measured, but many turned out to be relevant to small numbers of sites (e.g. evidence of disturbance from floods, pigs, mining, grazing, weeds, and proportional cover of crust), so were excluded in an effort to simplify the analysis.

CDA and Regression models were run in SPSS Inc (PASW Statistics Version 18.0.0).

3.1.7 Limitations of the Baseline Fauna Survey

The fauna assessment focused on species of terrestrial vertebrate fauna (mammals, birds, reptiles and amphibians). Existing databases and species prediction tools are biased towards vertebrates. The occurrence of terrestrial invertebrates was not assessed in detail unless a specific threatened invertebrate type (e.g. snails) was targeted for survey, or was likely to be present within the study area. Unlike terrestrial vertebrate fauna, there are relatively few data or identification tools available for terrestrial invertebrates in the region. Aquatic fauna (fish and aquatic invertebrates) were not assessed as part of this survey but were addressed in the GHD Aquatic Fauna Study (GHD 2013c).

As planned, the surveys were undertaken in the late dry (early November) and wet seasons (late February - early March). Rain fell in the weeks leading up to and during the dry season survey, such that some creeks and waterholes had water that had not been present a month before. The increase in water availability may have resulted in species dispersing over a broader area than would normally be expected during a dry season survey, resulting in lower detection rates for some species. The effect of this is likely to have been reduced by considering a large area for survey (i.e. much of the lease area) and by assessing a diversity of habitats (i.e. 16 sites across eight vegetation communities). The timing of the dry season survey towards the end of the northern Australian dry season coincides with the hottest daytime temperatures of the year. This is likely to have reduced the activity of some species, particularly birds and mammals and particularly during the middle of the day.

Heavy overnight rain and inundation impacted survey sites during wet season surveys. On one occasion during the survey, sites 3, 5, and 6 were partially or completely submerged for approximately 24-36 hours, due to expansion of the Edith River and Horseshoe Creek. Some or all of the traps and trap-lines at these sites were virtually ineffective during the period of inundation. Some pit-fall traps at the remaining sites were prone to filling with water following heavy rain, rendering them ineffective (i.e. captured animals could float to the rim of the pit and escape). This was caused by their topographic position and the presence of the fenceline, which acted as a water catchment. In such instances all water was removed from the pits during subsequent site checks. Bark or other floating objects were placed in pits to provide 'rafts' to avoid drowning captured fauna.

The increase in availability of water during the wet season may result in fauna dispersing over a broader area, resulting in reduced likelihood of trapping and lower detection rates for some species (i.e. reduced occurrence of fauna near permanent water sources, even for species that are present in the study area). The effect of this is likely to have been reduced by considering a large area for survey (i.e., much of the lease area) and by assessing a diversity of habitats (i.e. 16 sites across eight vegetation communities).



The standard requirements for fauna surveys in the NT include three days/nights only for a trapping program (Elliot, cage, pitfall and funnel traps). This duration for trapping is likely to influence the numbers and diversity of fauna detected. Animals that visit the surveyed area only occasionally are less likely to be detected than animals that live nearby. Rare or less common animals may be more likely to be detected with additional survey effort. GHD ecologists conducted the trapping program over four days and nights for both the dry and wet season surveys.

On most occasions, Anabat detectors and recorders gave “all night” recordings (i.e. no battery problems). However, at most sites, approximately 75-85% of the recorded time was hampered by insect noise. This is particularly difficult to avoid during the wet season. Anabat used a “zero crossing” processing method that tends to pick up the strongest sound at any one time. Bats with soft or whispering calls were generally not detected (e.g., *Nyctophilus* and *Hipposideros*). Heavy overnight rain impacted Anabat survey at some sites, particularly during the wet season. Anabat failure (thought to be mostly due to wet microphones) lead to no micro-bat data being collected from Site 2 during the dry season, and Sites 3, 4, 8, 10, 11, 13 and 14 during the wet season.

Each of the limitations presented is at least partially overcome by supplementing the survey results with those of previous assessments (e.g. Lane *et al.* (1990); DLRM database results).

The hand-held GPS and Trimble units used to record site information are typically accurate to within 10 metres. Maps presenting site information and species records should not be relied on for detailed design during construction of the mine.

3.1.8 Nomenclature

Common and scientific names for birds follow Christidis and Boles (2008). The DLRM fauna database was used for the nomenclature of mammals, reptiles and amphibians.

3.2 Threatened Species Surveys (May 2011 and September 2012)

The objective was to conduct systematic fauna surveys targeting EPBC and NT listed species in areas of native vegetation that the proponent proposes to develop and in areas adjacent to proposed development. The September 2012 survey focussed on areas relevant to the proposed Raw Water Dam expansion in the north-east of the Mt Todd study area. The surveys included all areas of vegetation or potential habitat proposed for development to accommodate mine expansion, new roads and other infrastructure. Tasks were broken down into:

- ▶ Identification of all listed threatened species and/or significant populations of migratory species that could be affected either directly or indirectly as a consequence of the proposal;
- ▶ Provision of a description of the conservation status and biology of each of the threatened species known to occur in the Mt Todd area; and
- ▶ Systematic surveys targeting listed threatened species in the study area.

3.2.1 Threatened and Migratory Species in the Mt Todd Study Area

Inspection of the DLRM fauna database and the results of the DSEWPac PMST search indicate the following listed threatened and/or migratory species as being or potentially being in the study area:

- ▶ Gouldian finch (*Erythrura gouldiae*);

- ▮ northern quoll (*Dasyurus hallucatus*);
- ▮ crested shrike-tit (northern) (*Falcunculus frontatus whitei*);
- ▮ partridge pigeon (*Geophaps smithii smithii*);
- ▮ bare-rumped sheath-tail bat (*Saccolaimus saccolaimus nudicluniatus*);
- ▮ masked owl (*Tyto novaehollandiae kimberli*);
- ▮ northern brush-tailed phascogale (*Phascogale pirata*);
- ▮ black-footed tree-rat (*Mesembriomys gouldii*);
- ▮ pale field-rat (*Rattus tunneyi*);
- ▮ freshwater sawfish (*Pristis microdon*);
- ▮ brush-tailed rabbit-rat (*Conilurus penicillatus*);
- ▮ red goshawk (*Erythrotriorchis radiatus*);
- ▮ painted honeyeater (*Grantiella picta*);
- ▮ grey falcon (*Falco hypoleucos*);
- ▮ Australian bustard (*Ardeotis australis*) (formerly listed as *threatened*, now listed as *near threatened*);
- ▮ Mitchell's water monitor (*Varanus mitchelli*);
- ▮ Mertens' water monitor (*Varanus mertensi*); and
- ▮ yellow-spotted monitor (*Varanus panoptes*).

Not all of the above species have been recorded from the Mt Todd area, and some are unlikely to occur. These include:

- ▮ Bare-rumped sheath-tail bat (*Saccolaimus saccolaimus nudicluniatus*);
 - Only found on or adjacent to coastal floodplains (Milne and Pavey 2011), which are not present on or adjacent to the study area;
 - Previous survey has not located the species in the study area (Lane *et al.* 1990).
- ▮ Northern brush-tailed phascogale (*Phascogale pirata*);
 - Usually located in tall open forests which are absent from the study area;
 - Uncommon and little is known of their ecology or behaviour in the Top End (Woinarski *et al.*, 2007);
 - Existing populations are restricted to locations closer to the coast (Woinarski *et al.* 2007);
 - Previous survey has not located the species in the study area (Lane *et al.* 1990).
- ▮ Brush-tailed rabbit-rat (*Conilurus penicillatus*);
 - Recent records are restricted to the Tiwi islands, Cobourg Peninsula, Kakadu, the Ingli Islands and Groote Eylandt (Woinarski *et al.* 2007);
 - Not recorded from locations as far inland as the project area, and there are no known records for the Yinberrie Hills;
 - It was not recorded during previous surveys of the study area (Lane *et al.* 1990).
- ▮ Freshwater sawfish (*Pristis microdon*);



- Recorded in the Daly River system, but not recorded from the Edith River;
 - It is usually recorded from sites lower in the catchment;
 - It has not been recorded during aquatic surveys adjacent to the study area (GHD 2013c).
- ▶ Masked owl (*Tyto novaehollandiae kimberli*);
- There is no record of this species from the Mt Todd-Yinberrie Hills area;
 - The species was not found during previous surveys of the Mt Todd study area (Lane *et al.* 1990);
 - This species is targeted using nocturnal call playback methods during the general fauna surveys.

Other than the masked owl, none of these five species was targeted during the threatened species survey. Their presence or apparent absence is investigated in the general fauna surveys (see sections 3.1 and 4.1) and the aquatic fauna surveys (GHD 2013c). These species would have been recorded as incidental observations if observed during these surveys. General fauna survey effort such as Anabat recordings, trapping and nocturnal surveys would be sufficient to account for these species (not freshwater sawfish) without specific targeted survey effort.

Species listed as migratory, but not threatened under the EPBC Act are recorded, or are predicted to occur in the study area by the DSEWPaC PMST (Appendix B). Each of these was reviewed to determine whether a migratory species has or is likely to have “important habitat” in the study area or represents part of an “ecologically significant population” according to definitions contained in the “Matters of National Environmental Significance: Significant Impacts Guidelines” (DEWHA 2009). Other than the Gouldian finch (which is considered in this report under the threatened species category), there is no evidence to suspect that Mt Todd provides “important habitat” for any migratory species or that any migratory species has an “ecologically significant” population in the area. Migratory species were not targeted in the threatened species survey. They are included as incidental observations during this study and were recorded during the general fauna surveys.

3.2.2 Review of the Conservation Status and Biology of the Threatened Species

The DLRM fauna database and the scientific literature were reviewed to provide background information on biology and conservation status of each of the threatened species. It should be noted that a recent review of the threatened species of the NT resulted in a number of changes to the threatened species listings since the targeted surveys were conducted. The result of this review is that species have been both added and removed from the NT threatened species list. These changes have been reflected in this report however, additional threatened species added to the list have not been specifically targeted. In all cases these species appear to have been adequately addressed by the survey effort invested over the various surveys conducted. More detailed information on the biology of the targeted threatened species is provided in Appendix C.

3.2.3 Scheduling

Two GHD zoologists conducted targeted threatened species surveys in existing and proposed developments of the Mt Todd Mine Site for a period of seven days and six nights from Tuesday 3 May to Saturday 7 May 2011 and Tuesday 18 to Wednesday 19 September 2012. Two rangers from the Jawoyn Association assisted with the May fieldwork.

The surveys were in accordance with a TPWC Act permit issued to GHD by the Parks and Wildlife Commission of the NT (Permit number 40623, expiry date 30 April 2014).



3.2.4 Weather

Weather during the threatened species surveys was variable (Bureau of Meteorology). Daily average maximum temperature during the May 2011 survey was 31.1 °C (range 30.0 °C to 32.2 °C) with an overnight average minimum of 17.0 °C (range 15.0 °C to 18.6 °C). Wind strength and direction were highly variable, as was cloud cover. Rainfall from the start of January through to the end of April 2011 totalled 1090.6mm at Katherine, 331.4mm (43.6%) higher than the long-term average (759.2mm) for that period.

Daily average maximum temperature during the September 2012 survey was 37.8 °C (range 37.5 °C to 38.2 °C) with an overnight average minimum of 17.7 °C (range 16.9 °C to 18.5 °C). Wind strength and direction were variable, as was cloud cover. Rainfall from the start of May through to 20 September 2012 totalled 2.8mm at Katherine, which was in keeping with the long-term average (15.1mm) for that period.

No rainfall was recorded during either of the survey periods and the weather was generally warm to hot with abundant sunshine.

3.2.5 Survey Techniques

Targeted threatened species surveys were conducted in proposed development areas, existing developments (previously developed areas) and 200m to 500m buffers around each. In addition, opportunistic observations were made throughout the targeted threatened species surveys and during travel between survey locations. Some trapping was conducted during the May 2011 survey. The September 2012 survey focussed on areas relevant to the proposed Raw Water Dam expansion in the north-east of the Mt Todd study area. Consequently, methods used during that survey were limited to active searching, bird watching, call playback, spotlighting and opportunistic observations.

All observations of threatened fauna species were documented, including Australian Map Grid (AMG) coordinates of the location of the observation, number of individuals present, and sex and breeding condition (if evident). Data were captured using a Trimble 'Nomad' field GPS. Table 3-2 and Figure 3-2 provide details on the level of survey effort expended on each of the investigated species.

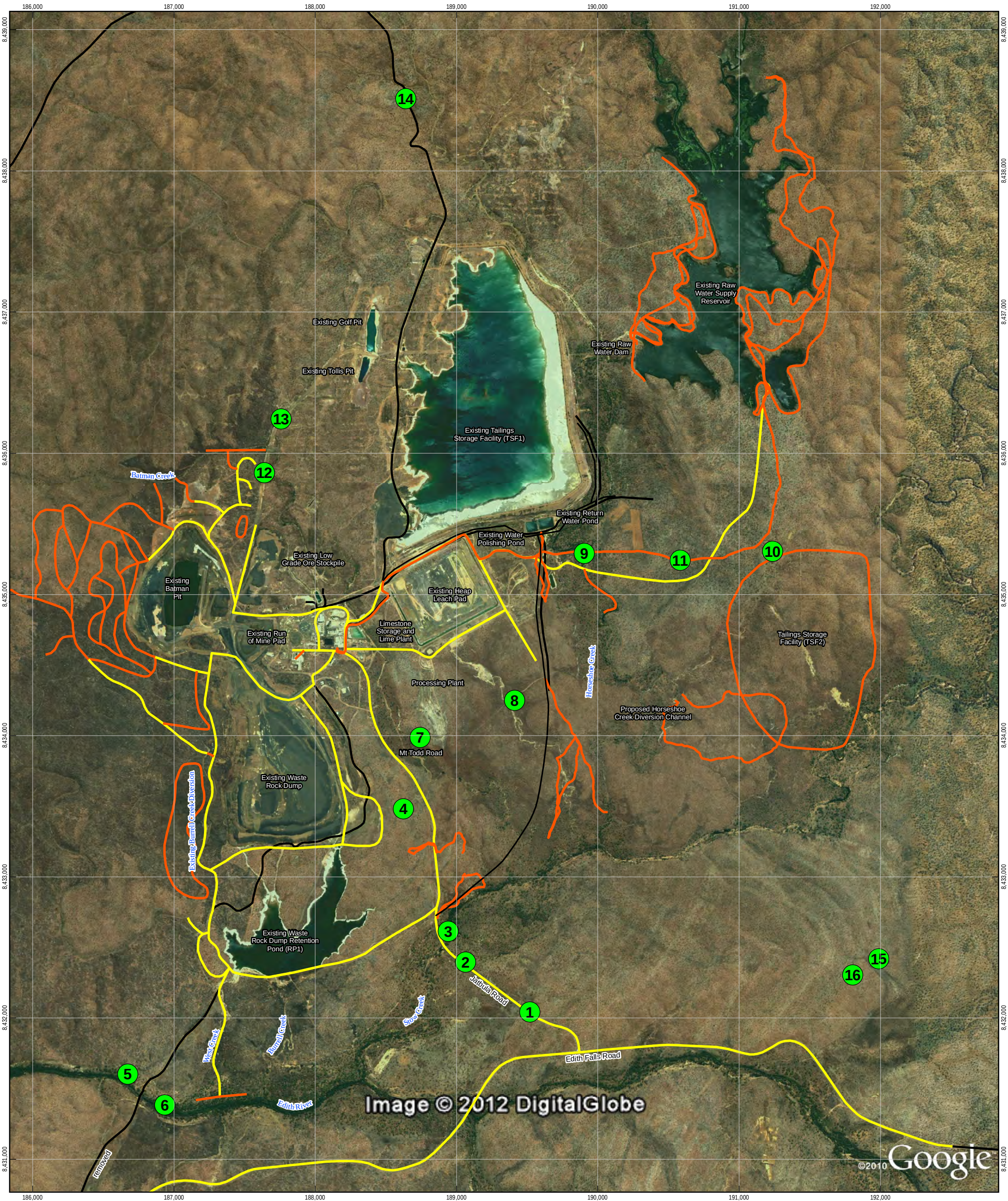
Threatened species observations made during dry and wet season surveys are detailed in Section 4.2.1.

Table 3-2 Summary of Survey Effort for Threatened Species in the Study Area

Survey method	Species targeted	Survey effort (threatened species surveys)
Call playback	crested shrike-tit (northern); and masked owl	31 separate call playback instances at least 500m apart. Two ecologists walking out and back along 6km transects each morning and again each afternoon for four days (May 2011); Two ecologists walking out and back along transects each morning for two days (distance covered approximately 12km) (September 2012); Two ecologists walking out and back along transects for two nights (distance covered approximately 4km); (total distance covered = approximately 120km during the day plus 4km at night).
Baited surveillance cameras	northern quoll; yellow-spotted monitor; Mertens' water monitor	Five cameras for four days and four nights (20 survey nights in total) (May 2011 only).
Transect surveys	All species	Two ecologists walking out and back along 6km transects each morning and again each afternoon for four days (May 2011) (total distance covered = 96km). Two ecologists over four 12-hour days (total survey effort = 96 hours);



Survey method	Species targeted	Survey effort (threatened species surveys)
		Two ecologists walking out and back along transects each morning for two days (distance covered approximately 12km) (September 2012); Two ecologists walking out and back along transects (distance covered approximately 4km) for two nights (September 2012); (total distance covered = approximately 120km during the day plus 4km at night).
Vehicle-based searches	All species	Approximately 30km of vehicle-based survey per day for four days (May 2011) plus approximately 15km of vehicle-based survey per day for two days (September 2012) (total of 150km).
Active nocturnal searches	All species	Two ecologists conducting spotlight surveys for at least one hour on two separate nights in May 2011 and two separate nights in September 2012 (total = at least eight person-hours).
Opportunistic Observations	All species	Two ecologists over four 12-hour days in May 2011 and two 12-hour days in September 2012 (total survey effort = 144 hours).



- LEGEND**
- Fauna Survey Sites
 - Access Roads
 - Routes Driven and Surveyed from Vehicle
 - Routes Walked



Northern quoll (*Dasyurus hallucatus*)

Methods used to target this species follow those of the 'Survey guidelines for Australia's threatened mammals' (DSEWPaC 2011):

- The mine area was searched for northern quoll habitat during the day. Habitats sought were rocky, especially rocky overhangs, crevices and boulders in extensive areas of unburnt outcropping in association with permanent water. No habitat fitted this description entirely;
- Baited motion-sensitive surveillance cameras were deployed in May 2011 at five sites in areas of suitable habitat. Only very minor examples of outcropping could be located (two cameras) despite extensive searches for suitable habitat in the study area. The other cameras were placed at water sources (two cameras) and in a small clearing near several large rocks (one camera). At each site, the camera was attached to a tree or log and directed towards an area where animal movement and activity was expected. A tin of tuna was emptied onto the ground in front of the camera to attract carnivores, and peanut butter smeared on rocks in addition to a buried mixture of peanut butter, rolled oats and honey. The cameras operated for four days and four nights, which exceeded the minimum three nights of survey recommended by the 'Survey methods used for fauna and flora on standard Biodiversity Unit survey sites'. Photos were downloaded and viewed after the survey;
- Scat searches were conducted in areas of suitable habitat as described in Section 4.1.5, and opportunistically in all areas; and
- Conversations with Jawoyn rangers were conducted to determine whether northern quolls were known to them or their families.

Crested shrike-tit (northern) (*Falcunculus frontatus whitei*)

The survey method followed the protocol for the northern shrike-tit developed by Ward (2009), and the 'Survey guidelines for Australia's threatened birds' (DSEWPaC 2010). Suitable vegetation types in the study area were surveyed. These included 'Vegetation Type 4: *E. tintinnans* *Eucalyptus* spp. *Erythrophleum chlorostachys* woodland', 'Vegetation Type 6: *E. tintinnans* *Corymbia dichromophloia* woodland', 'Vegetation Type 9: *E. tectifica* woodland', and 'Vegetation Type 11: *E. latifolia*, *C. bigalerita* open woodland with areas of grassland'. Methods included:

- Approximately 120km of transects walked by two people;
- Call playback of the *F. frontatus whitei* call (using a Toa megaphone and MP3 player) in suitable habitat, at a series of 31 sites at least 500m apart;
- At each site, broadcasting calls for five minutes, after which the player was moved 5 - 10m and set up to broadcast in another direction for five minutes;
- Listening for a response during the broadcast and for an additional two minutes afterwards;
- Using binoculars to identify birds active in vegetation around the broadcast site;
- Replication of survey effort where possible;
- Comprehensive coverage of the proposed mine area while searching for the species; and
- Surveys conducted from sunrise to 12noon, and then again from 4:30pm until sunset.



Gouldian finch (*Erythrura gouldiae*)

Surveys for the Gouldian finch (*Erythrura gouldiae*) followed the methods described in the 'Survey guidelines for Australia's threatened birds' (DSEWPaC 2010). Methods included:

- Zoologists and Jawoyn rangers slowly walking one to two kilometre transects meandering through woodland dominated by hollow-bearing *Eucalyptus tintinnans* (May 2011);
- Observations from walked transects west of the Batman Pit and in the vicinity of the Edith River (May 2011);
- Five-minute pauses every 100 to 200m (observers spaced 50 to 100m apart) to listen and watch for the presence of Gouldian finches (May 2011);
- Opportunistic searches for the presence of Gouldian finches in all observed mixed-species flocks of foraging birds (May 2011 and September 2012);
- General area-based searches conducted in smaller patches of habitat easily investigated by two zoologists/rangers in a one to two-hour period (May 2011);
- Replication of survey effort where possible; and
- Surveys conducted from sunrise to 12noon, and again from 4:30pm until sunset.

Partridge pigeon (*Geophaps smithii*)

Methods used to target this species follow the 'Survey guidelines for Australia's threatened birds' (DSEWPaC 2010). Methods included:

- Transect surveys and area searches through potentially suitable habitat;
- Approximately 120km of transects walked by two people during the day (May 2011 and September 2012 combined);
- Zoologists/Jawoyn rangers spaced approximately 50m apart (May 2011) to walk through suitable habitat in an attempt to detect this easily flushed species;
- Two-minute pauses every 100m or so to listen for the call of the partridge pigeon (May 2011);
- Replication of survey effort where possible;
- Approximately 150km of vehicle-based searches within the Mt Todd study area (May 2011 and September 2012 combined);
- A total of 144 person-hours spent in the Mt Todd study area (Table 3-2) searching for fauna (May 2011 and September 2012 combined);
- Comprehensive coverage of the proposed study area; and
- Surveys conducted from sunrise to 12noon, and then again from 4:30pm until sunset.

Australian bustard (*Ardeotis australis*), Red goshawk (*Erythrotriorchis radiatus*), Mertens' water monitor (*Varanus mertensi*), Mitchell's water monitor (*Varanus mitchelli*), Painted honeyeater (*Grantiella picta*), Grey falcon (*Falco hypoleucos*) and Yellow-spotted monitor (*Varanus panoptes*)

Each of these species is likely to be relatively wide-ranging and detectable using replicated 250 to 500m walking transects. Red goshawk detection methods are described in detail in the 'Survey guidelines for Australia's threatened birds' (DSEWPaC 2010) and generally require searches for nests in tall trees (>20m tall). Vehicle-based surveys involving slowly driving along tracks in the study area and looking for raptors and nests is considered a useful survey technique. Methods for these species included:



- ▶ Transects, commenced after sunrise and continued to around 12 noon and then from 4:30pm until sunset (taking advantage of the most appropriate times of day to detect bird and reptile activity);
- ▶ One to two long (length depended on the size of the habitat assessed) walked transects in the morning of each day to allow time for other survey techniques during the field trip (May 2011 and September 2012);
- ▶ Approximately 120km of transects walked by two people (May 2011 and September 2012 combined);
- ▶ A total of 144 person-hours spent in the Mt Todd study area (Table 3-2) (May 2011 and September 2012 combined);
- ▶ Comprehensive coverage of the proposed Mine development area;
- ▶ Waterways and wetlands in the study area actively searched for Mertens' water monitor (two zoologists moving quietly using binoculars in an attempt to observe individuals of this typically shy species from a distance before they retreated into the water) (May 2011 and September 2012); and
- ▶ Active searching and vehicle-based surveys (150km) to achieve broad assessments of the large study area in relatively short periods of time (May 2011 and September 2012). Each of the threatened species has the potential to cover a large home range and may be more readily encountered crossing roads than in the bush, and may perceive a vehicle as less threatening than ecologists on foot. Surveys of this type were undertaken on an opportunistic basis.

3.2.6 Limitations of Threatened Fauna Species Surveys

The threatened species surveys focused on species of terrestrial vertebrate fauna (mammals, birds, and reptiles). Existing databases and species prediction tools are biased towards vertebrates. Unlike terrestrial vertebrate fauna, there are relatively few data available on terrestrial invertebrates in the region. Aquatic fauna (fish and aquatic invertebrates) were not assessed as part of this survey as these were covered in a separate survey. Surveys for the one threatened amphibian species in the Northern Territory (*Uperoleia daviesae*; Howard Springs toadlet) were conducted during the wet season baseline survey. It should be noted here, that a recent review of the threatened species of the NT resulted in a number of changes to the threatened species listings since the targeted surveys were conducted. The result of this review is that species have been both added and removed from the NT threatened species list. These changes have been reflected in this report however, additional threatened species added to the list have not been specifically targeted. It is possible that additional changes to the list may occur again however, unless additional specific surveys are commissioned to target these species, the scope of this report does not cover these additional changes.

Survey results are likely to have been influenced by the conditions experienced in the lead up to the site visits. The surveys were undertaken early in the dry season (early May 2011), following a wet season of exceptionally high rainfall and late in the dry season (late September 2012), following a wet season of low rainfall and almost four months of virtually no rain. The abundance of rain prior to the May 2011 survey may have resulted in species dispersing out over a broader home range than would normally be expected, resulting in lower detection rates for some species. The absence of rain prior to the September 2012 survey may have resulted in species' distributions contracting to creeklines and waterbodies, resulting in higher detection rates for some species at those sites. The timing of the May survey towards the beginning of the tropical dry season coincides with decreasing daytime temperatures that may reduce the activity of some species, particularly reptiles. The timing of the September survey towards the end of the tropical dry season coincides with increasing daytime temperatures that are likely to increase



the activity of some species, particularly reptiles. These threatened species surveys are supplemented by baseline fauna surveys in the late dry and wet seasons.

Species such as the crested shrike-tit (northern) may not respond to call playback outside of the recommended months of September to March (DSEWPaC 2010) and may have been less easily detected during the May survey than the September survey. Additional surveys for this species were conducted during the dry and wet season baseline surveys. Other species targeted for the surveys such as the Gouldian finch tend to be more easily detected through waterhole surveys towards the end of the dry season, when surface water becomes less available and restricted to permanent waterholes.

Each of these limitations is at least partially overcome by supplementing the results of the surveys with those recorded by Lane *et al.* (1990) and the DLRM database results.

The hand-held GPS units used to record site information are accurate to within 10 metres. Maps presented to display site information and species records should not be relied on for detailed design during construction of the mine.

3.2.7 Nomenclature

Common and scientific names for terrestrial birds follow Christidis and Boles (2008). The DLRM fauna database was used for the nomenclature of mammals, reptiles and amphibians.



4. Results

4.1 Result of the Baseline Fauna Surveys (November 2011 and February 2012)

4.1.1 Review of Existing Data

The desktop assessment revealed records of 300 indigenous terrestrial vertebrate fauna species from within 10km of the study area (reported in Lane *et al.* 1990, and/or the DLRM Fauna Atlas). These included 36 species of mammals, 183 species of birds, 67 species of reptiles and 14 species of amphibians. A total of eight introduced fauna species are recorded, including seven mammals and one amphibian. These species are listed in Appendix D.

4.1.2 Overview of Results from the Present Survey

The dry and wet season surveys of the mine site resulted in:

- Records of 216 fauna species (Table 4-1);
- Detection of most of the species during the dry season (178 species; 82% of total);
- 69 species (13 species of mammals, 36 species of birds, 19 species of reptiles and one species of amphibian) detected during the dry season but not during the wet season;
- 38 species detected for the first time during the wet season (five species of mammals, 24 species of birds, seven species of reptiles and two species of amphibians);
- 112 species (52% of total) detected during both seasons.

Twenty-nine species detected during the surveys were new records for this area (i.e., within 10km of the mine site). These include six native species of mammal, six native species of bird, ten native species of reptile, and seven native species of amphibian.

Table 4-1 Numbers of Species (by Vertebrate Group) Detected in each of the Seasonal Fauna Surveys Undertaken by GHD

Group	Dry season (Nov 2011)	Wet season (Feb 2012)	Total
Mammals	26	17	31
Birds	96	84	120
Reptiles	38	26	45
Amphibians	18	19	20
Total	178	146	216

All species detected during the surveys are listed in Appendix D.

A small number of animals captured or observed during the surveys could not be identified to species level. This was because they escaped/fled before identification could be made (e.g. unidentified species of quail), or species identification was uncertain (e.g. frogs of the genus *Uperoleia*, skinks of the genus *Cryptoblepharus*). These records are listed in Appendix D, but are excluded from results shown in Table 4-2 and from all subsequent analysis.

4.1.3 Assessment of Sampling Effectiveness

Assessment of sampling techniques

Each of the sampling techniques resulted in effective sampling of differing taxonomic groups or combinations of groups. For example, pitfall and funnel trapping were particularly successful at detecting reptiles and amphibians, while the most successful technique for detecting birds was bird surveys (Table 4-2). In combination, the sampling techniques effectively sampled the fauna as a whole.

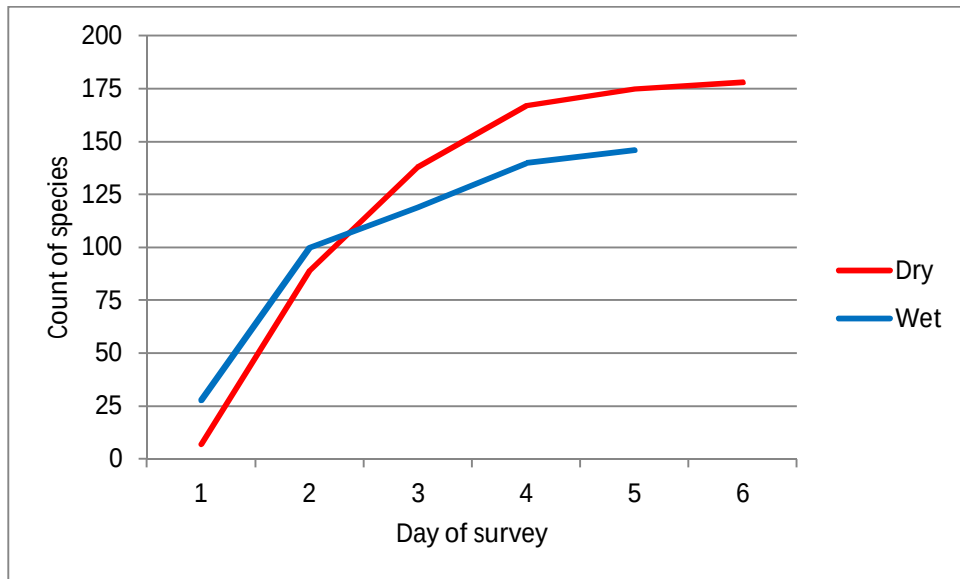
Table 4-2 Success of Sampling Techniques in Detecting Species of Different Taxonomic Groups

Group	Season	Bird surveys	Pits / funnels	Elliot's / cages	Active (daytime)	Active (night)	Anabat	Incidental obs.
Mammals	dry	0	1	2	5	2	15	5
	wet	1	0	2	0	0	10	5
Birds	dry	75	1	1	1	13	-	49
	wet	70	0	0	9	1	-	42
Reptiles	dry	0	27	3	15	12	-	14
	wet	0	17	0	7	8	-	11
Amphibians	dry	0	14	1	3	15	-	7
	wet	2	10	1	4	19	-	7
Total	dry	75	43	7	24	42	15	73
	wet	73	27	3	20	28	10	65
Total	-	97	47	8	38	51	18	104

More than half of the species were detected by one method alone. Of the 216 species detected across wet and dry season surveys, 119 were detected by one method alone and 97 were detected by more than one method. Of those detected by one method alone, 44 were detected during bird surveys, 29 were detected through incidental observations, four were detected during active daytime searches, nine were detected during active night searches, 12 were detected in pits/funnels, 18 were detected using Anabat, and three were detected in cage or Elliot traps.

Accumulation of detected species with time

Each of the seasonal surveys exhibited a species accumulation curve through time that was tending towards a plateau, indicating that the majority of species susceptible to the sampling techniques had been detected prior to the conclusion of each survey (Figure 4-1). In both seasons, less than two percent of the total number of species detected during that survey period were detected for the first time on the final day of the survey (3 of 178 species in dry; 2 of 146 species in wet).

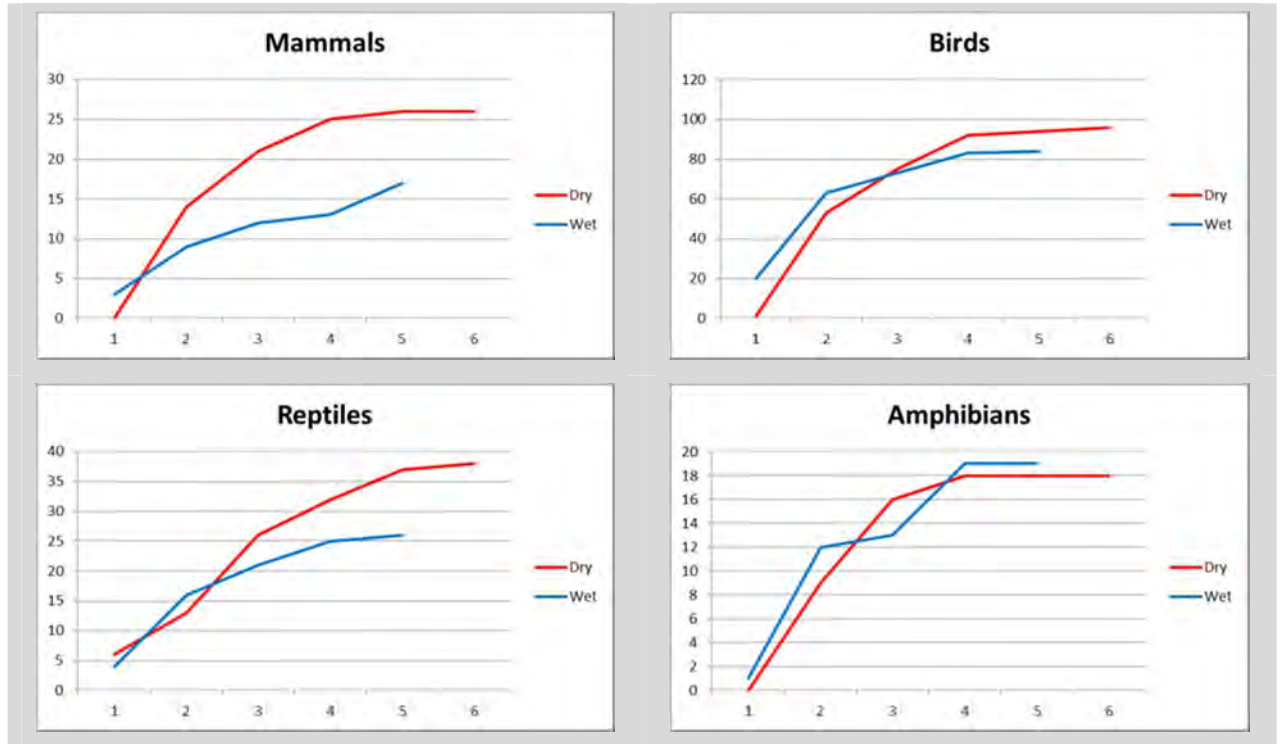


*In all graphs, the vertical axis represents count of species and the horizontal axis represents time in days.

Figure 4-1 Accumulation of Species Detected Through Time (Day of Survey Period) for each of the Seasonal Surveys

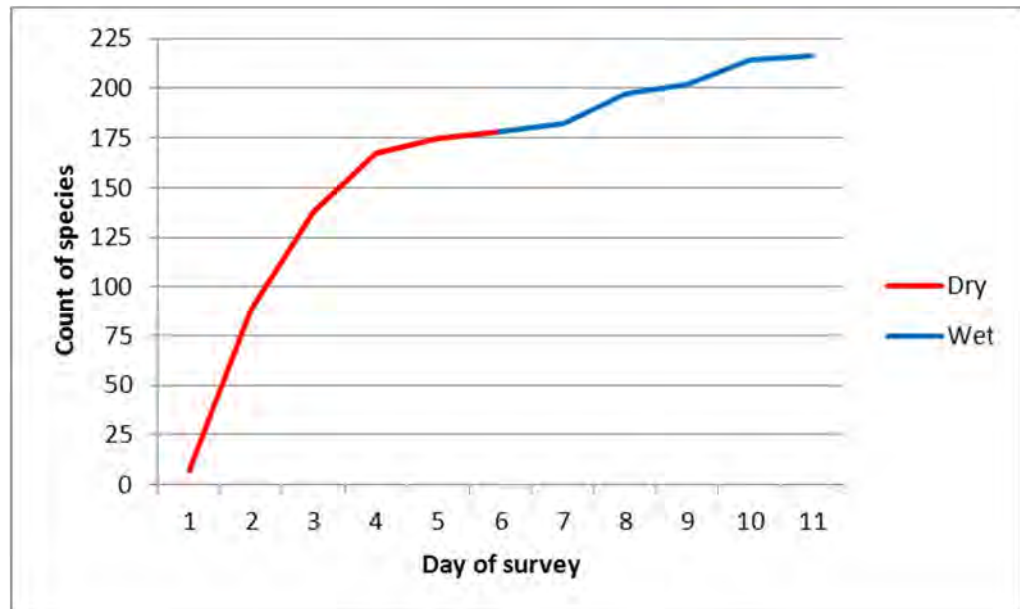
When divided into taxonomic groups, the dry season species accumulation curves indicate a fairly consistent asymptotic pattern (Figure 4-2), again indicating that the majority of species susceptible to the sampling techniques had been detected prior to the conclusion of that survey. The wet season species accumulation curves, however, showed a less consistent pattern (Figure 4-2) particularly for mammals and amphibians. The pattern for mammals was close to linear, probably influenced by small numbers of species detected overall (anabat surveys failed at seven sites during the wet season). The wet season pattern for amphibians shows two pulses in species accumulation (days 2 and 4). These pulses correspond with the night searches, during which many frog species were detected.

Combining species accumulation across both seasonal surveys indicates that most species were detected during the dry season survey, with relatively small numbers of species added over the course of the wet season survey (Figure 4-3). The curve at the conclusion of the dry season survey (day 6) tends towards a plateau. The overall curve between days 4 and 11 (latter part of the dry season survey and that during the wet season) continues on a gradual incline. Continued survey effort at the mine site could be expected to result in a slow accumulation of relatively few additional species.



In all graphs, the vertical axis represents count of species and the horizontal axis represents time in days.

Figure 4-2 Accumulation of Species in Each Taxonomic Group Detected during Each of the Seasonal Surveys

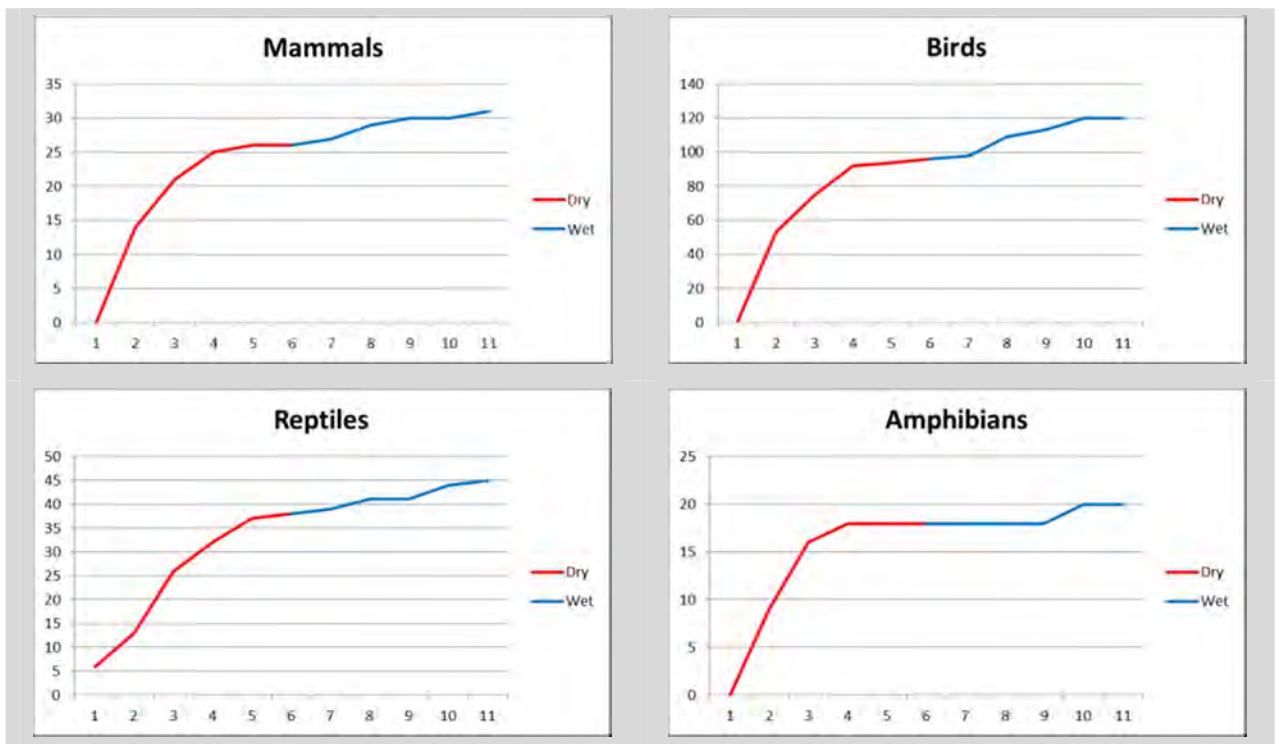


* In all graphs, the vertical axis represents count of species and the horizontal axis represents time in days.

*Day 7 represents the first day of the wet season survey

Figure 4-3 Accumulation of Species Detected through Time across Both Seasonal Surveys

The species accumulation curves for the different taxonomic groups exhibit a consistent pattern (Figure 4-4). The curves for mammals, birds and reptiles are similar to each other, with a gradual rather than pronounced increase in species accumulation over the course of the wet season. Most of the species in these groups had been detected during the dry season. The curve for amphibians flattens between day 4 and day 9, and two additional species were detected on day 10.



*In all graphs, the vertical axis represents count of species and the horizontal axis represents time in days, with day 7 representing the first day of the wet season survey.

Figure 4-4 Accumulation of Species in Each Taxonomic Group across Both Seasonal Surveys

4.1.4 Fauna Diversity and Abundance

Mammals

Thirty-one species of mammal were detected during the surveys, including four species of non-native mammals. A complete list of mammal species recorded during the surveys is provided in Appendix D. Mammals detected comprised the following ecological/morphological/taxonomical sub-groups:

- ▶ Bats – black flying-fox (*Pteropus alecto*) and up to 18 species of micro-chiropteran bats (insectivorous bats);
- ▶ Large carnivores – dingo (*Canis lupus dingo*);
- ▶ Macropods – agile wallaby (*Macropus agilis*), antilopine wallaroo (*Macropus antilopinus*), euro (*Macropus robustus*);
- ▶ Small ground mammals – common planigale (*Planigale maculata*), delicate mouse (*Pseudomys delicatulus*), pale field-rat (*Rattus tunneyi*), western chestnut mouse (*Pseudomys nanus*); and

- Non-native mammals – swamp buffalo (*Bubalus bubalis*), cattle (*Bos indicus*), donkey (*Equus asinus*), pig (*Sus scrofa*).

Bats had the highest species richness (19), followed by small ground-dwelling mammals and non-native mammals (four each) (Table 4-3).

Table 4-3 Diversity and Abundance of Sub-groups of Mammals Detected during Each of the Seasonal Surveys

Sub-group	Count of species			Count of individuals		
	Dry	Wet	Total	Dry	Wet	Total
Bats	16	10	19	2*	0*	2*
Large carnivores	1	1	1	3	4	7
Macropods	3	2	3	16	5	21
Small ground mammals	3	2	4	6	4	10
Non-native mammals	3	2	4	11	6	17
Total	26	17	31	38	19	57

* Anabat surveys not included, because they document numbers of calls rather than numbers of individuals

Other than bats, most mammals were detected by opportunistic observations (incidental) or active searching (e.g., macropod scat). One sampling technique (Elliot's / cages) was used in an effort to target small and medium-sized ground-dwelling mammals. With 2880 Elliot trap-nights and 576 cage trap-nights in total, a capture success of 10 individuals of four species indicates very low diversity and abundance of small ground-dwelling mammals (e.g. rats, mice, dasyurids).

One individual of one species of dasyurid was detected (common planigale).

One threatened species of mammal detected during the surveys is listed as *vulnerable* under NT legislation (pale field rat). Two species of mammal detected during the surveys are listed as *near threatened* under NT legislation (western chestnut mouse and Arnhem sheath-tailed bat)

Seven mammal species (23% of mammals) were recorded once only (euro, common planigale, delicate mouse, western chestnut mouse, common sheath-tail bat, cattle and donkey). Seventeen species of mammal were detected more than five times (dingo, agile wallaby, antilopine wallaroo, pale field-rat, pig and 12 species of microchiropteran bat). Other than bats, pigs were the most commonly detected mammal. This species is listed as 'invasive' under the EPBC Act.

No arboreal mammals (e.g., possums, tree-rats, phascogales, gliders) were seen over the two surveys, despite 64 person-hours of night-searching (mostly spent around trapping sites, but also driving between sites).

Birds

In total, 120 species of bird (all native) were detected over the course of the two seasonal surveys. Birds showed the highest species diversity of all the taxonomic groups of vertebrate fauna. A complete list of bird species recorded during the surveys is provided in Appendix D.

The birds detected were assigned to sub-groups determined on the basis of taxonomy (i.e., related types of birds) and/or ecology (e.g., similar habitat use). As far as practicable, sub-groups were determined by taxonomy (e.g., raptors, parrots/cockatoos, finches), but in an effort to reduce the numbers of groups, some taxonomic groups were combined on the basis of ecology (e.g. woodland birds, waterbirds). The following sub-groups were considered:

- ▶ Finches – five species of small granivorous finches;
- ▶ Parrots/cockatoos – parrots, rosellas, cockatoos, corellas, lorikeets, cockatiel, galah;
- ▶ Raptors – falcons, goshawks, eagles, kites, baza and buzzard;
- ▶ Cuckoos – four, mostly seasonal species of cuckoo;
- ▶ Woodland birds – a large group of species generally associated with treed habitats, including honeyeaters, cuckoo-shrikes, doves, warblers, babblers, and flycatchers;
- ▶ Ground birds – large and small species of birds that tend to remain on or near the ground (e.g., bustard, brulga, quail, stone-curlew, coucal, cisticola and fairy-wren);
- ▶ Waterbirds – species that show a strong association with ponds, lakes, swamps, water courses or riparian habitats, includes grebes, herons, egrets, ducks and geese, gallinules, ibis, shorebirds, pelican, stork and azure kingfisher; and
- ▶ Night birds – owls, frogmouths, nightjars and owl-nightjar.

Woodland birds included the most species and were the most abundant in terms of numbers of individuals recorded (Table 4-4). Parrots and cockatoos were common and the most abundant group if the ratio of species to individuals is considered (overall totals show an average of 54.1 individuals per species of parrot/cockatoos, versus 20.6 individuals per species of woodland birds).

Table 4-4 Diversity and Abundance of Sub-groups of Birds Detected during Each of the Seasonal Surveys

Sub-group	Count of species			Count of individuals		
	Dry	Wet	Total	Dry	Wet	Total
Finches	5	4	5	43	40	83
Parrots/cockatoos	8	7	9	266	221	487
Raptors	9	7	12	26	26	52
Cuckoos	4	1	4	35	4	39
Woodland birds	44	44	56	557	599	1156
Ground birds	7	7	8	43	79	122
Waterbirds	14	12	21	32	58	90
Night birds	5	2	5	14	2	16
Total	96	84	120	1016	1029	2045



Twenty-eight bird species (23% of birds) were recorded once only. Thirty-eight species (32% of birds) were recorded more than 10 times and seven species (6% of birds) were recorded more than 50 times each over the course of the surveys. The most commonly reported species were silver-crowned friarbird (*Philemon argenticeps*), rainbow lorikeet (*Trichoglossus haematodus*), peaceful dove (*Geopelia striata*) and Torresian crow (*Corvus orru*), with 103, 98, 72 and 67 records respectively.

Birds showed the highest species richness (145 species) of all the taxonomic groups of vertebrate fauna. Two threatened species and four *near threatened* species of bird were detected during the surveys: crested shrike-tit (northern), painted honeyeater, bush stone-curlew, Australian bustard, hooded parrot and yellow-rumped manikin respectively. . The crested shrike-tit (northern) is listed as Vulnerable under the EPBC Act. The crested shrike-tit (northern) was possibly detected during the dry season only (heard, not seen). Additional information on these species is provided in the Section 4.2.

Detection of the crested shrike-tit (northern) by GHD was not confirmed. Calls were heard on two separate occasions at two separate sites, but no individual was seen. It is possible that the calls were not those of this species. The environment was relatively noisy (insects, other birds, wind) and the calls were heard in the dry season (not the breeding season).

Four species of bird detected during the surveys are listed as Migratory under the EPBC Act: rainbow bee-eater, *Merops ornatus*; eastern great egret, *Ardea alba* (=modesta); cattle egret, *Bubulcus ibis*; and crested shrike-tit (northern), *Falcunculus frontatus whitei*.

Reptiles

Forty-five species of reptile (all native) were detected during the two seasonal surveys. A complete list of reptile species is provided in Appendix D. Most species (38) were detected during the dry season survey, with seven additional species (15.5% of total) added during the wet season survey.

Reptiles were categorised into the following taxonomical sub-groups: crocodiles, dragons (agamids), geckoes, monitors (varanids), pygopods (legless lizards), skinks and snakes.

Of the sub-groups, skinks and snakes were the most diverse, with 15 and 12 species detected respectively (Table 4-5). Skinks were abundant in regard to numbers of individuals recorded (overall total shows an average of 16.1 individuals per species). Geckoes were also abundant, with an average of 17.3 individuals per species. Snakes, while relatively diverse, were relatively uncommon, with an average of only 3.7 individuals per species.

Ten reptile species (22% of reptiles) were recorded once only. Fifteen species (33% of reptiles) were recorded more than 10 times and four species (8.9% of reptiles) were recorded more than 30 times each over the course of the surveys. The most commonly reported species were the striped rainbow skink (*Carlia munda*), northern dtella (*Gehyra australis*), Bynoe's gecko (*Heteronotia binoei*), and northern ridge-tailed monitor (*Varanus primordius*), with 84, 71, 34 and 31 records respectively.

Table 4-5 Diversity and Abundance of Sub-groups of Reptiles Detected during Each of the Seasonal Surveys

Sub-group	Count of species			Count of individuals		
	Dry	Wet	Total	Dry	Wet	Total
Crocodiles	1	0	1	6	0	6
Geckoes	7	2	7	101	20	121
Pygopods	0	1	1	0	1	1
Skinks	13	10	15	130	111	241
Dragons	5	3	5	36	9	45
Monitors	3	3	4	12	24	36
Snakes	9	7	12	21	23	44
Total	38	26	45	306	188	494

One reptile species (Mertens' water monitor, *Varanus mertensi*) detected during the wet season is listed as Vulnerable under NT legislation. Another monitor (northern ridge-tailed monitor, *Varanus primordius*) detected in both surveys is listed as Near Threatened.

Six reptile species detected during the surveys are listed as Data Deficient under NT legislation (brown tree snake, *Boiga irregularis*; Children's python, *Antaresia childreni*; common tree snake, *Dendrelaphis punctulata*; olive whipsnake, *Demansia olivacea*; Papuan whipsnake, *Demansia papuensis*; and spotted tree monitor, *Varanus scalaris*).

Amphibians

Twenty species of amphibian were detected during the two seasonal surveys. This includes the non-native cane toad (*Rhinella marina*), which was detected during both surveys. A complete list of amphibian species recorded during the surveys is provided in Appendix D. Most species (18) were detected during the dry season survey, with only two additional species recorded during the wet season survey.

Amphibians were categorised into the following ecologically/morphologically/taxonomically distinct sub-groups:

- ▶ Burrowing frogs – All frogs that burrow during the dry season, mainly comprising the Myobatrachid (southern frogs) genera *Uperoleia*, *Limnodynastes*, *Platyplectrum* and *Notaden*, also including the genus *Cyclorana*, which shares characteristics of Myobatrachidae and Hylidae (tree frogs);
- ▶ Ground frogs – Mainly ground hylids (i.e. 'tree frogs' with poorly developed toe-pads, such as *Litoria inermis* and *Litoria wotjulumensis*), one Myobatrachid (*Crinia remota*) and the non-native cane toad (*Rhinella marina*); and
- ▶ Climbing frogs – Arboreal hylids with well-developed toe-pads (e.g. *Litoria caerulea*, *Litoria rothii*).

Of the frog sub-groups, ground frogs were the most species rich, although species numbers did not vary greatly among the three groups (Table 4-6). Burrowing frogs were the most abundant in regard to numbers of individuals per species (overall average of 53.6 individuals per species). Ground frogs and

climbing frogs were very abundant also, with averages of 49.8 and 44.0 individuals per species, respectively. Amphibians had the highest relative abundance of all the vertebrate groups (mammals, birds, reptiles, amphibians), with 999 individuals of 20 species recorded over the course of the two surveys (Table 4-6).

Table 4-6 Diversity and Abundance of Sub-groups of Amphibians Detected during Each of the Seasonal Surveys

Sub-group	Count of species			Count of individuals		
	Dry	Wet	Total	Dry	Wet	Total
Burrowing frogs	6	7	7	145	230	375
Ground frogs*	8	8	9	165	283	448
Climbing frogs	4	4	4	109	67	176
Total	18	19	20	419	580	999

* includes one non-native species (cane toad, *Rhinella marina*).

Three amphibian species detected (giant frog, *Cyclorana australis*, northern dwarf tree frog, *Litoria bicolor*; ornate burrowing frog, *Platyplectrum ornatum*) are listed as Data Deficient under NT legislation. All three species were detected during both seasonal surveys.

More cane toads were captured during the surveys than any other species of amphibian. One hundred and thirty were captured in pits or funnels over the course of the two surveys, and a further 37 were captured in Elliot traps. The cane toad is non-native and listed under the EPBC Act as an 'invasive' species. The "biological effects, including lethal toxic ingestion, caused by cane toads (*Rhinella marina*)" is listed under the EPBC Act as a Key Threatening Process.

Two amphibian species (10% of amphibians) were recorded in one location only (javelin frog, *Litoria microbelos*, and rockhole frog, *Litoria meiriana*). Eight species (40% of amphibians) were recorded more than 20 times during the course of the surveys. The more commonly reported native amphibian species were the common green tree frog (*Litoria caerulea*), ornate burrowing frog (*Platyplectrum ornatum*), northern spadefoot toad (*Notaden melanoscaphus*) and marbled frog (*Limnodynastes convexiusculus*), with 37, 37, 26 and 26 records respectively.

4.1.5 Fauna Diversity - Variation among Sites, Habitats and Seasons

Fauna richness varies greatly across the 16 sites and across the eight vegetation communities. This section identifies the spatial patterns recorded. The combined taxonomic groups are evaluated and then each taxonomical group is evaluated separately to determine which species groups/sub-groups show the greatest variation in species richness across vegetation types.

All species

Species richness of the fauna is relatively similar across sites. The main exceptions are Sites 3, 9, 5 and 6 (*Eucalyptus* and *Melaleuca* forest/woodland in riparian habitats; Vegetation Communities 2 and 1 respectively). These habitats tend to have higher diversity than other sites, particularly during the dry season survey (Figure 4-5). The lowest diversity is recorded at sites 4, 13, 15 and 16 (open *Eucalyptus tintinnans*, *E. spp.*, *Erythrophleum chlorostachys* woodland and *E. tectifera*/*E. tintinnans*, *E. spp.*, and *Erythrophleum chlorostachys* woodland; Vegetation Communities 4 and 16 respectively).

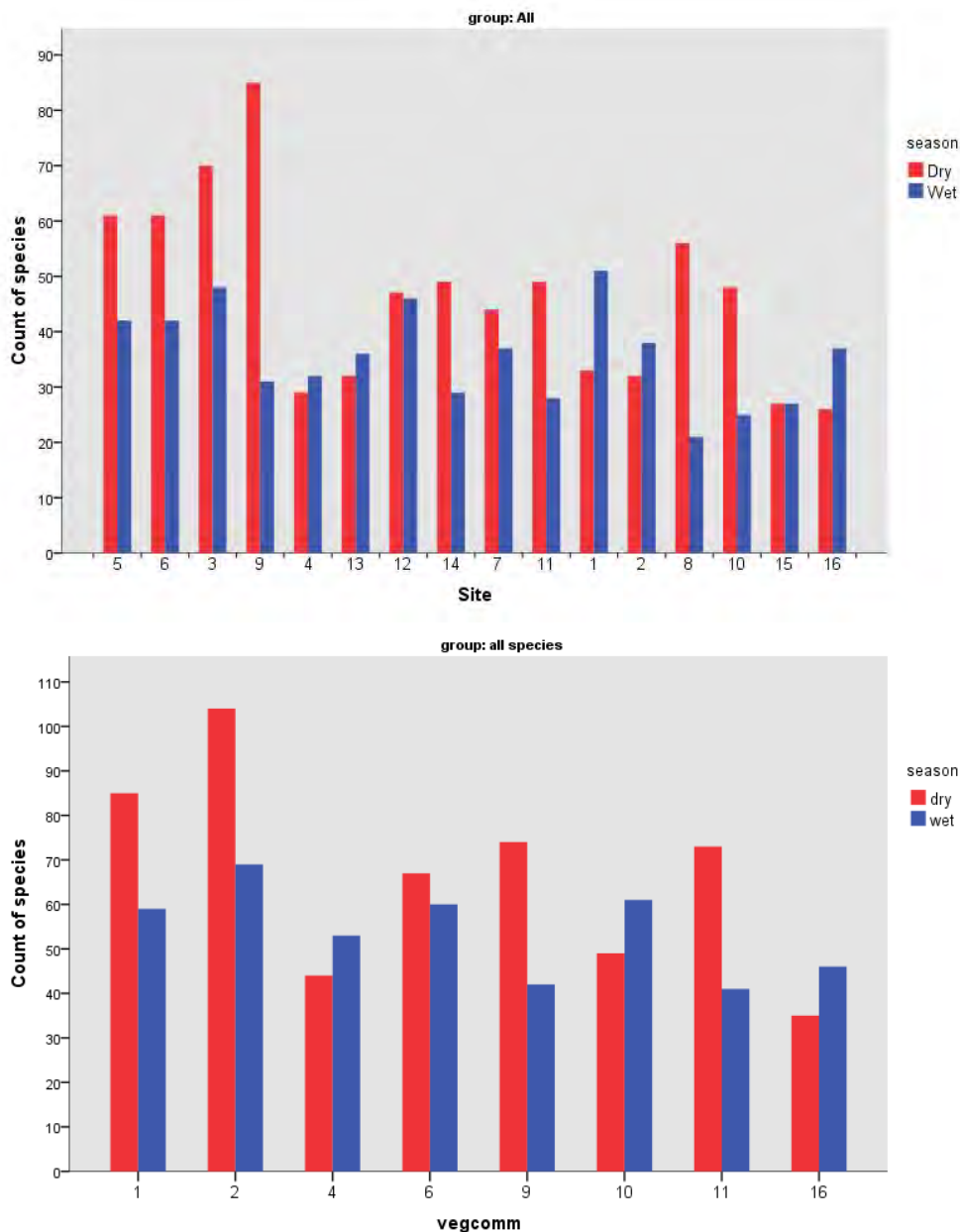


Figure 4-5 Species richness of all fauna recorded at each site (upper) and in each vegetation community (lower) in each seasonal survey

The prevailing pattern is that fauna species richness tended to be more even among sites during the wet season than during the dry season. The high species richness of the forest/woodland in riparian habitats during the dry season is associated with this uneven distribution. The high overall species richness in the riparian forests/woodlands was fairly consistent among sites (5, 6, 3 and 9) although in all cases richness was lower at individual sites during the wet season.

Canonical Discriminant Functions Analysis (CDA) found differences among the faunas recorded from the different vegetation communities, but those differences were not significant at the $\alpha < 0.10$ level (Appendix F). Analysis of the faunas of the vegetation types yielded a Wilks' Lambda of 0.25 with $\alpha =$

0.18. The two riparian communities (Vegetation Communities 1 and 2 (particularly 2)), and two *E. tintinnans* woodland types (Vegetation Communities 4 and 16) differed from others along Function 1, but were similar to each other along Function 2. The *E. tintinnans*, *C. dichromophloia* woodland and *E. tectifera* woodland (Communities 6 and 9) and to some degree *Corymbia latifolia*, *E. bigalerita* open woodlands (Community 11), differed from other groups in their values of Function 2 (Figure 4-6).

As shown in the tables in Appendix F (analysis 1), Function 1 is influenced almost entirely by bird species richness. This might be expected because the most broadly differing faunas (riparian communities, Vegetation Community 2 and to some degree Community 1; and two of the *E. tintinnans* communities, Vegetation Communities 4 and 16) have the higher and lower species richnesses respectively recorded, and birds make up the majority of species recorded (>60%). Function 1 explains 54% of variation in fauna species richness among vegetation communities.

Function 2 is strongly influenced by amphibian species richness. Function 2 explains an additional 27.2% of the variation in fauna species richness among communities.

Functions 1 and 2 together explain 81.2% of variation in the data. These results indicate that the faunas of the different vegetation types are reasonably distinct.

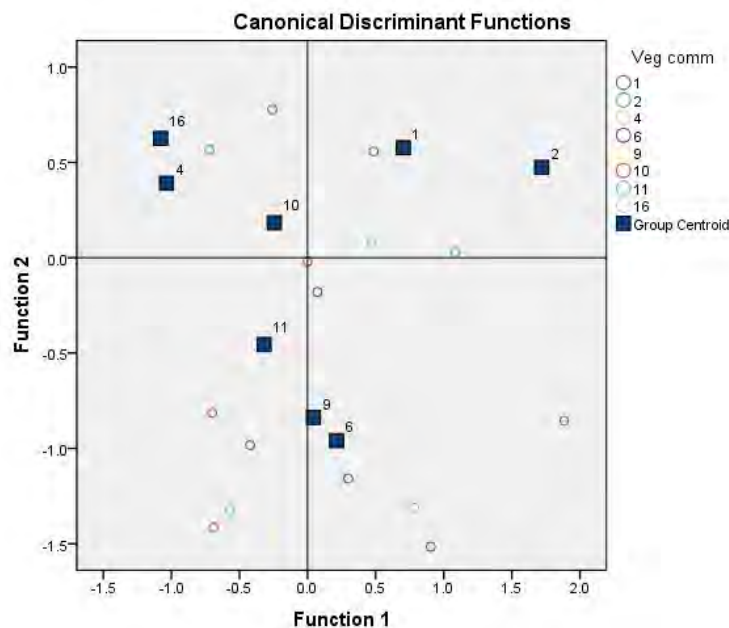


Figure 4-6 CDA Plot of Faunas in the Vegetation Communities when Compared on the Basis of the Species Richness Recorded at the Sampling Sites

Mammals

The species richness of mammals across the area was moderately high, increased greatly by the diversity of micro-chiropteran bats (insectivorous bats). Without bats, mammal species richness at all sites was low. The highest mammal species richness recorded at any site was 13 species at Site 8 (Figure 4-7, upper), while the lowest recorded was three species at site 3 during the wet season and three and four species at site 15 during the dry and wet seasons respectively. No mammals were recorded at six sites during the wet season survey (Figure 4-7, upper).



Mammal species richness at 10 sites was higher during the dry season than during the wet season. The reverse was true at two sites. Mammals were recorded only during the dry season at six sites and only during the wet season at one site. Mammals were recorded during both surveys at nine sites.

As with the pattern for all species (above), mammal species richness tended to be more evenly distributed among sites during the wet season than during the dry season.

The marked seasonal differences among mammal species richness at sites can be explained at least partly by the results of the anabat surveys. Bat sampling results were obtained for 15 of the 16 sites during the dry season (sampling failed at site 2; i.e. no micro-chiropteran bats were recorded at that site). During the wet season, bat sampling failed at seven of the 16 sites due to heavy rain. This is reflected in the lower mammal species richness at those sites (sites 3, 4, 8, 10, 11, 13 and 14).

The *Corymbia latifolia*, *Eucalyptus bigalerita* open woodlands (Vegetation Community 11, Sites 8 and 10) had the highest species richness, with 16 mammal species in total. All 16 species were detected during the dry season survey, and no mammals were recorded in this habitat type during the wet season survey. The *Eucalyptus bigalerita*, *E. spp.* open forest and *Eucalyptus tectifica* woodland (Vegetation Communities 2 and 9, Sites 3/9 and 7/11 respectively) also had high species richness, with 15 mammal species, again in the dry season.

No mammals were recorded in the *E. tintinnans*, *E. spp.*, *Erythrophleum chlorostachys* woodland (Vegetation Community 4; Sites 4 and 13) or the *Corymbia latifolia*, *Eucalyptus bigalerita* open woodland (Vegetation Community 11; Sites 8 and 10) during the wet season. This is almost certainly due to failed bat sampling at those sites.

The CDA results were not significant (Wilks' Lambda = 0.088, $\alpha > 0.25$). This is likely to have resulted from the high level of variability in results for individual sites across seasons (Figure 4-8).

Function 1 is influenced by all mammal sub-groups, with no sub-group correlated significantly with the axis. Function 1 explains approximately half (48.5%) of the variation in mammal species richness among vegetation communities (Appendix F; Analysis 2). Function 2 is strongly influenced by the species richness of bats and then non-native mammals. At least partly, this result reflects low bat numbers recorded at some sites due to failed bat sampling. In addition, the *Eucalyptus bigalerita*, *E. spp.* open forest (Vegetation Community 2) and the *Corymbia latifolia*, *Eucalyptus bigalerita* open woodland (Vegetation Community 11) had more non-native mammals recorded than sites in other communities, particularly *Eucalyptus tectifica* woodland / *E. tintinnans*, *E. spp.*, *Erythrophleum chlorostachys* woodland (Vegetation Community 16). Function 2 explains an additional 36.5% of the variation in mammal species richness among communities, and Functions 1 and 2 together explain 85% of variation in the data.

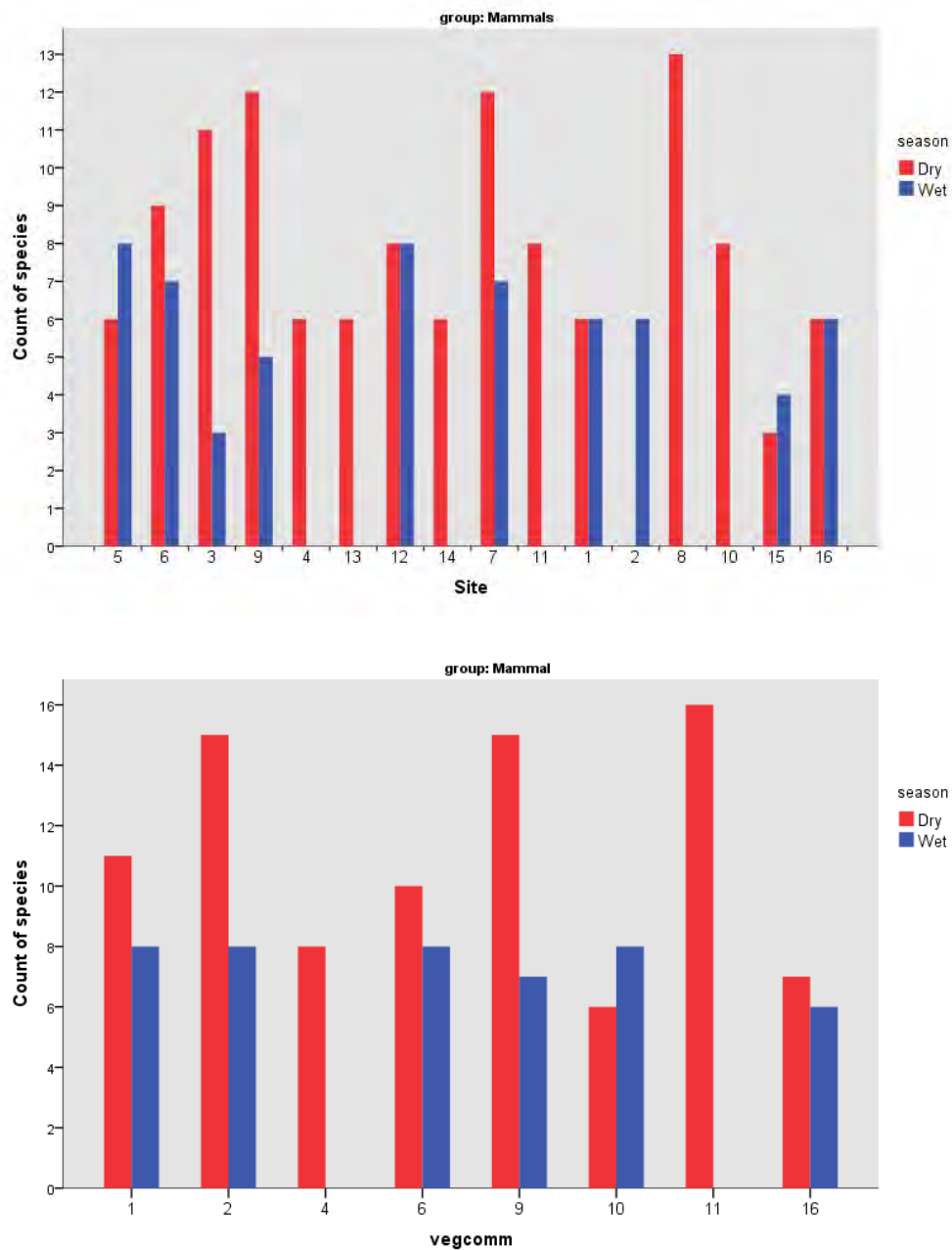


Figure 4-7 Species Richness of Mammals Recorded at Each Site (Upper) and in Each Vegetation Community (Lower) in Each Seasonal Survey

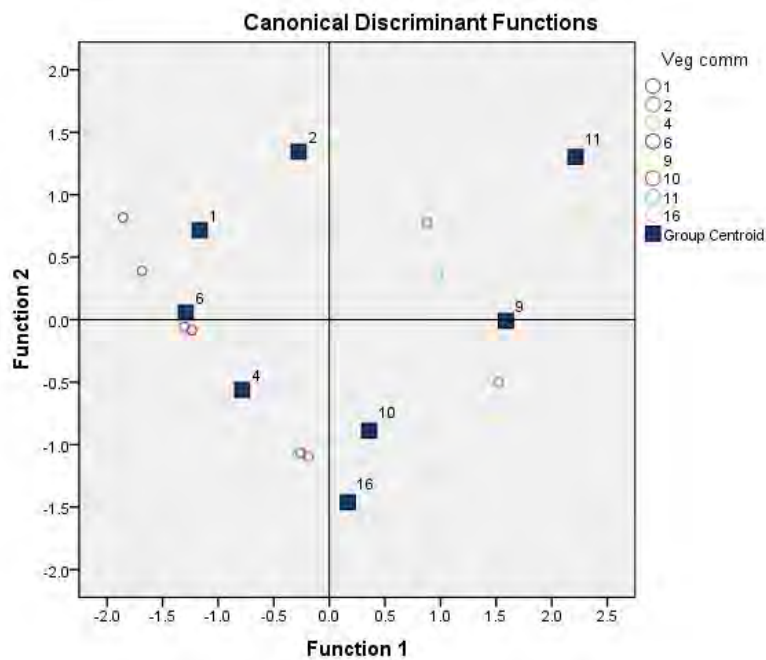


Figure 4-8 CDA Plot of the Mammal Fauna of Vegetation Communities when Compared on the Basis of Species Richnesses Recorded at Sites

Birds

More than 20 species were recorded at most sites, and more than 40 at some. The highest bird species richness recorded at any site was 51 species at Site 9 (*E. tectifera* woodland) in the dry season (Figure 4-9). The lowest diversity was fewer than 10 species at Site 4 (*E. tintinnans*, *E. spp.*, *Erythrophleum chlorostachys* woodland) in the dry season.

At eight sites, bird species richness was higher during the dry season than during the wet season, while the reverse was true for the other eight sites.

Two sites (Sites 15 and 16) had similar and relatively low bird species richness in the dry and wet seasons, while most other sites had far higher diversity in one season than the other. The largest difference was at Site 9 (*E. tectifera* woodland), where the wet season diversity was more than 30 species fewer than in the dry season. Site 8 (*C. latifolia*, *E. bigalerita* woodland) also had higher species richness in the dry season than in the wet season, with the wet season species richness being less than half that in the dry season. Sites 4 and 13 (*E. tintinnans*, *E. spp.*, *Erythrophleum chlorostachys* woodland) had twice as many bird species in the wet season as in the dry season.

The *E. bigalerita*, *E. spp.*, open forest (Vegetation Community 2, Sites 3 and 9) had the highest species richness, with more than 60 bird species in total. Species richness in this habitat was reduced by approximately one third during the wet season survey.

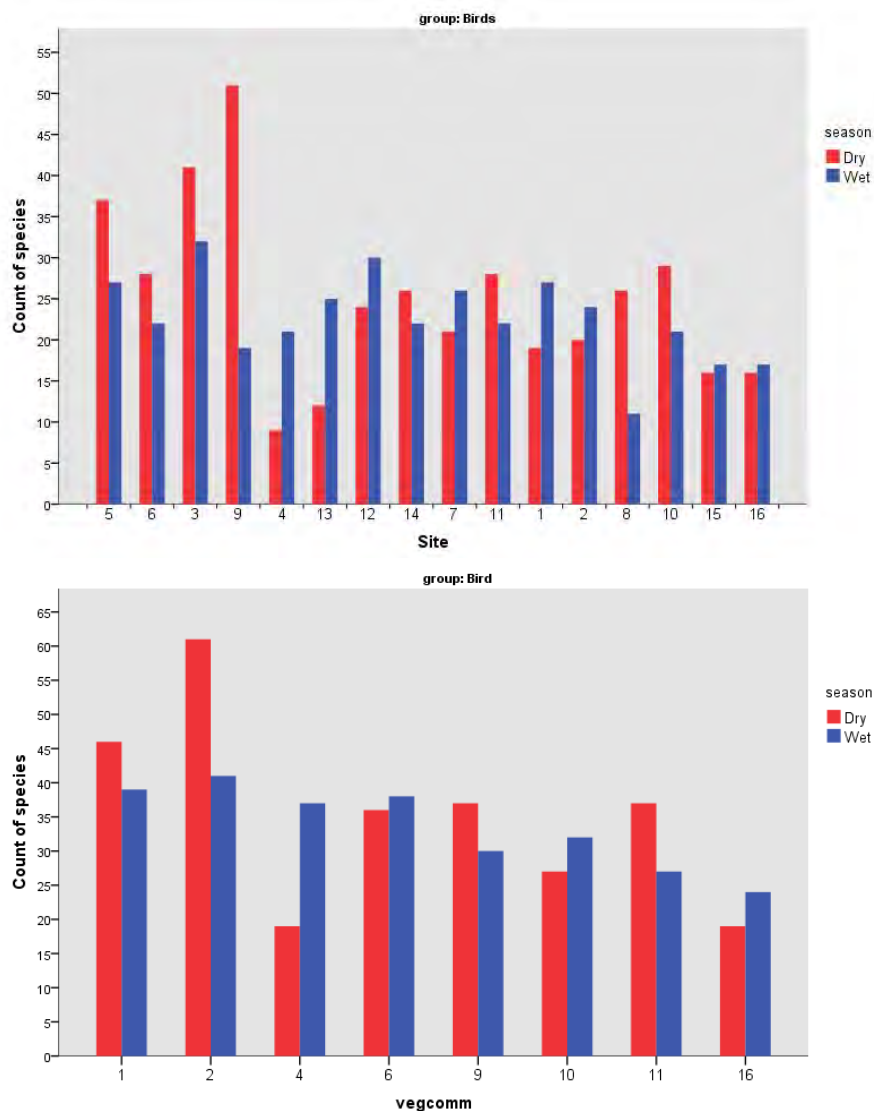


Figure 4-9 Species Richness of Birds Recorded at Each Site (Upper) and in Each Vegetation Community (Lower) in Each Seasonal Survey

The CDA results for birds were close to significant (Wilks' Lambda = 0.04, $\alpha \leq 0.10$). The Melaleuca forest birds (Vegetation Community 1; Sites 5 and 6) differed from the other faunas in its values of Function 1. Fauna in the *E. tectifica* woodland (Vegetation Community 9, Sites 7 and 11) also differed from other communities but at the opposite end of the Function 1 scale (Figure 4-10). Function 1 is primarily influenced by the number of raptor species (birds of prey) and explains just less than half (48.1%) of the variation in bird diversity among vegetation communities (Appendix F; Analysis 3). The Melaleuca woodland fauna had nine species of raptor, more than any other Vegetation Community. Community 9 (*E. tectifica* woodland) had none.

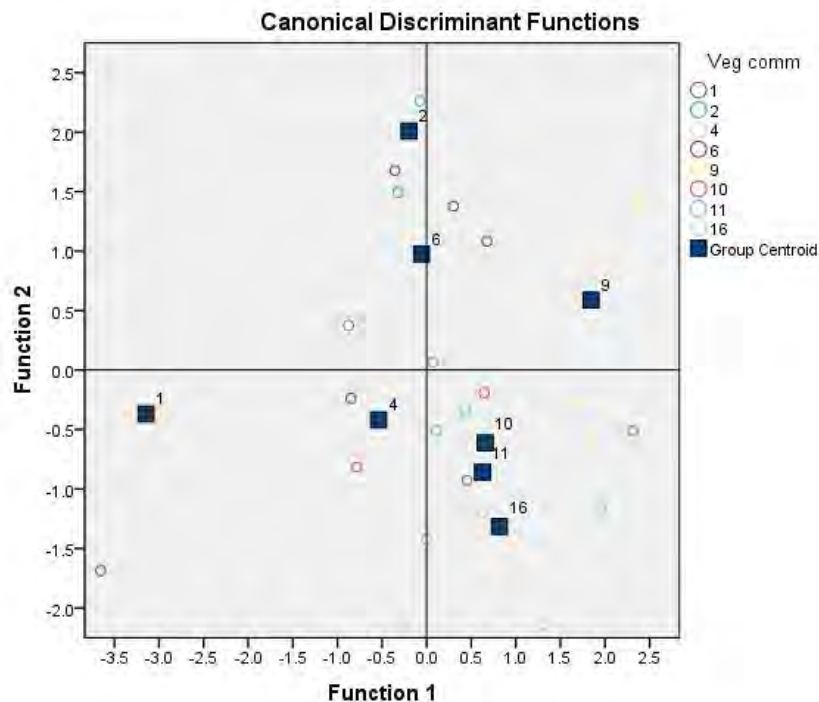


Figure 4-10 CDA Plot of the Faunas of the Vegetation Communities when Compared on the Basis of Number of Bird Species Recorded at Sites

The eucalypt riparian forest (Community 2, Sites 3 and 9) differed most from the others along Function 2, while the *E. tectifica*/*E. tintinnans* woodland (Community 16; Sites 15 and 16) bird fauna lay at the other end of that scale. Function 2 is strongly and equally influenced by species of finches and woodland birds, and explains an additional 27.0% of the variation in bird species richness among communities. The eucalypt riparian community had the highest species richness of woodland birds and finches, and the fauna of the *E. tectifica*/*E. tintinnans* woodland had lower numbers of woodland birds and no finches.

Functions 1 and 2 together explain 75% of variation in the data. The statistical significance of the results indicates that the bird faunas of the different vegetation types reasonably distinct.

Reptiles

No site recorded more than 12 reptile species in either the wet or dry season surveys. The highest reptile diversity recorded was 12 species at Sites 14 and 8 (*E. tintinnans* and *C. dichromophloia* woodland and *C. latifolia*, *E. bigalerita* open woodland respectively). Both counts were made during the dry season (Figure 4-11, upper). The lowest species richness was two species at the other *C. latifolia*, *E. bigalerita* open woodland site (Site 10, wet season). There were numerous site records of only three species during the wet season (Sites 5, 9, 14, 7 and 15) and at one site (Site 16) during the dry season.

Species richness was usually higher during the dry season than during the wet season. Only at one site (Site 16, *E. tectifica*/*E. tintinnans* woodland) was species richness higher in the wet season.

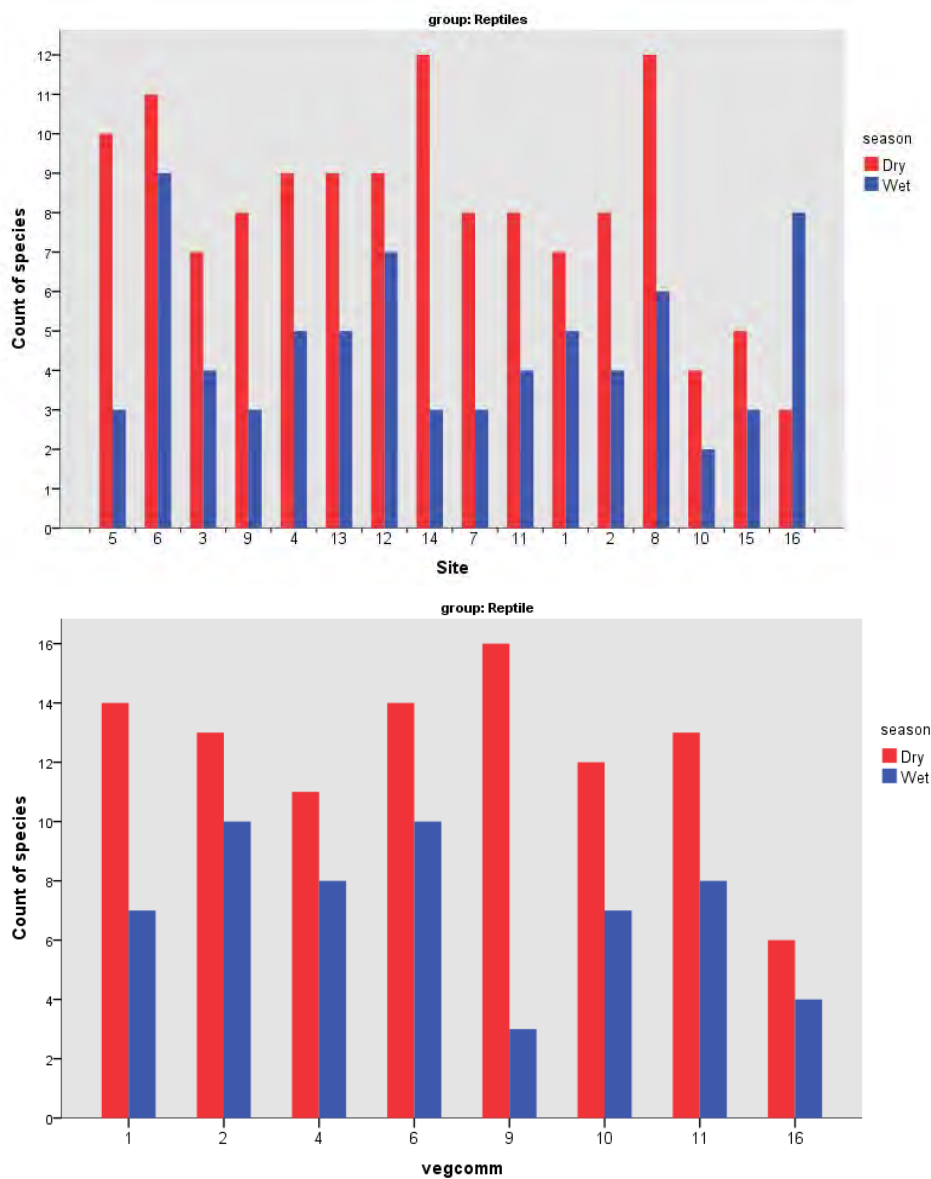


Figure 4-11 Species Richness of Reptiles Recorded at Each Site (Upper) and in Each Vegetation Community (Lower) in Each Seasonal Survey

E. tectifera woodland (Vegetation Community 9, Sites 7 and 11) had the highest species richness, with 16 reptile species recorded across the two seasons. Species richness in this vegetation type reduced to three species during the wet season survey; the largest seasonal change among reptiles. *E. tectifera*/*E. tintinnans* woodland (Vegetation Community 16, Sites 15 and 16) had the lowest number of reptile species.

The CDA results were significant (Wilks' Lambda = 0.097, $\alpha \leq 0.05$). Melaleuca forest (Community 1, Sites 5 and 6) and the eucalypt riparian forest (Community 2, Sites 3 and 9) differed most from the other vegetation types in their values for Function 1 (Figure 4-12). Function 1 is primarily influenced by species richness of monitors (also known as varanids or goannas). It explains more than half (52.4%) of the variation in reptile species richness among vegetation communities. No monitors were recorded in any of the four sites in communities 1 or 2, whereas at least one species of monitor was recorded in every other community.

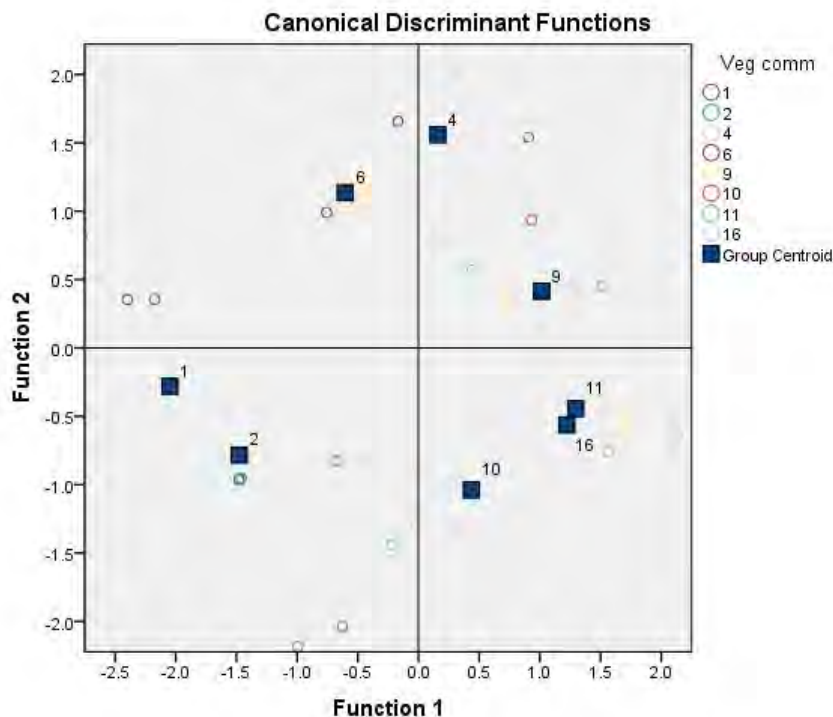


Figure 4-12 CDA Plot of the Faunas of Vegetation Communities when Compared on the Basis of Reptile Species Richnesses Recorded at Sites

E. tintinnans, *E. spp.*, *Erythrophleum chlorostachys* woodland (Vegetation Community 4, Sites 4 and 13) and *E. tintinnans*, *C. dichromophloia* woodland (Vegetation Community 6, Sites 12 and 14) differed most from the others along Function 2. *E. tectifera*, *C. confertiflora* woodland (Vegetation Community 10, Sites 1 and 2) lay at the other end of that scale. The sub-groups that had influenced Function 2 were monitors, dragons and geckoes, although no groups had a major influence alone. Function 2 explains an additional 29.0% of the variation in reptile diversity among communities.

Functions 1 and 2 together explain 81.5% of variation in the data. The statistical significance of the results indicates that the reptile faunas of the different vegetation types are reasonably distinct.

Amphibians

Three sites recorded 13 or more species in either the wet or dry season surveys. The highest number of amphibian species was 14 species at Site 9 (dry season, eucalypt riparian community) (Figure 4-13, upper). The lowest number of species was at Site 7 (*E. tectifera* woodland), where three species were recorded in the dry season and one species during the wet season.

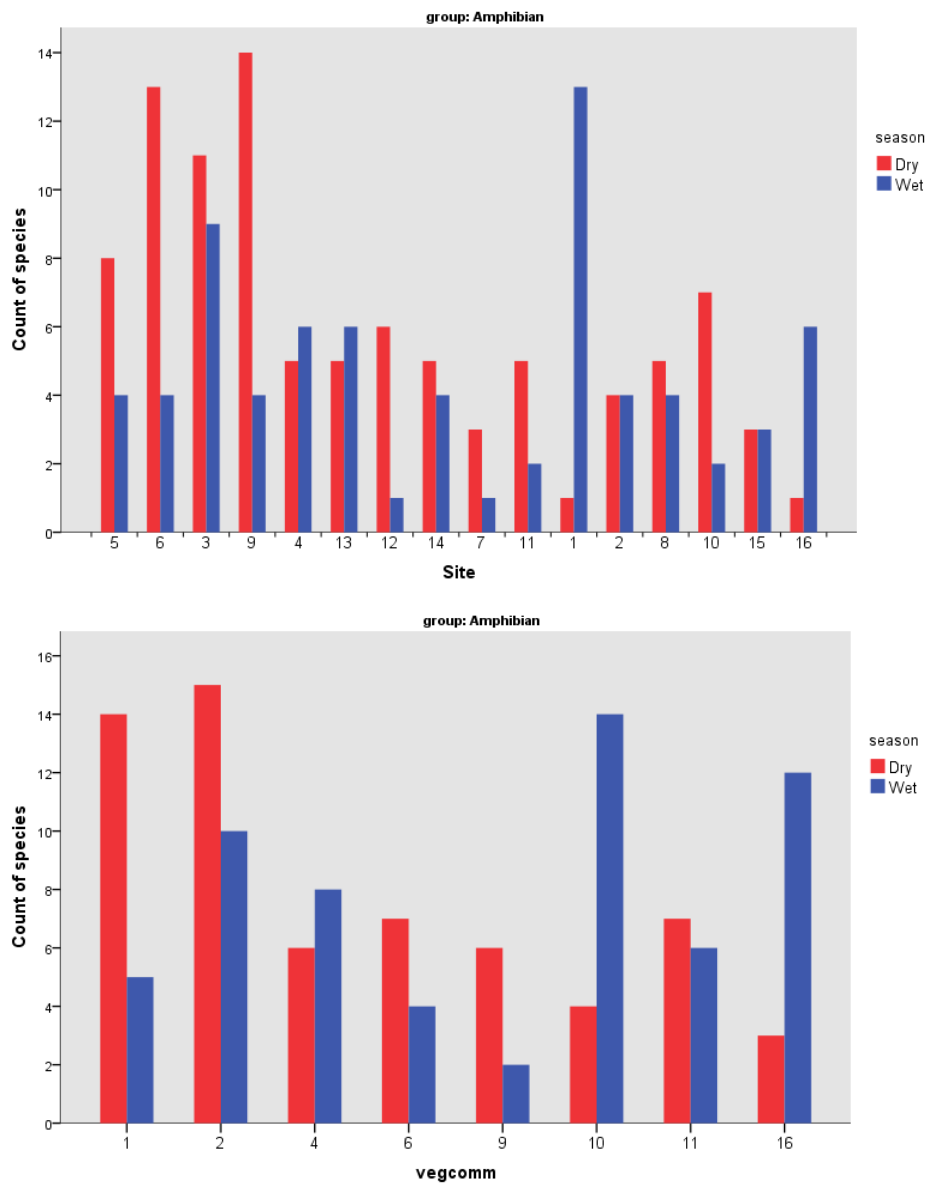


Figure 4-13 Species Richness of Amphibians Recorded at Each Site (Upper) and in Each Vegetation Community (Lower) in Each Seasonal Survey

Species richness varied between seasons. Amphibian diversity at six sites was higher in the dry season than in the wet season, while the reverse pattern occurred at two sites.

The riparian Melaleuca and eucalypt forests [Vegetation Communities 1 (Sites 5 and 6) and 2 (Sites 3 and 9)] had the highest amphibian species richness during the dry season, with 15 species in community 2. Wet season species richness was highest in *E. tectifica*, *C. confertiflora* woodland (Vegetation Community 10; Sites 1 and 2) and *E. tectifica*/*E. tintinnans* woodland (Vegetation community 16; Sites 15 and 16). These communities had the lowest species richness during the dry season.

The results of the CDA were significant (Wilks' Lambda = 0.299, $\alpha \leq 0.10$ (Appendix F, Analysis 5). Melaleuca forest (Vegetation Community 1, Sites 5 and 6) differed most from other communities in its values of Function 1. Function 1 is strongly and solely influenced by species of ground frogs and

explains more than half (55.4%) of the variation in amphibian species richness among vegetation communities. The amphibian fauna in the Melaleuca forest differs from most other communities by having higher numbers of ground frog species (eight species were recorded). At the other end of the scale, the *E.tintinnans*, *C. dichromophloia* woodland (Community 6, Sites 12 and 14) had the lowest diversity of ground frogs (two species). The introduced cane toad is included in the sub-group of ground frogs. This species was recorded at all sites over the course of the two surveys (13 sites during the dry season and 15 sites during the wet season).

The amphibian fauna of the eucalypt riparian forest (Community 2, Sites 3 and 9) differed most from the others along Function 2 (Figure 4-14). Function 2 is influenced by species richness of other frogs. Burrowing frogs have the major effect, followed by that of climbing frogs. Function 2 explains an additional 35.3% of the variation in amphibian species richness among communities.

Functions 1 and 2 together explain 90.7% of variation in the data. The statistical significance of the results indicates that the amphibian faunas of the different vegetation types reasonably distinct.

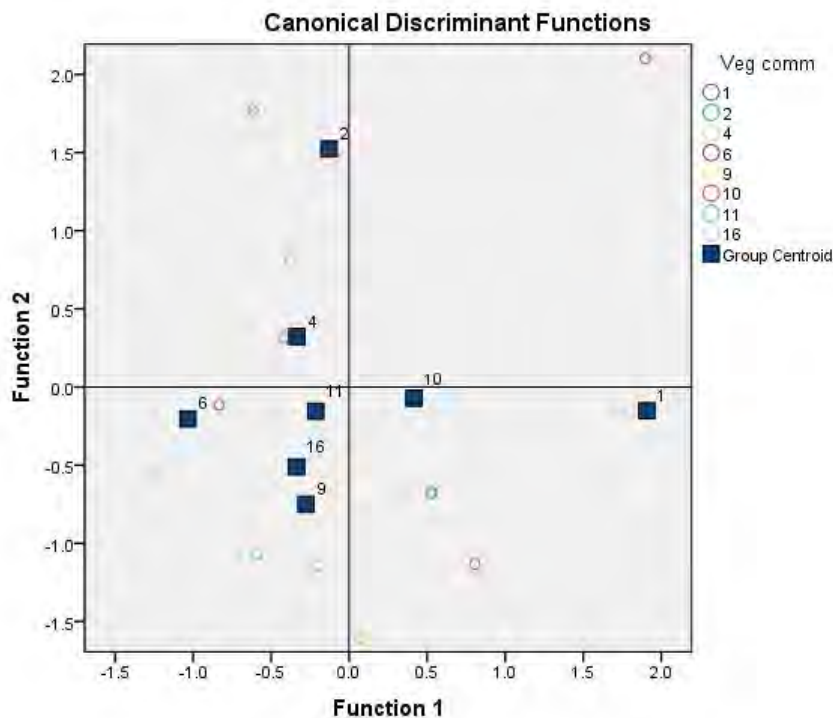


Figure 4-14 CDA Plot of the Faunas of the Vegetation Communities when Compared on the Basis of Amphibian Species Recorded at Sites

The relationship between habitat characteristics and fauna species richness (all species)

Multiple linear regression showed that fauna species richness (all species) at sites corresponded strongly with period since fire. Sites with evidence of more recent fire tended to have lower species richness ($r^2 = 0.546$; $\alpha < 0.01$) (Table 4-7). Detailed results are provided in Appendix F, Analysis 6a. No other habitat characteristic was identified in that model as having an influence on species richness.

When the regression model was repeated without period since fire as a variable, canopy height was identified as the next most influential variable ($r^2 = 0.272$; $\alpha < 0.05$) (Table 4-7; Appendix F, Analysis 6b). Sites with taller trees tended to have higher species richness.

When the four species groups (mammals, birds, reptiles and amphibians) were investigated separately, species richness of birds and amphibians (separate tests) showed the same pattern as for all fauna (Table 4-7, Appendix F, Analysis 8a and 10a, respectively). Sites with evidence of more recent fire tended to have lower species richness of birds ($r^2 = 0.571$; $\alpha < 0.01$) and lower richness of amphibians ($r^2 = 0.501$; $\alpha < 0.01$). When the regression models for both species groups were repeated without period since fire as a variable, canopy height was identified in both cases as the next most influential variable. Sites with taller trees tended to have higher richness of birds and amphibians (Table 4-7; Appendix F, Analysis 8b and 10b, respectively).

The regression model with forward stepwise entry of variables would not run for mammals or reptiles, indicating that no habitat characteristics corresponded strongly or significantly (using $\alpha < 0.1$) with species richness of those groups. To determine which of the variables had the greatest influence (albeit non-significant) on richness of those species groups, the regression models were run using backward stepwise removal of variables. For mammals, the model identified the most influential variables as being period since fire and canopy height (Table 4-7; Appendix F, Analysis 7), as was found independently for the regression models for all species, birds and amphibians. For reptiles, the model identified proportional canopy cover and proportional cover of vegetation less than 3m high as being the most influential (Table 4-7; Appendix F, Analysis 9), which differed from all other groups. Sites with higher proportional canopy cover and lower proportional cover of vegetation less than 3m high tended to have higher richness of reptiles.

Some of the assumptions that accompany linear regression models may have been violated to some degree by the data used. An inherent assumption of multiple regression is that all variables are independent of one another, which is unlikely to be true for our sites. For example, proportional cover of ground layer vegetation is likely to correlate strongly (and inversely) with proportional area of bare ground. Also, areas that have no evidence of recent fire are likely to have higher values of proportional cover of some layers of vegetation. Violation of assumptions may have altered the statistical results to some degree, but is considered unlikely to have altered the patterns found by using the regression analysis.

4.2 Results of the Threatened Species Surveys

4.2.1 Incidental Observations

Records were kept of incidental observations of all indigenous and introduced fauna during the threatened species surveys. A total of 140 indigenous terrestrial vertebrate fauna species were recorded during the threatened species fauna surveys (Appendix D), including six mammals, 117 birds, 14 reptiles and three amphibians. A total of four introduced fauna species including three mammals and one amphibian were recorded. A small number of observations were made of fauna that could not be identified to species (e.g., microchiropteran bats in flight, distant eyeshine from crocodiles, snake-eyed *Cryptoblepharus* skinks). These observations are shown in Appendix D but are not included in the species tallies.



Table 4-7 Summarised Results of Multiple Linear Regression Models Investigating Relationships between Fauna Species Richness and Habitat Characteristics

Model	R Square	Std. Error of the Estimate	Sum of Squares	df	F	Sig.	Strongest predictor/s
All fauna							
All habitat characteristics, forward stepwise entry of variables (6a)	.546	10.107	1723.509	1,14	16.871	.001	Period since fire
As above, excluding period since fire (6b)	.272	12.807	857.562	1,14	5.229	.038	Canopy height
Mammals							
All habitat characteristics, backward stepwise removal of variables (7)	-	-	-	-	-	> 0.1	Period since fire, Canopy height, % vegetation >3m high.
Birds							
All habitat characteristics, forward stepwise entry of variables (8a)	.571	5.910	650.003	1,14	18.612	.001	Period since fire
As above, excluding period since fire (8b)	.286	7.623	325.427	1,14	5.600	.033	Canopy height
Reptiles							
All habitat characteristics, backward stepwise removal of variables (9)	-	-	-	-	-	> 0.1	% canopy cover, % vegetation < 3m high, % bare ground.
Amphibians							
All habitat characteristics, forward stepwise entry of variables (10a)	.501	2.548	91.113	1,14	14.035	.002	Period since fire
As above, excluding period since fire (10b)	.356	2.893	64.812	1,14	7.743	.015	Canopy height



4.2.2 Threatened Species Observations

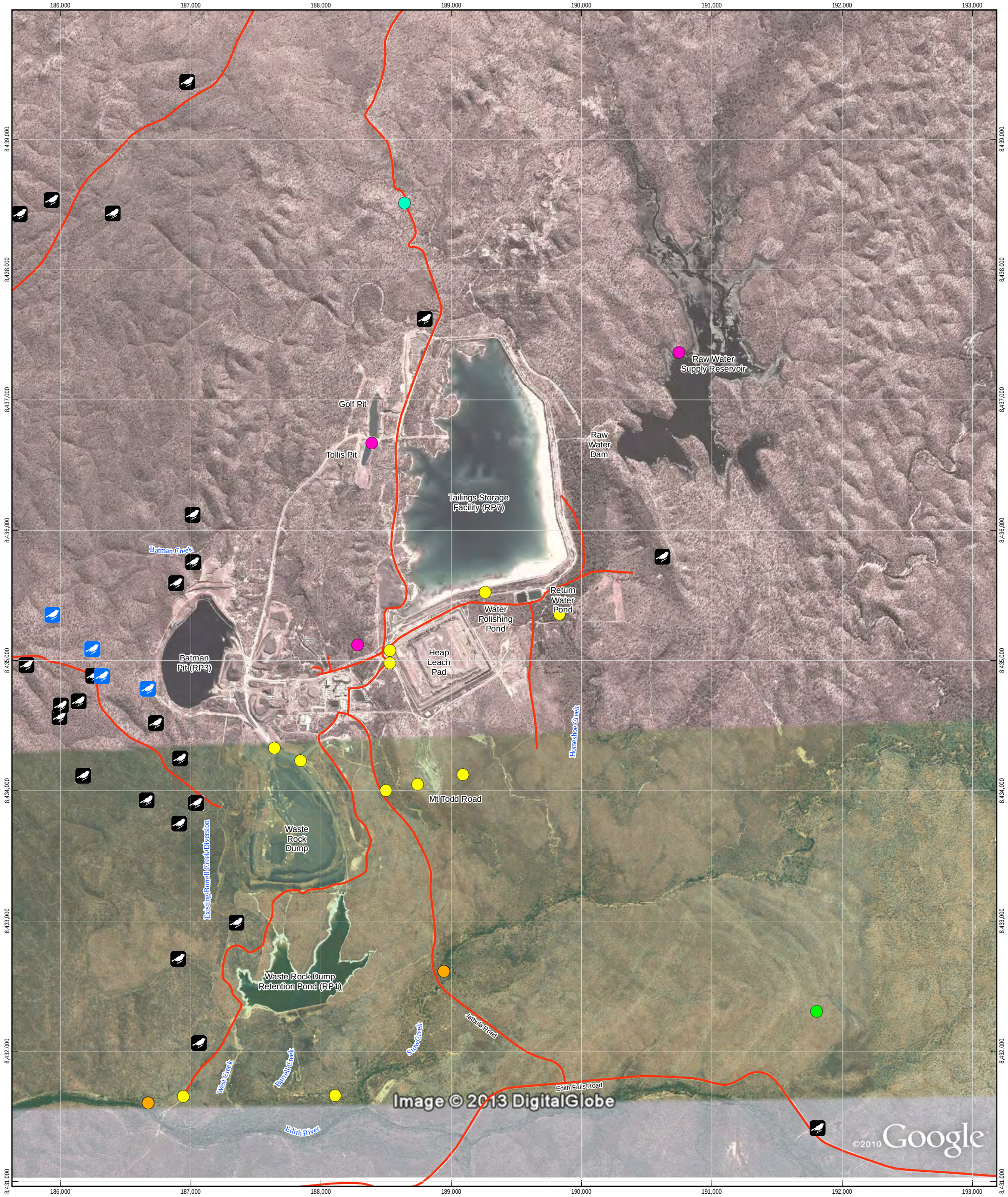
Observations of threatened species during the surveys are detailed below. Incidental observations of threatened species during dry and wet season baseline surveys were also recorded (Figure 4-15).

Gouldian finch (Erythrura gouldiae)

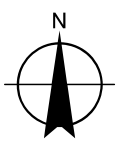
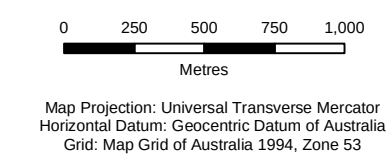
The Gouldian finch was recorded on six occasions during the threatened species survey in May 2011. It was not recorded during September 2012, or during the dry and wet season baseline surveys. 12 individual finches were observed in the Yinberrie Hills to the west of the Batman Pit on five separate occasions, with an additional 40-plus individuals observed adjacent to the Edith River along the Edith Falls Road (within the Yinberrie Hills population) (Table 4-8 and Photo 4-1).

Table 4-8 Gouldian Finch (*Erythrura gouldiae*) Observations from the Mt Todd Area during the Threatened Species Survey (May 2011)

Date	Coordinates	Location	No. birds/sex/comments
5/05/11	185938.788, 8435349.12	Yinberrie Hills	One red-faced adult female and one black-faced juvenile observed
5/05/11	186245.6162, 8435085.934	Yinberrie Hills	One red-faced male and black-faced female observed entering a hollow spout in a <i>Eucalyptus tintinnans</i> repeatedly and remaining inside for 2-5 minutes. Possible nesting tree.
5/05/11	186245.0802, 8435085.374	Yinberrie Hills	One red-faced male and black-faced female observed.
6/05/11	186318.3198, 8434878.306	Yinberrie Hills	One red-faced male and two black-faced females seen investigating a range of hollows in <i>E. tintinnans</i> trees.
6/05/11	186670.2937, 8434781.896	Yinberrie Hills	One black-faced male and two black-faced females seen investigating a range of hollows in <i>E. tintinnans</i> trees near the western edge of the Batman Pit.
7/05/11	185102.5443, 8429551.96	Edith River	Large feeding group of birds observed, including ≥20 <i>E. gouldiae</i> (possibly up to 40 or 50). Other birds included hooded parrot, long-tailed finch, masked finch, double-barred finch and diamond dove.
10/05/11	185102.5443, 8429551.96	Edith River	Large group of approximately 20 Gouldian finches seen resting in tree and shrub canopy.



- LEGEND**
- | | | |
|--|---|--|
|  Gouldian finch Records (GHD) |  Crested shrike-tit (Northern) (possible call heard) |  Pale field-rat |
|  Gouldian finch Records (NRETAS) |  Mertens' water monitor |  Access Roads |
|  Australian bustard |  Painted honeyeater | |



Vista Gold Australia Pty Ltd
Mt Todd Gold Project

Job Number 43-21801
Revision 1
Date 28 May 2013

**Mt Todd Mine Site Targeted
Threatened Species Survey Effort**

Figure 4-15



Photo 4-1 Adult male Gouldian finch (*Erythrura gouldiae*) (red-faced form) observed west of the Batman Pit, Mt Todd. Source: Alex Holmes GHD

Australian bustard (Ardeotis australis)

Ten separate observations of Australian bustard (formerly listed as *vulnerable* under the TPWC Act, now listed as *near threatened*) were recorded during the threatened species and baseline surveys. The majority of observations were made from vehicles during vehicle-based surveys around the Mine Site (threatened species surveys), or as incidental observations (baseline surveys). A total of nineteen Australian bustards were documented, with the majority of individuals detected in and around the Waste Rock Dump and Heap Leach Pad (Table 4-9 and Photo 4-2). It is impossible to determine whether the birds observed were repeated observations of the same individuals or single observations of larger numbers of individuals.



Table 4-9 Australian Bustard (*Ardeotis australis*) Observations from the Mt Todd Area

Date	Coordinates	Location	No. birds/sex/comments
May 2011 – Threatened species survey			
5 May	188528, 8434980	Heap Leach Pad	One male <i>A. australis</i> observed beside the road adjacent to the Heap Leach Pad.
5 May	187643, 8434328	Waste Rock Dump	Two female <i>A. australis</i> flew over the existing processing plant from the east and landed on the Waste Rock Dump. One male <i>A. australis</i> nearby.
6 May	187844, 8434228	Waste Rock Dump	One male <i>A. australis</i> observed beside the road at the summit of the Waste Rock Dump, may have been displaying for the two females reported above.
6 May	188529, 843474	Heap Leach Pad	One male and one female <i>A. australis</i> observed at the base of the Heap Leach Pad.
7 May	189261, 8435522	Tailings Storage Facility (TSF1)	One male and two female <i>A. australis</i> observed at the summit of the Tailings Storage Facility (TSF1).
November 2011 – Dry season survey			
2 Nov	188742, 8434048	South of Heap Leach Pad	One individual observed near fauna site 7.
3 Nov	188108, 8431659	South of Waste Rock Dump Retention Pond	One individual observed between fauna sites 4 and 5/6.
5 Nov	189830, 8435352	South of Return Water Pond	One individual observed near fauna site 9.
February 2012 – Wet season survey			
25 Feb	189089, 8434121	South of Heap Leach Pad	One male and one female observed beside road, between fauna sites 7 and 8.
28 Feb	186944, 8431654	Waste Rock Dump Retention Pond	Three individuals observed beside road near fauna sites 5/6.
September 2012 – Threatened species survey			
18 Sept	188500, 8434000	Site sign-in point	Three individuals observed flying overhead.



Photo 4-2 Adult male Australian bustard (*Ardeotis australis*) observed on waste rock dump, Mt Todd. Source: Alex Holmes GHD

Mertens' water monitor (Varanus mertensi)

At least three records of Mertens' water monitor were made during the threatened species and baseline surveys at the Mine Site (Table 4-2). One observation was made at the Tollis Pit in the north of the Mt Todd Mine Site during the May 2011 threatened species survey. A large individual was observed potentially foraging in the vicinity of the Mt Todd mine workshop during the wet season survey (February 2011) (Photo 4-3). Another individual was observed in the RWD during the September 2012 threatened species survey. A fourth individual (not confirmed) was potentially heard in September 2012 dropping into the water from the rocky shoreline on the east side of the RWD.



Table 4-10 Mertens' water monitor (*Varanus mertensi*) observations from the Mt Todd area

Date	Coordinates	Location	Comments
May 2011 – Threatened species survey			
5 May	188390, 8436667	Tollis Pit	One individual observed basking on edge of Tollis Pit.
September 2012 – Threatened species survey			
18 Sept	190747.928, 8431366.565	RWD (west side)	Large adult observed moving into the water. Monitor swam out to middle of lake prior to submerging.
February 2012 – Wet season survey			
28 Feb	188281, 8435117	Mt Todd mine workshop	One large individual observed moving past mine workshop and over track towards accommodation. Individual appeared to be foraging.



Photo 4-3 Mertens' water monitor (*Varanus mertensi*) observed at mine workshop, Mt Todd.
Source: Alex Holmes GHD

Crested shrike-tit (northern) (Falcunculus frontatus whitei)

Two unconfirmed detections of crested shrike-tit (northern) were made during the dry season surveys (November 2011). Both birds were heard and not seen. The possible detections were made at fauna sites 3 and 16, on 15 November 2011 (Table 4-11).

Table 4-11 Crested shrike-tit (northern) (*Falcunculus frontatus whitei*) observations from the Mt Todd area

Date	Coordinates	Location	Comments
November 2011 – Dry season survey			
3 Nov	188942, 8432614	Site 3	Call heard, however individual crested shrike-tit not observed despite searching
4 Nov	191804, 8432305	Site 16	Call heard, however individual crested shrike-tit not observed despite searching

Pale field-rat (Ratus tunneyi)

This species was recorded on six occasions during the dry and wet season baseline surveys at sites 3 and 5, both adjacent to creeklines. Animals were caught in baited Elliot traps.

Table 4-12 Pale field-rat (*Ratus tunneyi*) observations from the Mt Todd area

Date	Coordinates	Location	Comments
November 2011 – Dry season survey			
4-Nov	188942, 8432614	Site 3	Trapped in Elliot trap
4-Nov	186673, 8431603	Site 5	Trapped in Elliot trap
6-Nov	188942, 8432614	Site 3	Trapped in Elliot trap
6-Nov	186673, 8431603	Site 5	Trapped in Elliot trap
November 2011 – Wet season survey			
25-Feb	186673, 8431603	Site 5	Trapped in Elliot trap
27-Feb	186673, 8431603	Site 5	Trapped in Elliot trap

Painted honeyeater (Grantiella picta)

This species was recorded once during the dry season survey at site 14. This is just the second record for this species in the Katherine area, with the majority of the very few known records coming from the eastern parts of the Top End.



Table 4-13 Painted honeyeater (*Grantiella picta*) observations from the Mt Todd area

Date	Coordinates	Location	Comments
November – Dry season survey			
7-Nov	188641, 8438512	Site 14	Call heard and seen

Other threatened species

The following threatened species were not recorded during the targeted threatened species surveys or the baseline wet and dry season surveys:

- ▶ northern quoll (*Dasyurus hallucatus*);
- ▶ partridge pigeon (*Geophaps smithii*);
- ▶ red goshawk (*Erythrorhynchus radiatus*);
- ▶ grey falcon (*Falco hypoleucos*);
- ▶ masked owl (*Tyto novaehollandiae kimberlii*);
- ▶ Mitchell's water monitor (*Varanus mitchelli*); and
- ▶ yellow-spotted monitor (*Varanus panoptes*).

5. Discussion

5.1 Fauna of the Study Area - Overview

The numbers of fauna species detected during the baseline and threatened species targeted surveys were high. A total of 245 species were detected, including 145 birds, 32 mammals, 48 reptiles and 20 amphibians (Table 5-1). The species accumulation curves for the baseline surveys presented in section 4.1.3 show that additional survey effort in the area would likely result in the slow and gradual accumulation of relatively few additional species.

Table 5-1 Species of Vertebrate Recorded from the Study Area and Adjacent 10km of Surrounding Land (DLRM Atlas, Lane *et al.* 1990) and this Study (GHD 2011/2012)

Source Group	GHD 2011/2012	Lane <i>et al.</i> 1990	DLRM Atlas	Total
Mammals	32 (5*)	32 (3*)	42 (6*)	50 (7*)
Birds	145	129	183	197
Reptiles	48	44	64	77
Amphibians	20 (1*)	14	14 (1*)	22 (1*)
Total	245 (6*)	219 (3*)	303 (7*)	346 (8*)

* = non-native species included in cell total

5.2 Fauna Diversity Patterns

In the seasonal baseline surveys, more species were detected during the dry season than the wet season, but the wet season species counts were possibly underestimated due to survey constraints, mainly caused by difficulties associated with inclement weather (e.g. failed anabat sampling, reduced site access, site flooding leading to ineffective traps).

The riparian sites in *Eucalyptus* and *Melaleuca* forest/woodland tended to have higher diversity than other sites, particularly during the dry season survey. Presumably, this reflects at least two driving influences: 1) fauna tend to rely on water for survival, and 2) fauna habitat tends to rely on water. Water is found more reliably in riparian habitats, particularly in dry season. The lowest diversity was recorded in open *Eucalyptus tintinnans*, *E. spp.*, *Erythrophleum chlorostachys* woodland and *E. tectifica/E.tintinnans*, *E. spp.*, and *Erythrophleum chlorostachys* woodland. One of the primary differences between these habitats at the time of survey was the cover of ground vegetation. Riparian sites tended to have abundant ground layer vegetation, while the Eucalypt woodland in the stony hills tended to have a very sparse layer, mainly as a result of recent fire.

Notably, fire was identified as the most powerful indicator of species richness for all fauna groups except reptiles. Lower species richness was strongly associated with evidence of more recent fire. Our data do not allow strong conclusions to be drawn. The habitat attributes were rough field estimates (i.e. field estimations of fire frequency), and there was potential for confounded variables.



At most sites, mammal diversity was higher during the dry season than during the wet season. Vegetation communities tended to have a similar complement of mammals.

One of the most interesting results obtained through this survey is the extremely low abundance and relatively low diversity of non-volant mammals (i.e., not bats), particularly small and medium-sized mammals. We undertook 2880 Elliot trap-nights and 576 cage trap-nights for a capture success of 10 individuals of small ground-dwelling mammals, which is extremely low given the survey effort.

Bird diversity was high in both seasons, but diversity at any particular site changed from season to season, most likely as a result of water availability. Riparian sites had a very high number of bird species and woodland sites had far fewer species in the wet season. This pattern evened out in the wet season. Bird diversity was the foremost influence on vertebrate diversity patterns among vegetation communities. The riparian communities and *E. tintinnans* woodland types differed most in terms of bird diversity. The riparian communities had higher diversity of woodland birds and finches, while the *E. tintinnans* woodland types (particularly vegetation community 16; sites 15 and 16) had lower diversity of woodland birds and no finches recorded.

The targeted threatened species survey to the Raw Water Dam in September 2012 resulted in 15 species of birds being detected at the Mt Todd site for the first time in this project, six of which were not recorded during previous studies (Lane *et al.* 1990; NT Fauna Atlas). This highlights the habitat specificity of those species - most of the new species were waterbirds (e.g., cormorants and egrets) or shorebirds (e.g., sandpipers), and not likely to occur at any of the woodland/riparian sites visited for the seasonal baseline surveys.

The prevailing pattern among reptiles during the baseline surveys was that diversity was markedly higher during the dry season than during the wet season. Diversity of monitors drove the differences among vegetation communities. No other strong pattern in reptile diversity appeared to define the communities, which indicates that the differences among communities are complex, being made up of patterns in more than one reptile sub-group. Few large varanids were recorded during any of the three GHD survey periods, despite a relatively high diversity of varanids being recorded, and numerous individuals. Two Mertens' water monitors were recorded.

The prevailing pattern among amphibians was that diversity varied greatly between seasons. At six sites, amphibian diversity was far higher in the dry season than in the wet season, while the reverse pattern occurred at two sites.

Riparian habitats had the highest amphibian diversity during the dry season, presumably because that is where the water is. Seasonally flooded woodland sites (Sites 1, 2, 15 and 16) had by far the highest amphibian diversity in the wet season, having had the lowest diversity of all habitats during the dry season.

The amphibian diversity recorded by GHD during this survey (20 species) exceeds the number of species recorded historically for the Pine Creek area (14 species; DLRM Fauna Atlas). This suggests that the Mt Todd mine site provides favourable habitat for frogs, and secondly that the area has not been adequately surveyed for amphibian fauna. GHD recorded 20 species purely because a broad range of habitats was sampled at an appropriate time of year.

One species of amphibian is listed under the EPBC act as an 'invasive' non-native species (cane toad, *Rhinella marina*). This species was not recorded during the original fauna survey at this mine site (Lane *et al.* 1990), but is now the most common amphibian found.



5.3 Results of this Survey Compared with Previous Surveys/Information

5.3.1 Comparison with the Results of Lane *et al.* (1990)

The recorded species provide a sound description of the fauna at the Mt Todd Mine Site (Table 5-1). A comparable survey by Lane *et al.* (1990) recorded similar species counts in all fauna groups, except perhaps amphibians (discussed in more detail below).

The species counts for the area generated by the DLRM Fauna Atlas (and thus the overall total species list) are significantly higher than those recorded during this survey or by Lane *et al.* (1990). The DLRM lists comprise observations recorded from multiple sources over a long period. Many of the species are likely to be recorded rarely, so would not be expected to turn up in every survey.

The Lane *et al.* (1990) fauna survey of the Mt Todd site was before the mine had been constructed and operated, and before the arrival of the cane toad. That assessment provides an important benchmark for comparison with this one.

Lane *et al.* (1990) conducted two survey visits (2-9 December 1989 and 19-24 March 1990) resulting in detection of 219 terrestrial vertebrate fauna species. This total is marginally less than the 245 species recorded during the four visits by GHD. General survey effort for the two studies was broadly similar. Lane *et al.* (1990) conducted surveys over 13 nights, while GHD had 16 nights of survey. The studies differed in numerous ways in survey methods and effort applied to each fauna group. GHD sampled all fauna groups in eight different vegetation communities, and recorded additional species using wetlands associated with the Raw Water Dam. Lane *et al.* (1990) sampled five different habitats (rather than vegetation communities) for all fauna groups except birds, for which 12 different 'vegetation communities' were sampled.

GHD had a generally higher level of survey effort for each trapping/survey technique. This is particularly evident for Elliot trapping for small mammals; GHD's survey effort of 2540 Elliot trap-nights was more than twice the 980 Elliot trap-nights completed by Lane *et al.* (1990). Despite that, GHD recorded fewer small mammal species.

Each study used techniques that were not used in the other study, which is likely to have resulted in different species being detected. For example, to sample bats, Lane *et al.* (1990) employed a broader range of techniques than GHD (i.e. harp traps, mist nest, triplines, inspecting mines, investigating caves) and recorded 15 bat species (including fruit bats and micro-bats). GHD used anabat call detectors and detected 18 species of micro-bat (and two fruit bat species during other searches). In part, this reflects the recent technological developments that aid modern fauna surveys – acoustic recording, analysis and species identification for bats were not widely available in 1990. However, there were bat species detected by Lane *et al.* that were not detected by GHD (four species). Use of multiple sampling methods for bats is required to detect the full complement of species in the area. The four species not detected by GHD during the present surveys may persist in the Mt Todd area and may have been detectable using techniques such as harp and mist netting.

Lane *et al.* (1990) conducted a broad range of aquatic sampling techniques (surveying dams for birds, snorkelling deep pools for aquatic species, watching waterholes for turtles). These methods resulted in that study recording a greater suite of waterbirds and other water-dependent species. The targeted threatened species survey by GHD in September 2012 resulted in six wetland/waterbird/shorebird species that had not been recorded for Mt Todd or the Pine Creek Bioregion during previous studies



(Lane *et al* 1990; NT Fauna Atlas). Aquatic species were not part of this assessment but were targeted in a separate specialist study (GHD 2013c).

5.3.2 Possible Decline in Small Mammal Species

A number of small mammal species recorded by Lane *et al.* (1990) were not recorded by GHD. This may be at least partly because GHD's survey focussed on a smaller area and did not include the diversity of habitats that the 1990 survey did, even though there was some overlap in the habitats sampled during both surveys. Unlike Lane *et al.* (1990), GHD did not sample fauna in granite outcrops, mineshafts or natural caves. Although GHD sampled riparian areas and the Raw Water Dam, no time was spent sampling the waterways themselves. Species such as the black-footed tree-rat (*Mesembriomys gouldii*), and common rock-rat (*Zyzomys argurus*), which tend to occur in specialised habitats, may have been recorded in this survey had the study area been broadened. Species of small mammal less dependent on specific habitats, such as the northern short-tailed mouse (*Leggadina lakedownensis*) and red-cheeked dunnart (*Sminthopsis virginiae*), should have been recorded in the study area sampled by GHD. Their apparent absence is notable, and may reflect reports of declines in the NT's Top End small mammal fauna (Woinarski *et al.* 2001; 2010). Alternatively it may have resulted from a low probability of capture possibly caused by low population densities. Lane *et al.* (1990) recorded only one capture of each of the two species. Suggested reasons for declines in small mammal numbers are inappropriate fire regime, predation by feral cats and invasion by cane toads (Woinarski *et al.* 2010).

5.3.3 Possible Consequences of the Cane Toad Invasion

One obvious difference between the 1990 survey and the current assessment is the presence of the cane toad (*Rhinella marina*) in 2011/12. The cane toad is reported to have first arrived in the NT in 1982-3 (Freeland and Martin 1985). It is unlikely to have reached the Mt Todd area until the early 2000s, well after the Lane *et al.* (1990) surveys. The toad arrived in southern Kakadu National Park in 2001. Its arrival date at Mt Todd is unknown, but expected is to have been after this date.

There is little evidence to suggest that cane toads have profound effects on native fauna species diversity and abundance. One of the main potential threats posed by cane toads is to native fauna that attempt to eat them. All life stages of the cane toad are highly toxic and have the potential to impact on a broad array of wildlife (Freeland 1984). The biological effects, including lethal toxic ingestion, caused by cane toads are listed as a key threatening process under the EPBC Act (DSEWPaC 2012). A number of other possible impacts have been proposed: competition for habitat, shelter or food, cane toad predation on native species (Freeland 1984).

There is however no evidence of impacts on native frog communities (e.g. Freeland and Kerin 1986; Hagman and Shine 2006; Crossland *et al.* 2008), snakes are either unaffected, avoid toads or evolve not to eat toads (Freeland 2004; Phillips and Shine 2007), freshwater crocodiles are reported to successfully eat cane toads although there are reports of some deaths during the period of cane toad invasion (Freeland 2004); and populations of large-bodied monitors decline then evolve to avoid eating cane toads (Freeland 2004; Griffiths and McKay 2007). The only mammal demonstrated to have been impacted by the cane toad invasion, the northern quoll (Woinarski *et al.* 2008), is known to survive in its primary habitat, namely rugged rocky areas such as sandstone escarpments (Woinarski *et al.* 2008). There are no known significant impacts on populations of bird, fish, or lizard species other than large-bodied monitors (Freeland 2004).



The only known possible extinction caused by the cane toad is that of a species of proteocephalid tapeworm residing in the Children's pythons' intestines when adult, and in native frogs when a larva (Freeland 1994).

Lane *et al.* (1990) recorded 44 reptile species from the Mt Todd area, while GHD recorded 48 in 2011/2012. This suggests that the reptile diversity at the Mine Site is unlikely to have changed significantly since 1990, and that the arrival of the cane toad has not caused a marked decline in reptiles. The possible exceptions are the yellow-spotted monitor *Varanus panoptes*, Mitchell's water monitor *Varanus mitchelli* and Goulds' monitor *Varanus goudii* which were not detected by GHD in 2011/12. These species are likely to undergo evolutionary change and a population resurgence (Freeland 2004; Griffiths and McKay 2006).

5.3.4 Effects of Weather on the Results

The seasonal weather conditions experienced by Lane *et al.* (1990) and GHD (during the baseline surveys) differed little. In the dry-season both surveys experienced heavy rain either during or leading up to the survey. No rainfall had fallen at the site for at least three weeks leading up to the Lane *et al.* (1990) wet season survey. There was a light shower on the last day and some afternoon build up. Little rain fell. GHD's wet season survey was very wet. Some sites (mainly near waterways) became completely or partially inundated and/or inaccessible. An increase in water availability during the wet season may result in fauna dispersing over a broader area, and so lower detection rates for some species (i.e. reduced reliability and hence density of fauna near permanent water sources resulting in reduced likelihood of trapping, even if species are present in the study area). Inundation of fauna sampling sites rendered trapping methods such as pitfall traps ineffective, possibly reducing the diversity and abundance of fauna recorded during the wet season.

5.3.5 Effects of Fire on the Results

Some of the survey sites (particularly the *Eucalyptus tectifica* woodland / *E. tintinnans*, *E. spp.*, *Erythrophleum chlorostachys* woodland sites in the far east; Sites 15 and 16) had burned immediately prior to GHD's November 2011 survey (see photo of site 16 in Table 2-1). Nearly all understorey vegetation was gone from some sites, and canopy foliage was affected at some sites, possibly indicating a hot burn. The availability of ground cover vegetation (as fauna habitat) at fire-affected sites was very sparse. Species richness and fauna abundance may have been reduced by fire at affected sites. No mention of fire is apparent during or preceding the Lane *et al.* (1990) dry season survey.

5.3.6 Effects of Sampling

Some differences observed between the surveys are likely to be purely due to chance, especially for species that naturally occur in low densities and/or are very cryptic [e.g. chameleon dragon (*Chelosania brunnea*), northern death adder (*Acanthopis praelongus*), northern bandy bandy (*Vermicalla multifasciata*), and grey falcon (*Falco hypoleucos*)].

5.4 Threatened species

5.4.1 Gouldian Finch (*Erythrura gouldiae*)

Results of the May 2011 threatened species survey demonstrate that the Gouldian finch is likely to continue to breed in close proximity to the Batman Pit (within 100 to 200m). The observation of >50 Gouldian finches during that survey represents approximately 20% of the total estimated Yinberrie Hills population (250 birds; O'Malley 2005). Observing good numbers of this species during a brief one-week survey (May 2011) suggests that the Yinberrie Hills at the time of the survey continues to support a population of this species, with several sub-adult finches observed within the group of predominantly adult finches. This supports the results of DLRM's ongoing monitoring program which has detected no decline in Gouldian finch number.

This survey documented the presence of a possible nest in the vicinity of the existing Batman Pit, with a pair of Gouldian finches repeatedly visiting the same hollow and disappearing inside for a period of two to five minutes at a time (see Photo 5-1).

Impacts of the proposed Mt Todd mine expansion on Gouldian finch are discussed in section 6 below.



Photo 5-1 Male Gouldian finch (*Erythrura gouldiae*) visiting possible nest hollow. Source: Alex Holmes GHD

5.4.2 Northern Quoll (*Dasyurus hallucatus*)

The northern quoll is likely to have been present in a range of habitats across the Mine Site prior to the arrival of the cane toad. Lane *et al.* (1990) reported "scats and active animals in various habitats" during both surveys and trapped individuals during the 1990 survey.



Despite the use of remote fauna cameras, cage traps and suitable bait, no quolls were recorded by GHD. Woinarski *et al.* (2008) showed that following cane toad invasion northern quolls are more likely to be found in habitats with steep slopes, shallower soils, many rocks (particularly large rocks, boulders and outcrops) and limited fire disturbance. Habitats fitting this description were not present in the Mine Site footprint. The only outcrop located (two cameras set up at this location, M4 and 4S) was small in area and not connected to other outcropping.

The failure to detect northern quolls in 2011/2012 does not indicate the species' absence from Mt Todd. Quolls are secretive and can remain undetected in trapping surveys. The accompanying absence of habitat likely to support northern quolls following cane toad invasion (i.e. rocky outcrops) suggests that this species may not be present in immediate vicinity of the Mt Todd Mine Site. However, it may continue to persist in the broader Yinberrie Hills locality.

5.4.3 Crested Shrike-tit (Northern) (*Falcunculus frontatus whitei*)

The crested shrike-tit (northern) was heard twice (both observations unconfirmed) during the survey of the Mine Site and surrounding area. Lane *et al.* (1990) reports hearing the call of this species just to the north of the now established Batman Pit (this may be the record in the DLRM Fauna Atlas). There are three additional records of this species in the vicinity of the Mt Todd Mine Site.

In the Katherine region, this species is believed to prefer open mixed woodland with grassy understorey, on heavy soils shallowly inundated for much of the wet season (Ward *et al.* 2009). The distribution of this habitat type appears to be patchy in the area proposed for TSF2 closer to the Edith River. It also appeared to be present near Site 3. The shrike-tit has been recorded from a range of habitats and potentially could occur at very low density across the region. The previous records and the presence of potentially suitable habitat in the lower lying TSF2 and Yinberrie Hills suggest that this species may visit occasionally or be a rare resident of the study area.

Impacts of the proposed mine expansion on crested shrike-tit (northern) are discussed in section 6.

5.4.4 Partridge Pigeon (*Geophaps smithii*)

The partridge pigeon was not recorded during the current survey, nor was it recorded during the survey conducted by Lane *et al.* (1990). There are a number of records from near the railway line at the intersection of Edith Falls Road and the Stuart Highway (eight records in the NT Fauna Atlas). This species is known from the broader Yinberrie Hills area, but has not been recorded from the Mt Todd Mine site to date. This species is not overly cryptic and flushes readily when approached. It would likely be detected if present in the immediate vicinity of walked transects.

Partridge pigeons are thought to benefit from patchily distributed relatively cool, early-dry-season fires. The species prefers to feed in recently burnt areas but shelter, roost and nest in more vegetated areas nearby (Fraser *et al.* 2003). Patchy distribution of burnt and unburnt areas did not appear to be present in the Mt Todd Mine Site. Habitats in the area had either been burnt or were soon to be burnt. Broader habitats in the Yinberrie Hills and Edith River area appeared to support a 'patchy' network of habitats and may have been more suited to this species. Although the present survey did not document this species, it is possible that the partridge pigeon may persist in the Mt Todd Mine Site area.

Impacts of the proposed mine expansion on partridge pigeon are discussed in section 6.



5.4.5 Red Goshawk (*Erythrotriorchis radiatus*)

The red goshawk was not recorded during the current surveys, nor by Lane *et al.* (1990). Suitable nesting locations are usually in tall trees (> 30m) where the forest/woodland is also tall and generally above a height of 20m. They occur in groups of the tallest trees (> 25m) in tall open forests, woodland or tropical savannas with tree-lined waterways. These were not present in the proposed development areas. It is considered unlikely that the red goshawk breeds in the Mt Todd Mine Site. Red goshawks could potentially forage in the area occasionally. Their home range is reported to be in the order of 200km² (Aumann & Baker-Gabb 1991 in DSEWPaC 2010).

5.4.6 Grey Falcon (*Falco hypoleucos*)

The grey falcon was not recorded during the current surveys however, this species was recorded once during survey by Lane *et al.* at the northern end of the proposed mine site in October 1988 and two were seen near the end of old Edith Falls Rd in April 1990. Lane *et al.* (1990) also reports that this species was seen regularly between Katherine and Victoria River Crossing.

This species is found in low densities through much of the arid and semi-arid areas of Australia. The majority of records in the NT are from the southern regions, but the grey falcon has also been recorded in the Darwin area (DLRM 2013c). This species lives in lightly treed lowland plains, typically on inland drainage systems where the annual average rainfall is less than 500 mm. They generally only occur in low to very low densities and are seen as singles or pairs. It is likely that this species may continue to occasionally be present within the study area but at the most in very low densities.

5.4.7 Painted Honeyeater (*Grantiella picta*)

One observation was made of the painted honeyeater during the dry season survey. The Lane *et al.* 1990 survey did not record this species, however there is a recent Bird Atlas record of this species from the adjacent Nitmiluk National Park. This species has a broad distribution in eastern Australia but wherever it is found it occurs in low densities. Most breeding occurs in the inland slopes of south-eastern Australia and non-breeding birds disperse out into semi-arid and northern regions. There are few records of this species from the NT, with most records from the Barkly Tablelands. There is no evidence of a breeding population in the Northern Territory and the records are thought to be of irregular visitors from the south-east (though it is possibly a regular visitor in small numbers) (DLRM 2013a).

This species has a specialised diet, being almost entirely dependent on mistletoe fruits, although they may occasionally feed on nectar and insects. It is possible that this species may occasionally visit the study area when mistletoe are producing fruit, however this species is only ever likely to visit infrequently.

5.4.8 Pale Field-rat (*Rattus tunneyi*)

The pale field-rat was trapped on six occasions during the wet and dry season surveys in “grassy low open woodland with dense patches of vegetation”. This species was recorded once by Lane *et al.* and there is one previous record of this species from the NT fauna atlas within a 10 km radius of the study area in north-east of the mineral lease. This species inhabits higher rainfall areas of northern Australia, extending from the Kimberley to south-eastern Qld including the Top End of the NT. Formerly the range extended into arid and semi-arid areas and temperate south-western Australia but retracted to higher rainfall areas in the north (DLRM 2013b). This once widespread species is found in dense vegetation along creeklines, sheltering in extensive shallow burrows during the day. This species along with a suite



of other small mammals has declined sharply across the Top End of the NT in the previous 10 years with no clear explanation. On-going monitoring in three national parks has recorded significant declines of pale field-rat, including Kakadu NP a former stronghold for the species. It is thought that a combination of inappropriate fire regimes and predation by the feral cat may be to blame for the decline.

5.4.9 Australian Bustard (*Ardeotis australis*)

Eleven separate observations were made of a total of 19 Australian bustards. As discussed above, this species was formerly a threatened species in the NT, but has recently been downgraded to *near threatened*. All of the observations were documented in relatively disturbed localities such as at the base of the Heap Leach Pad, summit of the Waste Rock Dump and Tailings Storage Facility and flying over the sign-in point to the mine site. This species occurs in open habitats, preferring grasslands, low shrublands, grassy woodlands and other structurally similar but artificial habitats such as croplands and airfields. The locations (artificial habitats) where the observations were made fit this habitat description. This species is known to respond favourably to fire and is often located in recently burnt habitats, including woodlands. It is possible that the relatively large number of bustard observations may have been a response to recent fire. The possible lack of hunting pressures by humans in the Mt Todd Mine Site may provide a refuge for Australian bustard. The artificial open habitats created by the Mine Site, hunting protection afforded to bustards and the burning regime may be highly suited to this species.

5.4.10 Mertens' Water Monitor (*Varanus mertensi*)

Three observations were made of Mertens' water monitor in the Mt Todd Mine Site. No observations of this species during the surveys were from along the Edith River or Horseshoe Creek, despite there being suitable habitat there. Lane *et al.* 1990) documented records of two individuals along Horseshoe Creek and reported the species to be "most common along the Edith River".

Suitable habitat for this species is widespread throughout the study area and broader Yinberrie Hills and Edith River region. It is reported that this species underwent significant declines in abundance across the Top End following the arrival of the cane toad (*Rhinella marina*) (Griffiths and McKay 2007; Doody *et al.* 2008). It is likely that continued monitor/toad evolutionary interactions will determine the persistence of the Mertens' water monitor population in the study area rather than impacts resulting from the proposed development, given the wide availability of suitable habitat in and beyond the Mine Site.

Impacts of the proposed mine expansion on Mertens' water monitor are discussed in section 6.

5.4.11 Yellow-spotted Monitor (*Varanus panoptes*)

The yellow-spotted monitor was not recorded during the present surveys of the mine site or in the surrounding area. Only one record of this species in the mine area exists in the DLRM Fauna Atlas. That observation was made more than 20 years ago by Lane *et al.* (1990) at Horseshoe Creek. Habitat in and around the mine site is suitable for this species. This species is known from a range of habitats, including coastal beaches, floodplains, grasslands and woodlands.

Individual monitors that ingest cane toads die within 15 minutes on average (Freeland 2004). They do not seem to learn to avoid toads. Some individuals refuse to eat cane toads (Freeland 2004). Populations tend to begin recovery within 2 years of the cane toad's invasion (Freeland 2004). It is possible that it persists in the habitats at the Mine Site. It has been demonstrated that this species can persist in other areas where cane toads occur (Burnett 1997).



It is likely that continued monitor/toad evolutionary interactions will determine the viability of the yellow-spotted monitor population in the study area rather than impacts resulting from the proposed mine expansion, given the wide availability of suitable habitat for this species within and beyond the Mine Site. Impacts of the proposed mine expansion on yellow-spotted monitor are discussed in section 6.

5.4.12 Mitchell's Water Monitor (*Varanus mitchelli*)

Mitchell's water monitor was not recorded during the present surveys of the mine site or in the surrounding area. The Lane *et al.* 1990 survey reporting that Mitchell's water monitor was quite a common species along Horseshoe Creek and Yinberrie Creek. This was certainly not the observation during the current series of surveys. There are also numerous records of this species from the NT fauna Atlas from the 10 km radius search area around the study area. This species is found across the Kimberley region of WA and the Top End of the NT, with an isolated population in north-western Qld.

The most important conservation issue facing this species is its propensity to consume cane toads. As with the yellow-spotted monitor, it is likely that continued monitor/toad evolutionary interactions will determine the viability of the population in the study area rather than impacts resulting from the proposed mine expansion, given the wide availability of suitable habitat for this species within and beyond the Mine Site.



6. Assessment of Potential Impacts on Fauna

6.1.1 Foci of the Impact Assessments

The threatened species assessed are the nationally and NT listed Gouldian finch (vulnerable under TPWC Act and endangered under EPBC Act), crested shrike-tit (vulnerable) and partridge pigeon (vulnerable), and the NT listed pale field-rat (vulnerable), painted honeyeater (vulnerable), Mertens' water monitor (vulnerable), Mitchell's water monitor (vulnerable), and yellow-spotted monitor (vulnerable).

Potential impacts on the Mt Todd fauna as a whole are assessed.

6.1.2 Criteria for Determining Significant Impacts

Evaluations of the significance of potential impacts are based on the Commonwealth's *Significant Impacts Guidelines: Matters of National Environmental Significance* (the guidelines) as applied to critically endangered and endangered species (DEWHA 2009). This is considered to be an appropriately conservative approach for threatened species known to occur on site, and is used regardless of the conservation status of each species. For example, species listed as vulnerable under NT legislation are assessed under the Commonwealth guidelines for critically endangered and endangered species.

In the absence of a generally recognised set of criteria for assessing potential impacts on a local fauna as a whole, potential impacts on the community of fauna at the Yinberrie Hills are assessed according to the guidelines on significance of impacts on natural values of National Heritage places.

Definitions for threatened species impacts

Assessment under the guidelines requires use of two definitions. These are for *population* and *habitat critical to the survival of a species or ecological community*:

- ▶ A *population* of a species' is defined under the EPBC Act as an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable threatened species, occurrences include but are not limited to:
 - A geographically distinct regional population, or collection of local populations or;
 - A population, or collection of local populations, that occurs within a particular bioregion.
- ▶ *Habitat critical to the survival of a species or ecological community* refers to areas that are necessary:
 - For activities such as foraging, breeding, roosting, or dispersal;
 - For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
 - To maintain genetic diversity and long-term evolutionary development, or for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act.



Guideline on impact significance – critically endangered and endangered species

An action is likely to have a significant impact on a critically endangered or endangered species [but applied to all species here] if there is a real chance or possibility that it will:

- ▶ Lead to a long-term decrease in the size of a population;
- ▶ Reduce the area of occupancy of the species;
- ▶ Fragment an existing population into two or more populations;
- ▶ Adversely affect habitat critical to the survival of a species;
- ▶ Disrupt the breeding cycle of a population;
- ▶ Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- ▶ Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;
- ▶ Introduce disease that may cause the species to decline; or
- ▶ Interfere with the recovery of the species.

Guideline on impact significance – natural heritage values

An action is likely to have a significant impact on natural heritage values of a National Heritage place if there is a real chance or possibility that the action will:

- ▶ Modify or inhibit ecological processes in a National Heritage place;
- ▶ Reduce the diversity or modify the composition of plant and animal species in a National Heritage place;
- ▶ Fragment or damage habitat important for the conservation of biological diversity in a National Heritage place;
- ▶ Cause a long-term reduction in rare, endemic or unique plant or animal populations or species in a National Heritage place; or
- ▶ Fragment, isolate or substantially damage habitat for rare, endemic or unique.

6.1.3 Assessment of the “Real Chance or Possibility” of an EPBC Significant Impact

A “real chance or possibility” of a significant impact from a particular source is defined as there being an extreme or high risk of a population (or the fauna community) experiencing a significant consequence as defined in the guidelines e.g. reduce the diversity or modify the composition of plant and animal species in a National Heritage place.

Levels of risk, possible mitigation of risk and determination of residual risk to threatened species and the fauna community as a whole were determined using standard qualitative risk assessment procedures (Table 6-1) (AS/NZS ISO 31000:2009).



Table 6-1 Qualitative Risk Analysis Matrix

	Severity of Consequence					
Likelihood of Consequence		Critical (5)	Major (4)	Significant (3)	Moderate (2)	Minor (1)
	Almost Certain (5)	Extreme	Extreme	High	High	Medium
	Likely (4)	Extreme	High	High	Medium	Medium
	Possible (3)	Extreme	High	Medium	Medium	Low
	Unlikely (2)	High	Medium	Medium	Low	Very Low
	Rare (1)	Medium	Medium	Low	Low	Very Low

Levels of likelihood and severity of consequences are defined in Tables 6-2 and 6-3 respectively.

Table 6-2 Definition of Levels of Likelihood

Level of Likelihood	Definitions
Almost certain	The event is expected to occur in most circumstances (The event is likely to occur once per year).
Likely	The event will probably occur in most circumstances (The event is likely to occur once every 1 – 2 years).
Possible	The event might occur at some time (The event is likely to occur once every 2 – 5 years).
Unlikely	The event could occur at some time (The event is likely to occur once every 5 – 10 years).
Rare	The event may occur only in exceptional circumstances (The event is unlikely to occur in any to year period).

Table 6-3 Definitions of Levels of Consequence

Levels of Consequence	Definitions
Critical	Extensive long-term environmental harm and/or harm that is extremely widespread. Impacts unlikely to be reversible within 10 years.
Major	Major or widespread, unplanned environmental impact on or off the site. Significant resources required to respond and rehabilitate.
Significant	Significant, unplanned environmental impact contained within the site or minor impact that is off the site.
Moderate	Moderate, unplanned localised environmental impact (maybe of a temporary nature) or discharge contained on-site or with negligible off-site impact.
Minor	Minor environmental impact. Any impacts are contained on-site and short term in nature. No detrimental effect on the environment.



Assessments of risk are conducted assuming implementation of planned mitigation of potential impacts. Additional mitigation is proposed, and residual risk determined if/as required to reduce risk to below “Extreme” or “High” risk outcomes. The questions asked in each case were what was i) the likelihood of source of impact (e.g. land clearing) causing a particular consequence (e.g. a long-term decline in a threatened species population), and ii) the severity of the consequence if it occurred, with the resulting level of risk determining whether the particular consequence was significant in terms of the EPBC Guidelines.

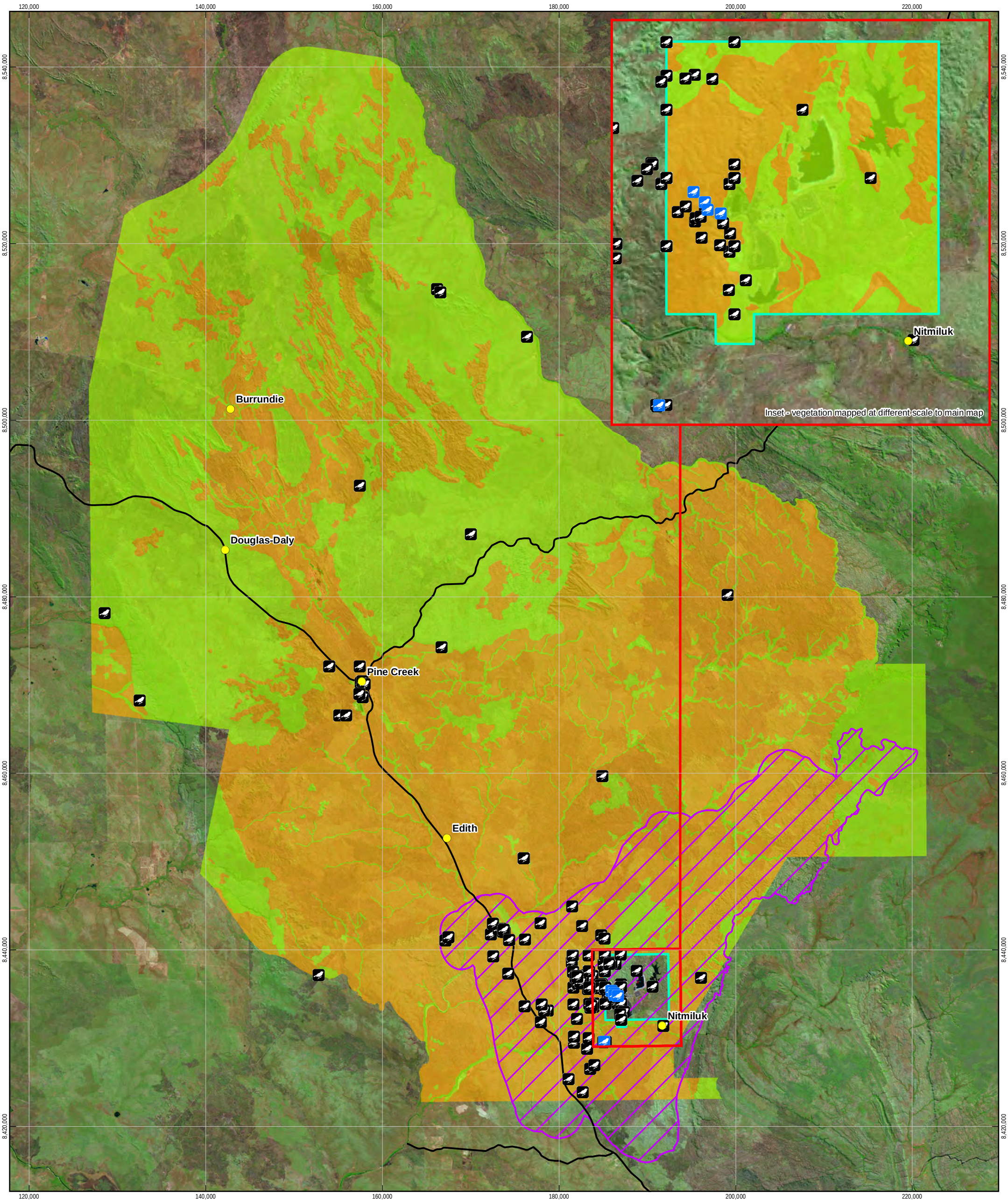
6.1.4 The Fauna and Populations of Threatened Species

Each of the eight species to be assessed can be regarded as having a “population” in the Yinberrie Hills. The assessment is risk averse in that two of the eight species were not recorded during the study (Mitchell’s water monitor and partridge pigeon), two possible records were obtained for one species (crested shrike-tit), and only one record was obtained for the painted honeyeater.

The populations of each of the threatened species occupy specific areas in and around the study area as defined by the species’ preferred habitats and biologies. Areas occupied/possibly occupied by the fauna and population of each species are unlikely to be related to boundaries imposed by mine site boundaries or mineral leases. The areas occupied by the populations of each species and of the entire fauna are:

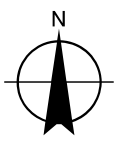
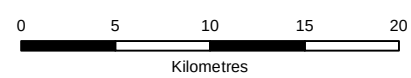
- Gouldian finch is assumed to occupy all the hillside *E. tintinnans* woodland breeding areas in the Yinberrie Hills (i.e. the site of conservation significance, much larger than and including the study area) during the breeding season and use adjacent lowlands in the wet season (this population is likely a component of the population extending from the study area north to Pine Creek (Figure 6-1);
- Crested shrike-tit (northern) is assumed to occupy all woodland habitats of the Yinberrie Hills (i.e. the site of conservation significance) and of the Mt Todd to Pine Creek region. Past observations and those made in this study suggest the species is uncommon in the study area;
- Partridge pigeon is assumed to occupy all woodland habitats in the Yinberrie Hills and the Mt Todd to Pine Creek region. Past observations and those made in this study suggest the species is uncommon in the study area;
- Pale field-rat is assumed to occupy all riparian habitats in the drainage systems of the Yinberrie Hills and Mt Todd to Pine Creek region;
- Painted honeyeater is assumed to occupy all woodland habitats of the Yinberrie Hills (i.e. the site of conservation significance) and of the Mt Todd to Pine Creek region. Past observations and those made in this study suggest the species is uncommon in the study area;
- Mertens’ water monitor is assumed to occupy all riparian habitats in the drainage systems of the Yinberrie Hills and Mt Todd to Pine Creek region;
- Mitchell’s water monitor is assumed to occupy all riparian habitats in the drainage systems of the Yinberrie Hills and Mt Todd to Pine Creek region;
- Yellow-spotted monitor is assumed to occupy all the Yinberrie Hills and all the Mt Todd to Pine Creek region; and
- The entire fauna is assumed to extend to at least the Yinberrie Hills and Mt Todd to Pine Creek region.

In reality the fauna and its threatened species extend much further than considered in the assessments.



LEGEND

- | | | |
|---------------------------------|---|--------------------------------------|
| Place Names | Major Roads | Communities |
| Gouldian finch Records (GHD) | Yinberrie Hills Site of Conservation Significance | Non <i>E. tintinnans</i> Communities |
| Gouldian finch Records (NRETAS) | Mt Todd Mineral Leases | <i>E. tintinnans</i> Communities |



Vista Gold Australia Pty Ltd
Mt Todd Gold Project

Job Number	43-21801
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Gouldian Finch Habitat

Figure 6-1



6.1.5 Potential Sources of Impact

Identified potential sources of impact are:

- Clearing of breeding and/or foraging habitat to allow expansion of the mine;
- Dust levels generated by mining and processing activities impacting on animals or their habitats;
- Noise generated by mining and processing activities impacting on animals;
- Wildfire damaging breeding and feeding habitat;
- Predation by, poisoning by and/or competition from exotic animals or habitat degradation caused by exotic plants;
- Poisoning from drinking tailings dam water;
- Loss of habitat caused by a lowering or contamination of the water table; and
- Artificial light.

Clearing of breeding and/or foraging habitat

Clearing of the vegetation of the study area is reported as cumulative clearing using the 1:250,000 vegetation mapping for the Mt Todd to Pine Creek region (GHD 2013a). Only the Mineral Leases have mapping at the more refined 1:50,000 scale (GHD 2013a). A small portion of the Yinberrie Hills is not included in the 1:250,000 mapping. Cumulative clearing is that conducted during the 1990s' mining of the mineral leases plus that proposed by Vista Gold. The affected vegetation types are:

- *E. tintinnans* hillside woodlands;
- All lowland woodland type present in the mineral leases;
- Riparian areas with permanent water; and
- All habitats present in the mineral leases.

The above vegetation types and the areas of each as reported below are taken from GHD (2013a).

Lowland woodlands encompass all Mineral Lease woodland vegetation types other than *E. tintinnans* hillside woodlands and the riparian vegetation. Reducing the vegetation to four types recognises the reality that fauna species easily transgress vegetation boundaries. None of the riparian woodland has or will be removed (GHD 2013a). Areas of vegetation at the 1:250,000 scale, other than the riparian vegetation, are provided in Table 6-4.

It should be noted here that vegetation type mapping for the Yinberrie Hills has been mapped at the 1:250,000 scale as opposed to the finer scale 1:50,000 mapping of the Mineral Lease. This may in fact overestimate the area of available habitat (i.e. *E. tintinnans* woodland) present with the Yinberrie Hills, however, this is currently the best available habitat data and has been used for this study.

Table 6-4 Areas of Habitat (1:250,000 scale) Previously and Proposed (1:50,000) to be Cleared (ha with % of Original Area) in the Study Area

Vegetation Type	Area in the Yinberrie Hills (ha)	Loss Due to Activity 1990-Current	Proposed Loss due to Mt Todd Project (ha)	Cumulative Area to be Cleared (ha)	Cumulative Percentage Cleared
<i>E. tintinnans</i>	34,652	155.40	140.28	295.68	0.85
Other Mt Todd Woodlands	37,055	733.13	468.44	1201.57	3.24
All Mt Todd Vegetation Types	71,707	888.54	608.72	1497.26	2.09

*Area of Yinberrie Hills mapped at 1:250,000 scale.

The proposed re-opening of the mine is likely to cause:

- ▶ Gouldian finches in the study area to lose:
 - A total cumulative loss (previously and proposed) of 295.68 or 0.75% of the original undisturbed *E. tintinnans* woodland in the Yinberrie Hills site of conservation significance;
 - A cumulative loss of 1201.57ha or 3.24% of the original undisturbed lowland woodland in the Yinberrie Hills site of conservation significance. This estimate is for woodland types found in the Mineral Leases and does not include large areas of other woodland types. The lowland woodlands are mostly on the eastern side of the mine and do not have significant areas of grass species providing seed in the wet season (*Alloteropsis semialata*, *Chrysopogon fallax* and *Triodia bitextura* (GHD 2013a));
- ▶ Crested shrike-tits in the study area to lose:
 - A cumulative loss of 1497.26ha or 2.09% of potentially rarely used, possible foraging habitat (*E. tintinnans*, lowland woodland habitats), in the Yinberrie Hills site of conservation significance. The absence of calls in the wet season suggests the area may not be used for breeding;
- ▶ Partridge pigeons in the study area to lose:
 - A cumulative loss of 1497.26ha of potentially rarely used foraging/breeding habitat (*E. tintinnans* and lowland woodland habitats) or 2.09% of this habitat in the Yinberrie Hills site of conservation significance;
- ▶ Pale field-rats in the study area to lose:
 - A cumulative loss of 1497.26ha of potentially rarely used foraging/breeding habitat (*E. tintinnans* and lowland woodland habitats) or 2.09% of this habitat in the Yinberrie Hills site of conservation significance;
- ▶ Australian bustards in the study area to lose:
 - A cumulative loss of 1497.26ha of potential foraging/breeding habitat (*E. tintinnans* and lowland woodland habitats) or 2.09% of this habitat in the Yinberrie Hills site of conservation significance;



- ▶ Painted honeyeaters in the study area to lose:
 - A cumulative loss of 1497.26ha or 2.09% of potentially rarely used, possible foraging habitat (*E. tintinnans*, lowland woodland habitats), in the Yinberrie Hills site of conservation significance. This species has been documented as an occasional visitor to the NT from the south-eastern states and is unlikely to breed in the Mt Todd area;
- ▶ Mertens' water monitors, Mitchells' water monitors and yellow-spotted monitors in the study area to lose:
 - A cumulative loss of 0ha of foraging/breeding habitat (riparian vegetation) resulting in a total cumulative loss of 0ha or 0% of the original riparian area in the mineral leases and in the Yinberrie Hills site of conservation significance; and the
- ▶ Entire fauna of the study area to lose:
 - A cumulative loss of 1497.26ha of breeding/foraging habitat (all habitats) or 2.09% of these habitats in the Yinberrie Hills site of conservation significance.

The areas to be cleared will form an island of cleared habitat in a near continuous area of native vegetation. The area is bounded to the south by the Edith Falls road and the west by the Stuart Highway. The proposed mining will not cause fragmentation of the habitat.

The proposed losses of habitat for these threatened species and the entire fauna are relatively small, less than has been experienced from past mining in the Mineral Leases; and negligible compared to the actual area over which the faunal populations are distributed. Cumulative losses remain relatively minor, totalling approximately 2.09% or less of the original areas.

The Gouldian finch population in the Yinberrie Hills does not appear to have declined as a result of clearing during earlier development of the Mt Todd mine. This is based on previous nest and waterhole monitoring (Ward and Voukolos 2009). This is likely associated with more than sufficient nesting hollows in the majority of the vegetation that remained. Nor did the clearing seem to have a negative impact on the likelihood of locating any of the threatened species or any element of the fauna as a whole (see comparison of these results with those from Lane *et al.* 1990 in the Discussion).

Clearing seems unlikely to have any significant direct impact on any of the threatened species and populations. The fauna as a whole is similarly likely to experience no major effects. Any impact would likely be negligible, and not amenable to detection at the population level.

Indirect impacts may include habitat changes that encourage invasive species to become established. This is discussed under exotic plants and animals below.

Dust levels generated by mining and processing activities

The Gouldian finch population appears to have been unaffected by the previous mining and its dust levels, whatever they may have been. There was no reduction in the frequency of Gouldian finch nesting in hollows close to, as opposed to further from, the pit during previous mining (Collins *et al.* 1993; Smith *et al.* 1995). The population as a whole remained relatively stable during previous mining.

Nor has there been any report on damage to vegetation arising from dust levels during mining. The robust sclerophyllous nature of the more dominant plant species in the site's vegetation and the long vertically hanging petioles of the dominant *Eucalyptus* and *Corymbia* would tend to minimise accumulation of dust in the dry season; minimising potential impacts (Neinhuis and Barthlott 1998). The



open leaf structure of eucalypt woodlands (i.e. low optical density) would aid in minimising impacts on the plants (Raupach *et al.* 2001).

Levels of dust deposition would need to exceed 7gm^{-2} for impact to be expected to affect plants (Farmer 1993). These levels were for cement dust which is more likely to be damaging than dust from the mine. The area covered by this contour is restricted to the near vicinity of the mine with possible impact on a relatively small area of Gouldian finch breeding habitat (GHD 2013).

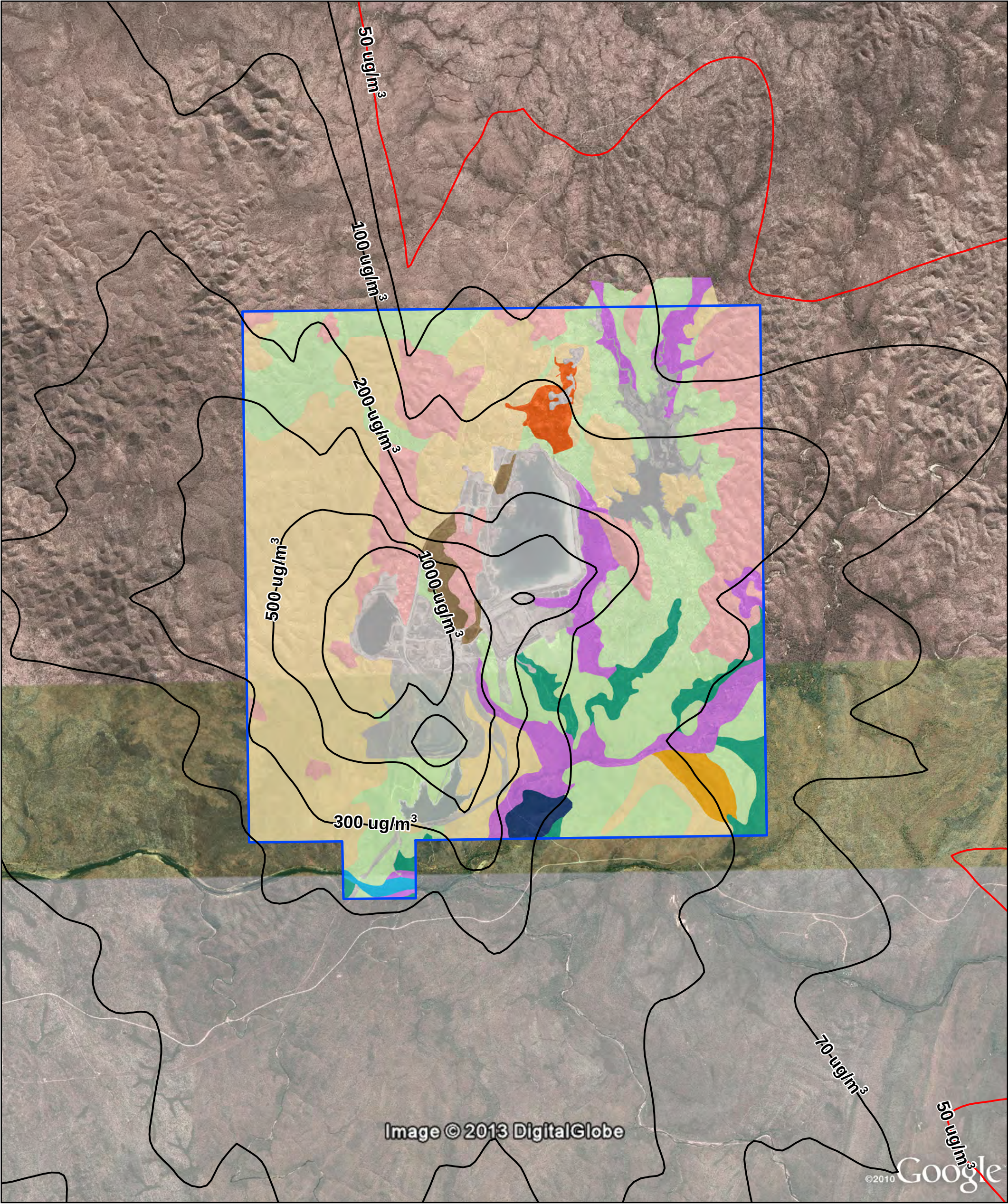
Levels of predicted ground level dust concentration greater than the NSW Office of Environment and Heritage (OEH) criteria (DEC 2005) for Total Suspended Particles (TSP) of $50\mu\text{g}/\text{m}^3$ are predicted to encompass all of the Mineral Leases, extending well to the south and well outside the Mineral Leases to the west and northwest (Figure 6-2) (GHD 2013). It would cover approximately 7,162ha of the mapped (1:50,000) Gouldian finch breeding habitat in the Yinberrie Hills site (but it would extend well beyond this), or a minimum of approximately 10.0% of the breeding habitat in the Yinberrie Hills site of conservation significance (the area of breeding habitat affected will actually be greater than 10.0% as this is only representative of the breeding habitat present within the 1:50,000 vegetation mapping extent. Additional Gouldian finch breeding habitat exists outside of this mapping extent but still within the Yinberrie Hills).

The GHD air quality assessment has also found that the Gouldian finch habitat at the Yinberrie Hills (to the west of the Batman Pit) has the potential to be exposed to predicted maximum 24-hour ground level concentrations of PM_{10} of greater than $200\mu\text{g}/\text{m}^3$, including background of $20.8\mu\text{g}/\text{m}^3$ (GHD 2013).

The New South Wales Department of Environment and Conservation (DEC) (DEC 2005) sets a dust criterion of $50\mu\text{g}/\text{m}^3$ TSP for human exposure. There is no applicable criterion for fauna. It would be anticipated that small birds like the Gouldian finch would require a lower dust criterion (Newman and Schreiber 1988) i.e. they have higher rates of inhalation per unit body mass than do humans. Effects on individuals are critically influenced by inhalation rates. The USEPA (2010) recommended equation for calculating active inhalation rates for passerine birds (Gouldian finches are passerines) is conservative in that the equation used is derived from non-passerines, which have a lower inhalation rate. The equation yields an inhalation rate of $125,705\text{cm}^3/\text{kg}$ body weight/h, compared to that of a 23-30 year old male human of $9,621\text{cm}^3/\text{kg}$ body weight/h (i.e. the Gouldian finch's rate is over 13 times that of the human).

The only threatened species to undergo a decline in the mine area during previous mining were Mertens' water monitor, Mitchell's water monitor, yellow-spotted monitor and northern quoll (section 5.4). All three declined regionally mostly in response to cane toad poisoning. The northern quoll had exhibited a range contraction prior to the invasion by cane toads (Braithwaite and Griffiths 1994).

The area's other threatened species were rarely recorded in the area prior to mining. These remain so today.



LEGEND		COMMUNITY	
Dust Concentration			
— Concentration ug/mg ³ (Criterion 50 ug/m ³)		1 Melaleuca forest, with bare areas	
— Criterion 50 ug/m ³		2 E. bigalerita Eucalyptus spp. open-forest	
□ Mount Todd Mineral Lease Extents		4 E. tintinnans Eucalyptus spp.Erythrophleum chlorostachys woodland	
		6 E. tintinnans C. dichromophloia woodland	
		6B E. tintinnans C. dichromophloia woodland (Disturbed)	
		9 E. tectifera woodland	
		10 E. tectifera C. confertiflora woodland	
		11 E. latifolia E. bigalerita open-woodland with areas of grassland	
		16 E. tectifera woodland \ E. tintinnans Eucalyptus spp. Erythrophleum chlorostachys woodland	
		999 Disturbance	



Noise levels generated by mining and processing activities

Previous mining generated noise from activities in and around the pit, road transport on dirt roads, waste rock management, and from the treatment of ore. Projected noise levels for the original EIS were that the 50 dB(A) contour would pass slightly to the west of the Batman Pit and within the developed areas to the north, south and east (NSR 1991). Overpressure from blasting was estimated to meet the compliance limit of 115dB_{linear} at 1,200m. Vibration was expected to be 5mms⁻¹ at 221m.

Levels of mining activity and anticipated noise levels are similar to those described in the initial EIS for the Mt Todd Gold Mine (GHD 2013b). The 50 dB(A) contour will pass near the western edge of the proposed pit, and the blast overpressure dissipates to 115dB_{linear} within 420m. Vibration is expected to be approximately 5mms⁻¹ at 221m.

FHA (2004) and Kaseloo (2005) reviewed the literature on bird responses to intense noise levels and found that responses varied greatly (FHA 2004). Approximately 60% of 43 species studied exhibited population declines adjacent to roads, with the declines directly related to levels of traffic (Kaseloo 2005). Kaseloo (2005) and FHA (2004) reported that susceptible species exhibited declining populations in areas with greater than 50 dB(A). Declines were however subject to variation among years with interaction with and between habitat quality and population density playing significant roles in determining the nature if any of a decline.

Many bird species remain unaffected by or persist with high population densities in areas with high noise levels e.g. near roads, mines or military testing/training grounds, airports (FHA 2004; Kaseloo 2005).

There was no reduction in the frequency of Gouldian finch nesting in hollows close to, as opposed to further from, the pit during previous mining (Collins *et al.* 1993; Smith *et al.* 1995). The population as a whole remained relatively stable during the previous mining.

The only threatened species that exhibited a population decline in the mine area were the Mertens' water monitor, Mitchells' water monitor, yellow spotted monitor and northern quoll. All four declined regionally most likely in response to cane toad poisoning.

The other threatened species were rarely recorded in the area and remain so today.

The fauna as a whole and the threatened species and populations are unlikely to suffer significant impacts from noise generated by mining activities. Any impact would likely be negligible, and not amenable to detection at the population level.

Wildfire

The Yinberrie Hills have a seemingly long history of possibly excessive late-dry-season hot fires (Anon. undated). There are no available analyses of which habitats in the study area or Yinberrie Hills as a whole are experiencing and/or have experienced negative impacts. Early season control fires have been used to manage fire in the area of the mine since the initiation of mining at Mt Todd. This continues today and is planned to continue during the proposed mining.

Seeds from sorghum are the primary breeding season food source for Gouldian finches (Dostine and Franklin 2002). Sorghum (*Sorghum timorensis*) is extremely fire tolerant (Watkins *et al.* 1989), has a seed set that is not influenced by fire (Scott *et al.* 2010a) and remains a dominant ground cover in the hills (GHD 2013a).

The Gouldians wet season food sources are primarily *Alloteropsis semialata*, *Chrysopogon falax*, and *Heteropogon triticeus*, with some wet seasons providing *Triodia bitextura* (Dostine *et al.* 2001; Lewis



2007). *A. semialata* seeds poorly following late dry season fires, *C. falax* is less impacted, and *T. bitextura* is very impacted (no seed). Little is known about the impacts of fire on seed set by *H. triticeus* (Dostine *et al.* 2001; Lewis 2007). *H. triticeus* is fire tolerant, increasing when there are annual fires (Fensham 1990) and disappearing after 14 years without fire (Scott *et al.* 2010b). The vegetation types to the west of the mineral lease area have a richer diversity of grass than those to the east of the existing pit (GHD 2013a, Section 4.2.2). The eastern vegetation types tended to be dominated by *S. timorensis* while the western types exhibited a diversity of *S. timorensis*, *Alloteropsis semialata*, *Chrysopogon falax*, *Heteropogon triticeus*, and *Triodia bitextura*. This diversity provides a year round source of food for the Gouldian finch which breeds in the western side of the mineral lease.

The existing fire regime has not had a negative impact on the population of Gouldian finches in recent times (although fire regimes more broadly may have contributed to previous declines). Possible declines in populations of Mertens', Mitchells' and yellow-spotted monitors cannot be attributed to fire impacts.. There are no data that can be used to determine whether the local, unchanged rarity of the crested shrike-tit, painted honeyeater and partridge pigeon is related to the long standing fire regime [although it is acknowledged that partridge pigeon require a patchy mosaic of burnt and unburnt vegetation (Fraser *et al.* 2003; DSEWPac 2010)]. The pale field-rat is thought to have declined over the past 10 years in the Top End due to a combination of ongoing inappropriate fire regimes (too frequent) affecting habitat suitability and predation by feral cats (DLRM 2013b). It is possible that the existing fire regime is not advantageous to this species (six individuals captured over the entire survey), however, the proposed operation of the Mt Todd mine is unlikely to alter the current regime. With some planning, the existence of personnel and machinery in the area may lead to a reduction in the frequency of burning due to safety concerns, which may be beneficial to this species.

The fauna and the threatened species and populations are unlikely to suffer significant impacts from wildfire associated with the proposed mine. Any impact would likely be negligible, and not amenable to detection at the population level.

Exotic plants and animals

The study area has relatively minor feral animal problems other than the ubiquitous presence of the Cane toad (*Rhinella marina*), and the potential for significant impacts from pigs in lowland and riparian areas. It is unlikely that the proposed mining activity would result in enhanced feral animal populations or increases in the number of feral animal species. The exotic weeds problem is relatively minor in the intact vegetation. Weed concentrations along disturbed edges to vegetation are the object of a long-term weed management plan. Weeds in the area, especially Gamba grass, have the potential to significantly alter the structure, and by increasing fuel loads, alter the species composition of vegetation (GHD 2013a).

Virtually all the species of feral animal and exotic plant capable of causing significant habitat change are present in or have ready access to the mine site without intervention from the proposed mining.

Introduction of exotic disease harmful to the fauna would most likely be brought to the site via introduction of a new species of exotic animal to Australia, or via transmission of a new disease by mosquito or other arthropod vector. This mining proposal has no intention or capability of introducing either a new exotic animal or exotic disease. Mosquitos will be subject to ongoing management throughout the life of the mine (Medical Entomology Centre for Disease Control 2012).

Intrusion or export of exotic weeds will be managed through a system of vehicle wash downs pre-departure and post-entry to the mine site. Any additional weed species colonising the site would be



exterminated before it attained a significant population size. Exotic animal incursions e.g. black rats will be exterminated.

With the proposed mitigation (section 7) the fauna and the threatened species and populations are unlikely to suffer significant impacts from additional or existing exotic animals or plants. Any impact would likely be negligible, and not amenable to detection at the population level.

Poisoning from drinking tailings dam water

Bird mortalities from drinking tailings water may become significant once the level of weak-acid-disassociable (WAD) cyanide concentrations are over 100mg/L. WAD cyanide disassociates in the acidic stomach environment when ingested by vertebrates, resulting in release of free cyanide and causing potential poisoning. Mortalities are usually non-existent when concentrations of WAD cyanide are less than 50mg/L (NICNAS 2010). This level of WAD cyanide is in keeping with the international guideline on the release of cyanide containing tailings water (ICMI 2006).

Vista Gold will destroy the majority of WAD cyanide in tailings water prior to release. This will be undertaken using the air-sulphur dioxide process. Trial treatments have yielded WAD concentrations of 39.8mg/L (Tetra Tech 2011).

Concentration of some metals (e.g. arsenic, copper, lead) in trial tailings dam water are higher than the ANZECC & ARMCANZ, (2004) levels recommended for release into the environment (Tetra Tech 2011). The ANZECC Guidelines are conservative, and together with the Gouldian finch being less likely to drink at the tailings dam than at smaller available sources, it seems unlikely that metal poisoning will be an issue.

Tailings dam operation during previous mining, and recent maintenance of large surface volumes of metal (especially copper) containing water in the Batman Pit and other water bodies has not resulted in a decline in the Gouldian finch population.

The vast majority of the birds described by Donato (1998) as experiencing mortality from tailings dam water were not passerines. There are anecdotal reports of granivorous bird species drinking from tailings dams and suffering mortalities (Donato 1998). The general absence of passerines and granivores from mortality lists is likely to be the result of them not coming in contact with tailings water. For example, Gouldian finches typically drink from small water bodies (Dostine *et al.* 2001). The tailing dam is a large expanse and not typical Gouldian finch drinking habitat.

Previous release of tailings water does not seem to be associated with significant decline of fauna in the area, including decline of threatened species.

The fauna and the threatened species and populations are unlikely to suffer significant impacts from consumption of tailings water. Any impact would likely be negligible, and not amenable to detection at the population level.

Lowering or contamination of the water table

The impermeable nature of the hornfels in the western portion of the mine sites, and the hornfels basement rock to the south and east are expected to cause a localised drawdown of the water table (Tetra Tech 2013). The basement rock to the east is overlain by the less metamorphosed Burrell Creek Formation and is more permeable. This is likely to result in a reversal in groundwater flow from away from the pit to towards the east. Groundwater in the vicinity of water storages (to the east and south of the pit) at the mine site are causing water mounding and contamination of ground water with metals



(Tetra Tech 2013). Areas to the immediate north and west of the mine (hornfels) are unlikely to suffer significant lowering of the water table or contamination (Tetra Tech 2013). Mounding and contamination are proposed for rehabilitation during the course of the mine life.

Areas of Gouldian finch breeding habitat in areas of hornfels to the west of the pit are likely to be largely unaffected by draw down from mine operation. Areas to the east and south of the mine are largely cleared and this will expand during mine development. These areas may provide some wet season food sources for the Gouldian finch although these are not as abundant as reported in areas in the western side of or outside the mineral leases (GHD 2013a).

Impacts on the Gouldian finch from groundwater draw down and possible groundwater contamination are expected to be unlikely and of very limited extent should they occur. Impacts on populations of other species are likely to be reflected in the size of the areas of lowland habitat cleared rather than groundwater changes i.e. low likelihoods of impacts.

The fauna and threatened species and populations are unlikely to suffer significant impacts from groundwater changes. Any impact would likely be negligible, and not amenable to detection at the population level.

Artificial light

Artificial light is known to cause numerous forms of negative impacts on a wide range of fauna species. These include:

- ▶ Disorientation of marine turtles (e.g. Witherington 1990; Witherington and Martin 1996);
- ▶ Disorientation of migrating birds (e.g. Longcore *et al.* 2008);
- ▶ Attraction and disorientation of amphibians (Buchanan 2006);
- ▶ Disorientation of bats (e.g. Stone *et al.* 2009; Polak 2011);
- ▶ Attraction of and enhanced mortality of insects (e.g. Yoon *et al.* 2010; Ferreira and Scheffrahn 2011; Fox 2012);
- ▶ Alteration of bird calling behaviour (e.g. Kepempenaers *et al.* 2010; Longcore 2010);
- ▶ Breeding behaviour of amphibians (e.g. Baker and Richards 2005);
- ▶ Small mammal activity rhythms (e.g. Rotics *et al.* 2011); and
- ▶ Daily migratory patterns of fish (Riley *et al.* 2011).

The study of the effects of artificial light on fauna is in its infancy and viewed as a new focus for research in ecology, and a pressing conservation challenge (Longcore and Rish 2004). Recorded responses from fauna subjected to artificial light are many and vary widely among species. Other than relatively superficial observations (e.g. cane toads are attracted to light) there are few if any generalities that can be applied to fauna, or even a particular species that has not been well studied. For example, while cane toads are attracted to light, the effects of artificial light on the toads is not understood. Do cane toads feeding under lights grow faster, maintain better body weight, have higher survival and higher reproductive output than cane toads feeding away from light, or *vice versa*? These are the sorts of question that would need to be answered to assess the effects of light on cane toads, or any other species that was attracted to light.



The proposed 24 hours per day, seven days per week operations of the Mt Todd Gold Mine has potential to negatively impact on the fauna, and specific species of fauna. The level of ignorance as to what the precise impacts may be precludes valid impact assessment. The valid approach under this circumstance is not to assess the potential impacts, but to implement measures to mitigate the types of impacts that have been recorded for other faunas and species of relevance. Impacts would depend on hours of operation and scale of nocturnal lighting. As discussed above there were no recorded or subsequently detected impacts of fauna from previous mining.

6.1.6 Assessments of Impacts on Threatened Species

Details of the risk assessments of individual sources of risk to the threatened species and the fauna of the Yinberrie Hills are provided in Appendix H.

Assessments of the cumulative risks of all sources of impact on each threatened species and the entire fauna are provided below. In each case the majority of sources of impact generate “Very Low” or “Low” levels of risk. This means that either zero or one source of impact individually constitutes at most a “Medium” level of risk for the Guidelines’ consequences. In no case is it thought the the impacts are additive or synergistic. In some cases a “Very Low” level of risk stemming from land clearing seems to be rendered irrelevant by its potential spatial overlap with the higher risk posed by dust.

Gouldian finch

The maximum risk to the Yinberrie Hills population of the Gouldian finch is “High” (Table 6-5). The predicted level of ground level dust is high and based on a conservative scenario of possibly a higher generation of dust than may occur. This uncertainty, together with uncertainties about the potential effects of high dust levels on individual finches, the varying effects of various levels of dust concentration, the possible pattern of dust distribution through the breeding habitats, and the limited knowledge of other potential breeding areas in the Yinberrie Hills indicate that a precautionary approach be taken. This is described in section 7.

Table 6-5 Risk Assessment for Gouldian Finch

Consequence	Likelihood of consequence	Severity of consequence	Risk
<i>Long-term decrease in the size of a population</i>	Possible	Major	High
<i>Reduce the area of occupancy of the species²</i>	Possible	Major	High
<i>Adversely affect habitat critical to the survival of a species</i>	Possible	Major	High
<i>Fragment an existing population into two or more populations</i>	Unlikely	Minor	Very Low
<i>Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline</i>	Possible	Moderate	Medium
<i>Result in invasive species that are harmful to the Gouldian finch</i>	Unlikely	Moderate	Low
<i>Introduce disease that may cause the species to decline</i>	Rare	Minor	Very Low

² The area of occupancy of the species relates to impacts at the level of the species geographic range. A small loss of breeding habitat, as in this case, is unlikely to result in a range reduction.



Crested shrike-tit (northern)

All but one of the risk levels to the crested shrike-tit are “Very Low” (Table 6-6). The single instance of “Low” was attributed to the potential impacts of wildfire on the habitat. This possibly reflects the existing situation where fire may favour food resources for the Gouldian finch (e.g. native sorghum and wet season seeding grasses), and impact negatively on the crested shrike-tit’s habitat. The shrike-tit is rarely recorded from the area and is unlikely to be impacted by the proposed mine.

Table 6-6 Risk Assessment for Crested Shrike-tit (Northern)

Consequence	Likelihood of consequence	Severity of consequence	Risk
<i>Long-term decrease in the size of a population</i>	Unlikely	Minor	Very Low
<i>Reduce the area of occupancy of the species</i>	Rare	Minor	Very Low
<i>Adversely affect habitat critical to the survival of a species</i>	Unlikely	Minor	Very Low
<i>Fragment an existing population into two or more populations</i>	Rare	Minor	Very Low
<i>Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline</i>	Rare	Minor	Very Low
<i>Result in invasive species that are harmful to the crested shrike-tit</i>	Unlikely	Moderate	Low
<i>Introduce disease that may cause the species to decline</i>	Rare	Minor	Very Low

Partridge pigeon

All but one of the risk levels to the partridge pigeon are “Very Low” (Table 6-7). This is largely due to this species not having been recorded from the study area i.e. consequences cannot be severe and likelihoods of impacts are low.

Table 6-7 Risk Assessment for Partridge Pigeon

Consequence	Likelihood of consequence	Severity of consequence	Risk
<i>Long-term decrease in the size of a population</i>	Rare	Minor	Very Low
<i>Reduce the area of occupancy of the species</i>	Rare	Minor	Very Low
<i>Adversely affect habitat critical to the survival of a species</i>	Unlikely	Minor	Very Low
<i>Fragment an existing population into two or more populations</i>	Rare	Minor	Very Low
<i>Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline</i>	Rare	Minor	Very Low
<i>Result in invasive species that are harmful to the partridge pigeon</i>	Unlikely	Moderate	Low
<i>Introduce disease that may cause the species to decline</i>	Rare	Minor	Very Low

Painted honeyeater

Risk from the proposed operation of the Mt Todd mine is considered to be ‘Very Low’ for the painted honeyeater. This species is thought to be an occasional visitor to the Top End, with few records. The



record from this survey was the second for the Katherine region, with only a single previous record from the nearby Nitmiluk National Park.

Table 6-8 Risk Assessment for Painted Honeyeater

Consequence	Likelihood of consequence	Severity of consequence	Risk
<i>Long-term decrease in the size of a population</i>	Unlikely	Minor	Very Low
<i>Reduce the area of occupancy of the species</i>	Unlikely	Minor	Very Low
<i>Adversely affect habitat critical to the survival of a species</i>	Unlikely	Minor	Very Low
<i>Fragment an existing population into two or more populations</i>	Rare	Minor	Very Low
<i>Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline</i>	Rare	Minor	Very Low
<i>Result in invasive species that are harmful to the painted honeyeater</i>	Unlikely	Minor	Very Low
<i>Introduce disease that may cause the species to decline</i>	Rare	Minor	Very Low

Australian bustard

All risks to the Yinberrie Hills population of Australian bustards are uniformly “Very Low” (Table 6-8). This reflects the species’ apparent preference for the cleared areas of the study site.

Table 6-9 Risk Assessment for Australian Bustard

Consequence	Likelihood of consequence	Severity of consequence	Risk
<i>Long-term decrease in the size of a population</i>	Rare	Minor	Very Low
<i>Reduce the area of occupancy of the species</i>	Unlikely	Minor	Very Low
<i>Adversely affect habitat critical to the survival of a species</i>	Unlikely	Minor	Very Low
<i>Fragment an existing population into two or more populations</i>	Rare	Minor	Very Low
<i>Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline</i>	Rare	Minor	Very Low
<i>Result in invasive species that are harmful to the Australian bustard</i>	Unlikely	Minor	Very Low
<i>Introduce disease that may cause the species to decline</i>	Rare	Minor	Very Low

Pale field-rat

All risks to the Yinberrie Hills population of pale field-rats are uniformly “Very Low” (Table 6-10). The primary impacts to this species appear to be a combination of inappropriate fire regimes and predation by feral cats. The re-opening of the mine is unlikely to exacerbate these impacts.



Table 6-10 Risk Assessment for Pale Field-rat

Consequence	Likelihood of consequence	Severity of consequence	Risk
<i>Long-term decrease in the size of a population</i>	Rare	Minor	Very Low
<i>Reduce the area of occupancy of the species</i>	Unlikely	Minor	Very Low
<i>Adversely affect habitat critical to the survival of a species</i>	Unlikely	Minor	Very Low
<i>Fragment an existing population into two or more populations</i>	Rare	Minor	Very Low
<i>Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline</i>	Rare	Minor	Very Low
<i>Result in invasive species that are harmful to the pale field-rat</i>	Unlikely	Minor	Very Low
<i>Introduce disease that may cause the species to decline</i>	Rare	Minor	Very Low

Mertens' water monitor, Mitchell's water monitor and yellow-spotted monitor

The three monitor species are likely to be subject to "Very Low" levels of risk from the mine (Table 6-11).

Table 6-11 Risk Assessment for Mertens' Water Monitor and Yellow-spotted Monitor

Consequence	Likelihood of consequence	Severity of consequence	Risk
<i>Long-term decrease in the size of a population</i>	Rare	Minor	Very Low
<i>Reduce the area of occupancy of the species</i>	Rare	Minor	Very Low
<i>Adversely affect habitat critical to the survival of a species</i>	Rare	Minor	Very Low
<i>Fragment an existing population into two or more populations</i>	Rare	Minor	Very Low
<i>Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline</i>	Rare	Minor	Very Low
<i>Result in invasive species that are harmful to the species</i>	Unlikely	Minor	Very Low
<i>Introduce disease that may cause the species to decline</i>	Rare	Minor	Very Low

The Yinberrie Hills fauna

The consequences of the mine's re-development have two "High" risk values (Table 6-12). The "High" risks are associated with the potential impacts of dust on the Gouldian finch, and possibly other fauna.



Table 6-12 Risk Assessment for the Yinberrie Hills

Source of risk	Likelihood of consequence	Severity of consequence	Risk
<i>Modify or inhibit ecological processes in a National Heritage place</i>	Possible	Significant	Medium
<i>Reduce the diversity or modify the composition of plant and animal species in a National Heritage place</i>	Possible	Major	High
<i>Fragment or damage habitat important for the conservation of biological diversity in a National Heritage place</i>	Rare	Minor	Very Low
<i>Cause a long-term reduction in rare, endemic or unique plant or animal populations or species in a National Heritage place</i>	Possible	Major	High
<i>Fragment, isolate or substantially damage habitat for rare, endemic or unique animal populations or species in a National Heritage place</i>	Rare	Minor	Very Low



7. Suggested mitigation measures and proposed monitoring

The DLRM EIS Guidelines for this Project call for the establishment of “mechanisms to determine the long-term impact of environmental impacts associated with key environmental issues (monitoring and reporting)”.

7.1 Dust Mitigation

Monitoring should focus on dealing with uncertainties surrounding the highest recorded risk to the Yinberrie Hills fauna. There is the potential for dust to impact the Yinberrie Hills Gouldian finch population. This is also the highest risk to the fauna as a whole. The uncertainties are:

- ▶ The levels of near-ground dust concentration and dust deposition in the breeding habitat adjacent to the Mt Todd mine before and during mine operation;
- ▶ The effects of dust levels on intensity of Gouldian finch nesting and nesting success;
- ▶ The future population levels of the Gouldian finch in the Yinberrie Hills;
- ▶ The status of other potential breeding areas in the Yinberrie Hills and the Mt Todd to Pine Creek region; and
- ▶ Fire management in the whole of the Yinberrie Hills.

7.1.1 Dust Monitoring

Dust monitoring is recommended in the mine air quality study (GHD 2013). The proposed monitoring would be an expansion of that program. It would require a carefully constructed and appropriate statistical design to allow assessment of the effects of distance from the mine and habitat features on dust levels.

7.1.2 Nesting Intensity and Success

The only practical way of conducting monitoring is the establishment of large numbers of artificial nest boxes throughout the area potentially subject to $>50\mu\text{g}/\text{m}^3$ levels of dust concentration. It is critical that placement of the artificial nests be soundly statistically designed prior to establishment. This should be done in conjunction with the design of the dust monitoring. Nest boxes would simplify the task of assessing frequency of nesting and nesting success. The feasibility of using artificial nest boxes needs to be investigated prior to commitment of monitoring. The nest boxes should be established prior to the breeding season prior to construction commencing. This would allow assessment of the effectiveness of the nest boxes, and develop baseline pre-mining data (e.g. this could occur prior to the 2013 breeding season in the event that construction progressed in 2013). Field work could be coordinated with volunteer groups and the Jawoyn Rangers.



7.1.3 Monitoring Gouldian Finch Populations

The long-term monitoring conducted by DLRM is a critical baseline database. It should be continued, possibly with assistance from the mine. This program is based on counting Gouldian finches around waterholes late in the dry season. It should be expanded and used as a tool for determining presence and size of populations adjacent to potentially large areas of suitable breeding habitat in the Yinberrie Hills and/or Mt Todd to Pine Creek region, and so reduce uncertainty about other breeding areas. This should be preceded by a critical desk-top examination of the attributes of these other possible breeding areas in comparison with the known area adjacent to the mine. This may allow subsequent field work to focus on areas most likely to support breeding Gouldian finches.

7.2 Land Clearing

Areas of land to be cleared should be clearly marked to ensure no intrusion into lands intended to remain intact. Clearing will be monitored to ensure compliance with areas marked for clearing and no intrusion of any kind will be made on areas outside the clearing zone. The Gouldian finch habitat, *E. tintinnans* woodlands adjacent to the pit, should only be cleared during the non-breeding season (i.e. wet season) where practical.

7.3 Noise

Standard mitigation should be applied to minimise noise levels (GHD 2013b).

7.4 Wildfire

The existing system of early dry season controlled burns should be maintained. Subsequent fires late in the dry season (following early dry season burns) should be avoided as should multiple instances of fires in the same habitats within the same calendar year (i.e. only one burn per year should occur in Mt Todd area during the early dry season). Additionally to this, the introduction to a 'patchy' mosaic approach to burning should be investigate whereby patches of habitat could be left unburnt for subsequent years and not burnt at all. This approach may be beneficial for a range of species including partridge pigeon, pale field-rat and Gouldian finch.

7.5 Invading Foreign Organisms

Standard mitigation using sound waste management will limit potential for colonisation by black rats (*Rattus rattus*).

An active weed management program and the other weed mitigation measures in GHD (2013a) are critical to controlling existing exotic plants, and stemming invasion by others.

7.6 Artificial Light

The potentially negative impacts of artificial light can be mitigated by:

- ▶ Limiting artificial light to areas actively required and turning off lights when not required;
- ▶ Ensuring that artificial lighting does not point upwards or laterally i.e. should point towards the ground;
- ▶ Use of lower rather than higher lighting installations;



- ▶ Avoiding the flood of light into natural habitats;
- ▶ Use of lower wavelengths of light wherever possible i.e. red/yellow lights;
- ▶ Use of low light intensities that are as low as possible without reducing safety or efficiency; and
- ▶ Avoiding painting large structures bright colours.

These steps should be taken where it is safe to do so.



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- ▶ Vista Gold staff at the mine site for providing detailed descriptions and locations of some of the fauna species observed around the study area and immediate surrounds; and
- ▶ David Jaeschke and his workers for assistance installing the survey sites.

The contents and views expressed within this report are entirely those of GHD and should not be considered to reflect the views of the parties listed above.



Appendix A

Legislation and licencing requirements



Commonwealth Legislation

Environment Protection and Biodiversity Conservation Act 1999

Under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), any development requires assessment if it has the potential to affect one or more of eight matters of National Environmental Significance (NES) (DEWHA 2009). The matters of NES include:

- ▶ World Heritage properties;
- ▶ National Heritage places;
- ▶ Wetlands of international importance (listed under the Ramsar Convention);
- ▶ Listed threatened species and ecological communities;
- ▶ Migratory species protected under international agreements;
- ▶ Commonwealth marine areas;
- ▶ The Great Barrier Reef Marine Park; and
- ▶ Nuclear actions (including uranium mines).

The environment under the EPBC Act includes:

- a) Ecosystems and their constituents;
- b) Natural and physical resources;
- c) Qualities and characteristics of locations, places and areas;
- d) Heritage values of places; and
- e) The social, economic and cultural aspects of a thing mentioned in paragraphs a), b) or c).

The EPBC Protected Matters Search Tool indicates that Kakadu Stages 1&3 (a RAMSAR listed wetland) and 10 threatened species and 14 migratory species are likely to, may or are known to occur in the search area (Project area plus a 10km buffer). These however are upstream of the mine and will not be impacted.

Immediately adjacent to the western edge of the Batman Pit is known breeding habitat for the Gouldian finch, listed as endangered under this act. The pit is proposed to be expanded to the west. This will result in a total cumulative loss (previously and proposed) of 260.65ha or 0.75% of the original undisturbed *E. tintinnans* woodland in the Yinberrie Hills site of conservation significance. This is one of the vegetation types where the Gouldian finch breeds, making nests in hollows of *E. tintinnans*.

A referral under the EPBC Act has been submitted to the Federal Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) at the beginning of April 2011.

The Federal Minister of Environment has declared the action (Project) a “controlled action” and therefore the environmental assessment process will be under the NT/Commonwealth bilateral environmental assessment process.



Northern Territory Legislation

Environmental Assessment Act 1982 and Environmental Assessment Administrative Procedures Act 1984

The *Environmental Assessment Act 1982* and the *Environmental Assessment Administrative Procedures Act 1984* ensure, to the greatest extent practicable, that each matter affecting the environment which is, in the opinion of the NT Minister, a matter which could reasonably be considered to be capable of having a significant effect on the environment, is fully examined and taken into account in, and in relation to:

- The formulation of proposals;
- The carrying out of works and other projects;
- The negotiation, operation and enforcement of agreements and arrangements (including agreements and arrangements with authorities of the Commonwealth, the States and other Territories);
- The making of or the participation in the making of, decisions and recommendations; and
- Incurring of expenditure.

A Notice of Intent (NOI) was prepared in accordance with the Information Guidelines for a Notice of Intent (NOI). The NT Environment Minister determined an Environmental Impact Statement will be required.

Territory Parks and Wildlife Conservation Act 2006

Several species including the pale field-rat and Mertens' water monitor are listed as threatened under the *Territory Parks and Wildlife Conservation Act 2006* (TPWC Act). Additional species including partridge pigeon and yellow-spotted monitor may also be present within the study area. Mitigation measures as highlighted in section 6 are likely to effectively address impacts on these species as critical habitat to these species does not appear to be present within the study area or proposed development footprints. Species such as the Mertens' water monitor and yellow-spotted monitor are seriously affected by the introduced cane toad, which is currently impacting on their populations as each of these species may suffer mortality following cane toad ingestion. The artificial habitats present within the Mt Todd Mine Site appear to be favoured by the Australian bustard, with 11 separate observations during the various GHD surveys. Recent fires and lack of hunting within the study area may have also contributed to the number of Australian bustard observed. Partridge pigeon may also be present within the study area, however, habitats within the surrounding Edith River and Yinberrie Hills localities appeared to provide enhanced habitat for this species with increased patchiness from burning regimes.

Mining Management Act 2001

The *Mining Management Act 2001* provides for authorisation of mining activities, management of mining sites, preparation of the environment on mining sites and related purposes. The Act is administered by NT Department of Resources (DoR). The objectives of the act are to:

- Ensure the development of the Territory's mineral resources are in accordance with environmental standards consistent with best practice in the mining industry;
- Protect the environment by:
 - The authorisation and monitoring of mining activities requiring appropriate management of mining sites;



- Facilitating consultation and cooperation between management and workers in implementing environment protection management systems;
 - Implementing audits, inspections, investigations, monitoring and reporting to ensure compliance with agreed standards and criteria; and
 - Specifying the obligations of all persons on mining sites with respect to protection of the environment.
- ▶ Assist the mining industry to introduce programs of continuous improvement to achieve best practice environmental management;
 - ▶ Enable persons connected with the mining industry to participate in the implementation of this Act through the establishment of a Mining Board to advise the Minister on:
 - Guidelines for the industry;
 - Specification of competencies required by persons involved in the industry;
 - Best practice in mining activities; and
 - Minimise the liability of the Territory by requiring the payment of security to provide for the rehabilitation of mining sites or to rectify environmental harm caused by mining activities.

The NOI was submitted to the DoR, who referred the Project to the EPA (formerly NRETAS).

Planning Act 2009

The *Planning Act 2009* defines "development" as an activity that involves carrying out works on land, including clearing of native vegetation. "Works" is defined as any activity on land other than mining or agriculture, resulting in a physical change to the land or a part of the land.

The planning scheme requires native vegetation to be cleared in accordance with the Land Clearing Guidelines 2010 (NRETAS 2010), which contain guidelines for clearing, including the submission of a property management plan by the applicant. The Land Clearing Guidelines do not apply to this project, because the proposed works are being undertaken as part of a mining operation. However one of the requirements stipulated in the Environmental Impact Statement (EIS) guidelines (EPA (formerly NRETAS) 2011) is to discuss proposed clearing with regard to issues raised and recommendations contained in the Clearing Guidelines.



Appendix B

Results of the EPBC protected matters search



EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information about the EPBC Act including significance guidelines, forms and application process details can be found at <http://www.environment.gov.au/epbc/assessmentsapprovals/index.html>

Report created: 25/06/12 15:03:23

[Summary](#)

[Details](#)

[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

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[Caveat](#)

[Acknowledgements](#)



This map may contain data which are
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[Coordinates](#)

Buffer: 10.0Km



Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see <http://www.environment.gov.au/epbc/assessmentsapprovals/guidelines/index.html>

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International	1
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	None
Threatened Ecological Communities:	1
Threatened Species:	11
Migratory Species:	15

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate. Information on the new heritage laws can be found at <http://www.environment.gov.au/heritage/index.html>

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at <http://www.environment.gov>.

<u>Commonwealth Lands:</u>	None
<u>Commonwealth Heritage Places:</u>	None
<u>Listed Marine Species:</u>	11
<u>Whales and Other Cetaceans:</u>	None
<u>Critical Habitats:</u>	None
<u>Commonwealth Reserves:</u>	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

<u>Place on the RNE:</u>	9
<u>State and Territory Reserves:</u>	1
<u>Regional Forest Agreements:</u>	None
<u>Invasive Species:</u>	10
<u>Nationally Important Wetlands:</u>	None

Details

Matters of National Environmental Significance

Wetlands of International Significance (RAMSAR)	[Resource Information]
Name	Proximity
<u>Kakadu (stage 1 & 3)</u>	Upstream from Ramsar

Threatened Ecological Communities	[Resource Information]
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For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
<u>Arnhem Plateau Sandstone Shrubland Complex</u>	Endangered	Community may occur

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence within area
Threatened Species		[Resource Information]
Name	Status	Type of Presence
BIRDS		
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat known to occur within area
Erythrura gouldiae Gouldian Finch [413]	Endangered	Species or species habitat known to occur within area
Falcunculus frontatus whitei Crested Shrike-tit (northern), Northern Shrike-tit [26013]	Vulnerable	Species or species habitat likely to occur within area
Geophaps smithii smithii Partridge Pigeon (eastern) [64441]	Vulnerable	Species or species habitat likely to occur within area
Rostratula australis Australian Painted Snipe [77037]	Vulnerable	Species or species habitat may occur within area
Tyto novaehollandiae kimberli Masked Owl (northern) [26048]	Vulnerable	Species or species habitat may occur within area
MAMMALS		
Conilurus penicillatus Brush-tailed Rabbit-rat, Brush-tailed Tree-rat [132]	Vulnerable	Species or species habitat may occur within area
Dasyurus hallucatus Northern Quoll [331]	Endangered	Species or species habitat likely to occur within area
Phascogale pirata Northern Brush-tailed Phascogale [82954]	Vulnerable	Species or species habitat likely to occur within area
Saccolaimus saccolaimus nudiclunatus Bare-rumped Sheath-tail Bat [66889]	Critically Endangered	Species or species habitat may occur within area
SHARKS		
Pristis microdon Freshwater Sawfish [66182]	Vulnerable	Species or species habitat likely to occur within area
Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat may occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat may occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Migratory Terrestrial Species		
Coracina tenuirostris melvillensis Melville Cicadabird [26187]		Species or species habitat may occur within area
Erythrura gouldiae Gouldian Finch [413]	Endangered	Species or species habitat known to occur within area
Falcunculus frontatus whitei Crested Shrike-tit (northern), Northern Shrike-tit [26013]	Vulnerable	Species or species habitat likely to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Poecilodryas superciliosa cerviniventris Derby White-browed Robin [26190]		Species or species habitat likely to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat may occur within area
Migratory Wetlands Species		
Ardea alba Great Egret, White Egret [59541]		Species or species habitat may occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Vulnerable*	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat may occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Ardea ibis Cattle Egret [59542]		area Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Vulnerable*	Species or species habitat may occur within area

Reptiles

Crocodylus johnstoni Freshwater Crocodile, Johnston's Crocodile, Johnston's River Crocodile [1773]		Species or species habitat may occur within area
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Extra Information

Places on the RNE [Resource Information]

Note that not all Indigenous sites may be listed.

Name	State	Status
Natural		
Yinberrie Hills	NT	Interim List
Acacia Helicophylla Sites	NT	Registered
Calytrix Faucicla Sites	NT	Registered
Calytrix Verticillata Sites	NT	Registered
Edith Falls Reserve (former)	NT	Registered
Hibiscus Menzelii Sites	NT	Registered
Nitmiluk National Park (1978 boundary)	NT	Registered
Historic		
Horseshoe Creek Battery and Settlement Site	NT	Indicative Place
Mount Todd Battery and Settlement Site	NT	Indicative Place

State and Territory Reserves [Resource Information]

Name	State
Nitmiluk (Katherine Gorge)	NT

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resources Audit,

Name	Status	Type of Presence
Frogs		
<u>Bufo marinus</u>		
Cane Toad [1772]		Species or species habitat likely to occur within area
Mammals		
<u>Bubalus bubalis</u>		
Water Buffalo, Swamp Buffalo [1]		Species or species habitat likely to occur within area
<u>Felis catus</u>		
Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
<u>Sus scrofa</u>		
Pig [6]		Species or species habitat likely to occur within area
Plants		
<u>Andropogon gayanus</u>		
Gamba Grass [66895]		Species or species habitat likely to occur within area
<u>Brachiaria mutica</u>		
Para Grass [5879]		Species or species habitat may occur within area
<u>Lantana camara</u>		
Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
<u>Parkinsonia aculeata</u>		
Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
<u>Parthenium hysterophorus</u>		
Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed [19566]		Species or species habitat may occur within area
<u>Pennisetum polystachyon</u>		
Mission Grass, Perennial Mission Grass, Missiongrass, Feathery Pennisetum, Feather Pennisetum, Thin Napier Grass, West Indian Pennisetum, Blue Buffel Grass [21194]		Species or species habitat likely to occur within area

Coordinates

-14.15402 132.12231

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- [Department of Environment, Climate Change and Water, New South Wales](#)
- [Department of Sustainability and Environment, Victoria](#)
- [Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [Department of Environment and Natural Resources, South Australia](#)
- [Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts](#)
- [Environmental and Resource Management, Queensland](#)
- [Department of Environment and Conservation, Western Australia](#)
- [Department of the Environment, Climate Change, Energy and Water](#)
- [Birds Australia](#)
- [Australian Bird and Bat Banding Scheme](#)
- [Australian National Wildlife Collection](#)
- Natural history museums of Australia
- [Museum Victoria](#)
- [Australian Museum](#)
- [SA Museum](#)
- [Queensland Museum](#)
- [Online Zoological Collections of Australian Museums](#)
- [Queensland Herbarium](#)
- [National Herbarium of NSW](#)
- [Royal Botanic Gardens and National Herbarium of Victoria](#)
- [Tasmanian Herbarium](#)
- [State Herbarium of South Australia](#)
- [Northern Territory Herbarium](#)
- [Western Australian Herbarium](#)
- [Australian National Herbarium, Atherton and Canberra](#)
- [University of New England](#)
- [Ocean Biogeographic Information System](#)
- [Australian Government, Department of Defence](#)
- [State Forests of NSW](#)
- Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the [Contact Us](#) page.



Appendix C

Brief reviews of threatened species biology and conservation status



Northern quoll (*Dasyurus hallucatus*)

The northern quoll is listed as critically endangered under the Northern Territory (NT) *Territory Parks and Wildlife Conservation* (TPWC) Act 2006 and endangered under the Federal *Environment Protection and Biodiversity Conservation* (EPBC) Act 1999. This species was formerly distributed across northern Australia, from the northwest cape of WA to southeast Qld but has contracted seriously ((Braithwaite and Griffiths 1994; Menkhorst and Knight 2011). The decline has been exacerbated by the spread of the cane toad (*Rhinella marina*) (Woinarski *et al.* 2008). The Northern quoll is highly susceptible to the poison of this species. Rapid contractions and local extinctions of populations have been reported following the toad's invasion of Cape York Peninsula (Burnett 1997) and parts of Kakadu National Park (van Dam *et al.* 2002; Watson and Woinarski 2003). This species is now restricted to six main areas including the Hamersley Range and Kimberley in WA, north and west Top End NT, north Cape York, Atherton, Cairns area and Carnarvon Range – Bowen area, Qld.

Habitat preferences for this species include a wide range of eucalypt forest and woodland habitats associated with steep dissected rocky terrain. They are also found in monsoon rainforest patches, vegetation along creek lines, adjacent to mangroves and around human settlements on beaches (Pollock 1999, Oakwood 2002, 2008 in DSEWPaC 2011). Important factors in the landscape appear to be shallow soils, large cover of rocks including outcropping rock, proximity to permanent water and the period since last fire (Woinarski *et al.* 2008).

This species is predominantly nocturnal and an opportunistic omnivore feeding largely on invertebrates (particularly insects) but including small mammals, birds (and their eggs), frogs, nectar and fruits. Reproduction is annual and highly synchronised within a population. All the males die following mating (Oakwood 2004).

There is one previously documented record of the Northern quoll approximately four kilometres to the northwest of the Mt Todd mineral lease (see Figure below). This record may be the individual trapped during the Lane *et al.* (1990) survey. They reported that "scats and active animals were observed in both surveys in various habitats", although these records don't appear to have been included in the NT Fauna Atlas. There are an additional three NT Fauna Atlas records for this species from in the broader area of the Yinberrie Hills, well outside of the Mt Todd mineral lease.

Pale field-rat (*Rattus tunneyi*)

The pale field-rat is found in high rainfall areas of the northern Australia ranging from the Kimberley to south-eastern Queensland including the Top End of the NT. Formerly the range extended into arid and semi-arid areas and temperate south-western Australia but retracted to higher rainfall areas in the north. This once widespread species is found in dense vegetation along creeklines, sheltering in extensive shallow burrows during the day and forming loose colonies.

The pale field-rat is has undergone considerable declined across the Top End of the NT over the past ten years, with no clear explanation. On-going monitoring in three national parks have recorded significant declines of pale field rat, including Kakadu National Park a former stronghold for the species (Woinarski *et al.* 2010). The current Territory wide decline is probably due to ongoing inappropriate fire regimes (too frequent) affecting habitat suitability, and predation by feral cats (Woinarski *et al.* 2010).

Crested shrike-tit (northern) (*Falcunculus frontatus whitei*)

The Crested shrike-tit (northern) is a subspecies of the crested shrike-tit, differing from subspecies in eastern and southern Australia. It is sparsely distributed across the top half of the NT and across to the



western Kimberley in Western Australia (Ward *et al.* 2009). This species is not well known (DSEWPac 2010). Robinson and Woinarski (1992) collated 26 records from 22 localities at that time. The species is listed as vulnerable under the TPWC and the EPBC Acts.

Pairs of northern shrike-tit occupy exclusive territories (approximately 22ha in area) and are resident the year round (Ward *et al.* 2009). Habitat requirements in the Katherine region appear to be open mixed woodland with grassy understorey on heavy soils shallowly inundated for much of the wet season (Ward *et al.* 2009). Records in northern Arnhem Land come from low *Melaleuca* spp. woodland in grassy drainage lines. There are reports of the species in hillier areas such as Borroloola and the Yinberrie hills.

The relatively small size of shrike-tits (15-17cm total length), their quiet foraging behaviour (in the east and south they are noisy foragers as they peel back bark to glean insects) and sparse distribution are likely to contribute to the small number of records for the subspecies. They are distinctive and easily identified once located and have a distinctive call. Calls broadcasted during the breeding season may elicit a response.

There is one northern shrike-tit record from the Mt Todd mineral lease, immediately north of the Batman Pit (see Figure below). Lane *et al.* (1990) reported hearing a crested shrike-tit calling to the west of where the Batman Pit now exists (reported as “west of the proposed mine site”). Three other records were documented from within five kilometres of the mine lease.

Gouldian finch (*Erythrura gouldiae*)

The Gouldian finch is listed as endangered under the EPBC Act and vulnerable under the TPWC Act. The conservation status of this species was relaxed in December 2012, from endangered to vulnerable, by the NT Government, based on a large series of Gouldian finch records in new location across the Top End in the past few years. It was distributed throughout the tropical savannahs of northern Australia. Over the past 100 years it has undergone a large population decline and contraction in range (O'Malley 2005; Woinarski *et al.* 2007). This species is now restricted to isolated populations mostly in the Kimberley and the NT. It is now rarely encountered in Queensland (O'Malley 2005).

The Gouldian finch occupies two different components of the landscape on an annual cycle (Dostine *et al.* 2001; Zhang and Hempel 2001; Lewis 2007). During and following nesting (mostly between March and July) birds are predominantly confined to *Eucalyptus tintinnans* woodlands on rock hillsides. *E. tintinnans* provides holes suitable for nesting (Price 1992; Tidemann *et al.* 1999, 2009). Breeding occurs from February to October (Tidemann *et al.* 1999). During this period they forage on shed seeds of native sorghum (*Sorghum intrans*) and obtain water from permanent rocky waterholes (Dostine and Franklin 2002; Woinarski *et al.* 2007). Sorghum is tolerant of hot fires (Watkins *et al.* 1989). Shortly after germination of *S. intrans* seed in the early wet season, they disperse to sites where new grass is available from early seeding perennial grasses (Dostine *et al.* 2001, Lewis 2007).

A succession of grass species produce foods eaten by the Gouldian finch during the wet season. The sequence of seeding, from earliest to latest is *Alloternopsis semialata*, *Chrysopogon falax*, *Triodia bitextura*, *Heteropogon triticeus*. *T. bitextura* is sensitive to hot late season fires and does not seed well following fire (Dostine *et al.* 2001, Lewis 2007). *A. semialata* is relatively tolerant of cool early dry season fires but does not seed well following hot late season fires (Lewis 2007). *C. falax* is more tolerant of hot late season fires than *T. bitextura* and *A. semialata* (Lewis 2007).

Daily movements by the Gouldian finch seem approximately the same during the wet and dry seasons (means of 924m and 825m respectively (Lewis 2007). The daily area covered in the dry season (885ha)



may be less than in the wet season (2,054ha) (Lewis 2007). The available estimates of daily movements and range are associated with high levels of variation that make interpretation difficult.

The threatened status of the Gouldian finch seems associated with poor survival during the early wet season (Woinarski and Tidemann 1992). A range of threatening processes may impact this species. These include high levels of infestation with the endoparasitic air-sac mite *Sternostoma tracheacolum* and an associated significant pathology among wild birds (Tidemann *et al.* 1992; Bell 1996). Pastoralism, trapping for the aviary trade and inappropriate fire regimes have been suggested as possible threats (Franklin 1999; Woinarski *et al.* 2007), although no direct evidence is available to link these possibilities to the Gouldian finch decline.

The Yinberrie Hills population of Gouldian finch is one of only two known populations that exceed 150 adults birds (O'Malley 2005). The Yinberrie Hills population is regarded as the largest known, with a total population of up to 250 adults (O'Malley 2005). The Yinberrie Hills are important due to the presence of trees supporting suitable nesting hollows, presence of reliable dry season water and foraging opportunities. A long-term nest monitoring programme was established following the commissioning of the Mt Todd mine (Price 1992; Collins *et al.* 1993; Smith *et al.* 1995; Bamford and Bamford 1996) based on the occupancy of nesting hollows. Twenty 1 ha quadrats were sampled for nests along four concentric arcs. The arcs were placed on radii of 1, 1.75, 2.75 and 3.5km respectively and extended to the north, west and south of the Batman Pit on the Mt Todd Mine Site. Quadrats were distributed non-uniformly along each of the arcs, rather than at regular intervals. Each of the 80 quadrats contained at least 20 *E. tintinnans* trees. Results from the nest monitoring program indicated no significant change in the occupancy of appropriate hollows over four years of sampling (1992, 1993, 1995 and 1996). No relationship was found between nesting frequency and distance from the mine although available nest hollows varied in quadrats from one year to the next. There were statistical problems with the sample design. Annual waterhole monitoring from 1996 of adult and immature birds undertaken in the late dry season by NRETAS appears to indicate no change in population over the years 1996 to 2010 (NRETAS *pers. comm.*; Woinarski *et al.* 2007). Further reports by Ward and Voulkolos (2009) also conclude that the species does not appear to be increasing or decreasing in the Yinberrie Hills.

The NT Fauna Atlas contains 496 records of this species from the Yinberrie Hills including from the Mineral Leases (see Figure below). The abundance of records reflects the high level of survey effort expended as a result of the various monitoring programmes implemented for this species.

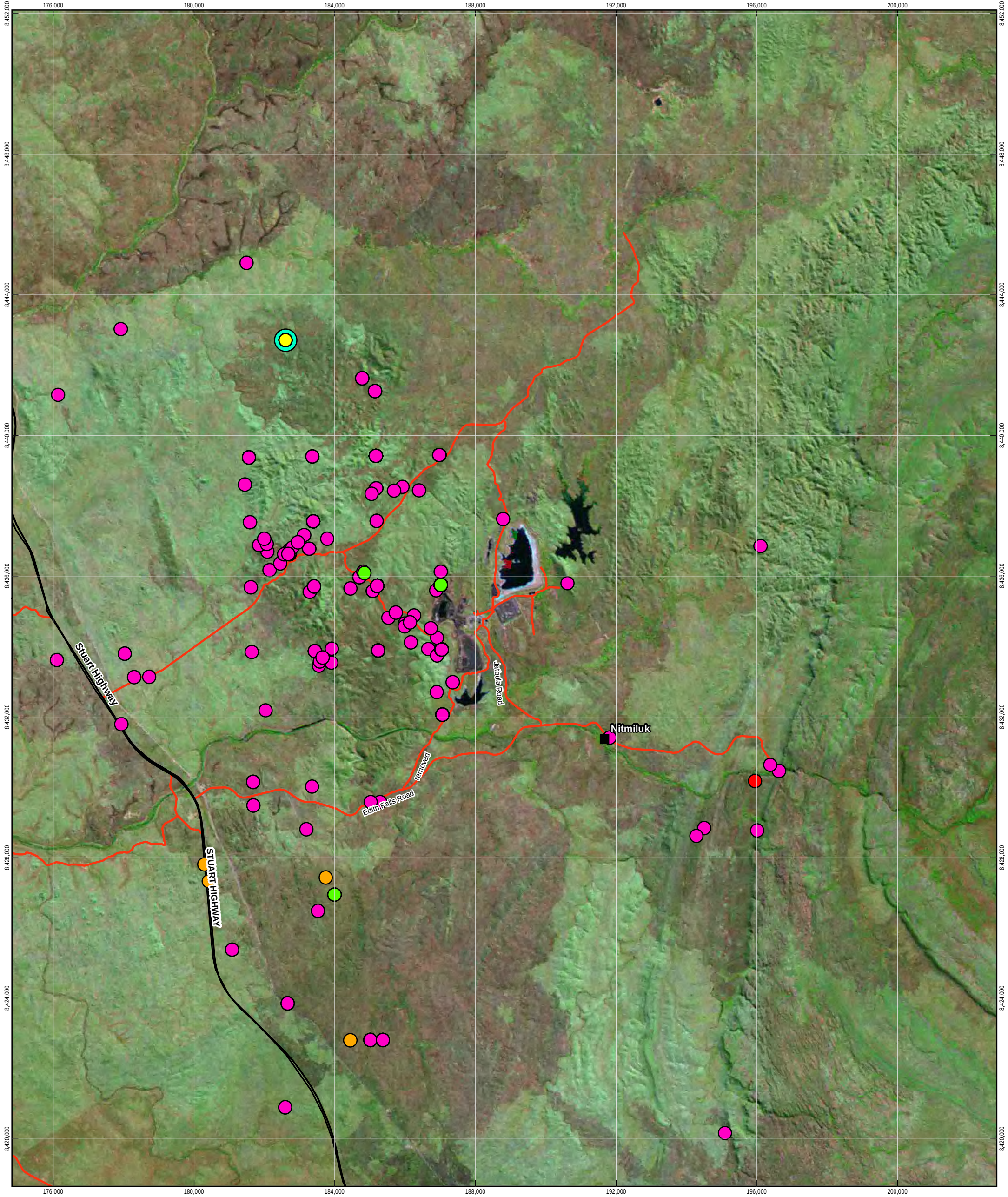
Partridge pigeon (eastern) (*Geophaps smithii smithii*)

The partridge pigeon is listed as vulnerable under the EPBC and TPWC Acts. It remains abundant in some locations such as parts of Kakadu National Park (NP), Litchfield NP and the Tiwi Islands.

Threats affecting this species may include predation by feral cats (they are a ground nesting and foraging species), and dry seasons leading to diminished water resources (it relies on daily access to drinking water). Other more profound threats of broader influence may include the introduction of exotic and vigorously growing grasses. Changed fire regimes from frequent small patchy burns to broad-scale relatively hot fires are exacerbated by greater fuel loads from exotic grass species (Fraser *et al.*, 2003; Woinarski *et al.* 2007). Partridge pigeon benefit from patchily distributed relatively cool early dry season fires. The partridge pigeon prefers to feed in recently burnt areas but shelter, roost and nest in vegetated areas (Fraser *et al.*, 2003; DSEWPac 2010). It occurs in open forest and woodland dominated by Darwin stringybark (*Eucalyptus tetradonta*) and Darwin woollybutt (*Eucalyptus miniata*) with a structurally diverse understorey (Braithwaite 1985; Higgins and Davies 1996; Garnet & Crowley 2000).



Partridge pigeon are gregarious, occurring in small flocks or as singles or pairs. There are eight records for this species within approximately four kilometres of the mine lease. It is known to occur adjacent to the railway line on the Edith Falls Road (Mike Reed *pers comm.*). There are no records from the Mineral Leases (see Figure below).



LEGEND

■

Place Names

●

Gouldian finch

●

Partridge pigeon

●

Northern quoll

●

Grey falcon

●

Crested shrike-tit (northern)

●

Pale field-rat

—

Major Roads

—

Access Roads



Painted honeyeater (Grantiella picta)

The painted honeyeater has a broad distribution in eastern Australia, but is nowhere very numerous. Most breeding occurs in the inland slopes of south-eastern Australia, and non-breeding birds move widely out into semi-arid and northern regions.

There are few records of this species in the Northern Territory, most coming from the Barkly Tablelands and a recent record from Nitmiluk NP. There is no evidence of a breeding population in the Territory and the records are thought to be of irregular visitors from the south-east (though it is possibly a regular visitor in small numbers).

Painted Honeyeaters are the most specialised honeyeaters, being almost wholly dependent on mistletoe fruits, but may also feed on nectar and insects. They inhabit woodlands and open forest and prefer habitats with more mature trees since these host more mistletoe (Garnett *et al.* 2011).

Red goshawk (Erythrorchis radiatus)

The red goshawk is listed as vulnerable under the EPBC and TPWC Acts. It occurs across much of northern Australia from Broome WA to south-west Qld. It inhabits coastal and subcoastal tall, open forests and woodlands, tropical savannas with tree-lined waterways and the edges of rainforests (Marchant and Higgins in DSEWPac 2010). Nests are located above a height of 20m in tall trees (> 30m), generally in groups of the tallest trees (>25m). Further inland suitable nesting trees are restricted to the banks of major waterways. Red goshawk nests are large, generally constructed on live branches in living trees and often built where a large, horizontal limb forks and provides support. There is usually sufficient clearance to allow birds to approach with sticks up to 2m long (Baker-Gabb *pers. comm.* in DSEWPac 2010).

The red goshawk is very secretive and generally silent. Its presence is most likely detected by the presence of the distinctive basket-shaped stick nest in habitat as described above. Survey methods include driving along inland rivers searching for tall trees suitable for nesting and driving tracks in tropical woodland searching for suitable nesting trees. Some success has been achieved conducting call playback during the breeding season. Lane *et al.* (1990) did not record this species and there are no records from the area in the NT Fauna Atlas.

Australian bustard (Ardeotis australis)

The Australian bustard is listed as near threatened under the TPWC Act. It is widespread, although generally scarce in the Northern Territory (Woinarski *et al.* 2007). It is more common in the north of Australia, occurring in loose aggregations, particularly during the breeding season when they exhibit a unique 'exploded' lek mating system where the males occupy display arenas visited by females for mating (Woinarski *et al.* 2007).

The Australian bustard typically occurs in open habitats, preferring grasslands, low shrublands, grassy woodlands and other structurally similar but artificial habitats such as croplands and airfields (Downes and Speedie 1992 in Woinarski *et al.* 2007). This species responds favourably to fire and is often located in recently burnt habitats, including woodlands.

Threats to this species include fluctuations in rainfall, altered fire regimes, predation by exotic species, habitat alteration, pesticides, grazing and hunting pressure (e.g. effects of traditional hunting on a species with a low reproductive rate using modern weapons).



Methods to detect this species generally involve covering large distances in appropriate habitat, possibly vehicle-based or via transects. This species was recorded by Lane *et al.* (1990) and there are six records from the Yinberrie Hills in the NT Fauna Atlas.

Mertens' water monitor (Varanus mertensi)

Mertens' water monitor is listed as vulnerable under the TPWC Act. It has a broad geographic range, occupying coastal and inland waters across the far north of Australia from the Kimberley to the western side of Cape York Peninsula. This is a semi-aquatic monitor and strong swimmer that consumes fish, frogs, aquatic invertebrates, carrion, insects and small vertebrates. It has undergone significant declines in abundance across the Top End since the arrival of the cane toad (*Rhinella marina*) (Doody *et al.* 2009).

Tests of the effects of cane toad toxin on *V. mertensi* have found that this species is highly susceptible and easily able to ingest toads sufficiently large to cause mortality (Doody *et al.* 2009). Research has shown that monitor populations typically experience acute population crashes of 71 to 97% (Doody *et al.* 2009) then slowly increase due to ongoing selection of monitors that avoid toads, with broader impacts on populations not as severe as at individual locations (Woinarski *et al.* 2007).

Methods to detect this species include walking slowly along the fringes of waterways and waterbodies, observing potential basking locations with binoculars to avoid disturbing individuals. Two records for this species are present in the NT Fauna Atlas, possibly the two individuals recorded from the upper reaches of Horseshoe Creek by Lane *et al.* (1990). The 1990 survey reported *V. mertensi* to be "most common along the Edith River".

Mitchell's water monitor (Varanus mitchelli)

Mitchell's water monitor is listed as vulnerable under the TPWC Act. Similar to Mertens' water monitor, this species has a broad geographic range, occupying coastal and inland waters across the far north of Australia from the Kimberley to the western side of Cape York Peninsula. This is a semi-aquatic monitor and strong swimmer that preys on fish, frogs, aquatic invertebrates, carrion, insects and small vertebrates.

Mitchell's water monitor inhabits all of the NT's northern river systems (except the southern Gulf). The most important conservation issue this species faces is its propensity to eat cane toads and it is likely that continued monitor/toad evolutionary interactions will determine the viability of populations of this species within the NT in the future.

Methods to detect this species include walking slowly along the fringes of waterways and waterbodies, observing potential basking locations with binoculars to avoid disturbing individuals.

Yellow-spotted monitor (Varanus panoptes)

The yellow-spotted monitor is listed as vulnerable under the TPWC Act. It has a broad range across the far north of Australia from the Kimberley in Western Australia to Cape York Peninsula and southwards through most of Qld. The yellow-spotted monitor is a robust terrestrial species that occupies a variety of habitats including coastal beaches, floodplains, grasslands and woodlands, foraging on a variety of terrestrial vertebrates, insects and carrion. Similar to *V. mertensi*, this species is capable of ingesting cane toads large enough to cause mortality to the extent that this species has experienced significant declines (Doody *et al.* 2009).

There is evidence that *V. panoptes* continues to persist in areas such as around Townsville where cane toads occur (Burnett 1997). Kutt *et al.* 2005 reports that this species continued to persist following cane



toad invasion at a site recently sampled on Cape York Peninsula. Studies at Kakadu National Park reported variation in the response of *V. panoptes* to cane toads, with some sub-populations declining markedly, while others did not, suggesting that some animals may avoid cane toads. As with *V. mertensi*, local monitor populations are likely to suffer crashes then slowly increase over time.

Methods to detect this species include vehicle-based area searches, walked transects and baited camera traps. Lane *et al.* (1990) reported a large individual near Horseshoe Creek. This record is present in the NT Fauna Atlas.



Appendix D

List of fauna species for the study area recorded during the current and previous surveys



Common Name	Scientific Name	GHD (ALL)	GHD DRY	GHD WET	GHD May 2011	GHD Sept 2012	DLRM Fauna Atlas	Lane <i>et al.</i> 1990	NT status	E
Mammals										
Short-beaked Echidna	<i>Tachyglossus aculeatus</i>	X			X		X	X	LC	
Northern Quoll	<i>Dasyurus hallucatus</i>						X	X	CE	
Brush-tailed Phascogale	<i>Phascogale pirata</i>								EN	
Common Planigale	<i>Planigale maculata</i>	X	X				X	X	LC	
Red-cheeked Dunnart	<i>Sminthopsis virginiae</i>						X	X	DD	
Rock Ringtail Possum	<i>Petropseudes dahli</i>						X		LC	
Sugar Glider	<i>Petaurus breviceps</i>						X	X	LC	
Black-footed Tree-rat	<i>Mesembriomys gouldii</i>						X	X	VU	
Brush-tailed Tree-rat	<i>Conilurus penicillatus</i>								VU	
Common Rock-rat	<i>Zyzomys argurus</i>						X	X	LC	
Northern Short-tailed Mouse	<i>Leggadina lakedownensis</i>						X	X	LC	
Grassland Melomys	<i>Melomys burtoni</i>						X		LC	
Delicate Mouse	<i>Pseudomys delicatulus</i>	X		X					LC	
Western Chestnut Mouse	<i>Pseudomys nanus</i>	X	X				X	X	NT	
Pale Field-rat	<i>Rattus tunneyi</i>	X	X	X			X	X	VU	
Water Rat	<i>Hydromys chrysogaster</i>						X		LC	
Unidentified rodent (sp. 1)		X	X	X					LC	
Unidentified rodent (sp. 2)		X	X	X					LC	
Agile Wallaby	<i>Macropus agilis</i>	X	X	X	X	X	X	X	LC	
Antilopine Wallaroo	<i>Macropus antilopinus</i>	X	X	X			X	X	LC	
Black Wallaroo	<i>Macropus bernardus</i>						X		DD	
Euro	<i>Macropus robustus</i>	X	X		X		X	X	LC	



Common Name	Scientific Name	GHD (ALL)	GHD DRY	GHD WET	GHD May 2011	GHD Sept 2012	DLRM Fauna Atlas	Lane <i>et al.</i> 1990	NT status	E
Northern Nailtail Wallaby	<i>Onychogalea unguifera</i>						X		NT	
Short-eared Rock-wallaby	<i>Petrogale brachyotis</i>						X		LC	
Dingo	<i>Canis lupus</i>	X	X	X	X		X	X	LC	
Black Flying-fox	<i>Pteropus alecto</i>	X	X		X		X	X	LC	
Little Red Flying-fox	<i>Pteropus scapulatus</i>	X				X	X	X	LC	
Northern Free-tailed Bat	<i>Chaerephon jobensis</i>	X	X	X			X	X	LC	
Gould's Wattled Bat	<i>Chalinolobus gouldii</i>	X?	X?	X			X	X	LC	
Hoary Wattled Bat	<i>Chalinolobus nigrogriseus</i>	X?	X?	X			X	X	LC	
Dusky Leaf-nosed Bat	<i>Hipposideros ater</i>						X	X	LC	
Northern Leaf-nosed bat	<i>Hipposideros stenotis</i>						X	X	VU	
Ghost Bat	<i>Macroderma gigas</i>						X	X	NT	
Northern Bentwing Bat	<i>Miniopterus schreibersii orianae</i>	X		X					LC	
Northern Bentwing Bat/Forest Pipistrelle	<i>Miniopterus orianae/Pipistrellus adamsi</i>	X?	X?	X?					LC	
Beccari's Free-tailed Bat	<i>Mormopterus beccarii</i>	X?	X?	X			X	X	LC	
Large-footed Myotis	<i>Myotis macropus</i>	X?	X?						LC	
Pygmy Long-eared Bat	<i>Nyctophilus walkeri</i>	X?	X?						LC	
Eastern Long-eared Bat	<i>Nyctophilus daedalus</i>	X?	X?				X	X	LC	
Lesser Long-eared Bat	<i>Nyctophilus geoffroyi</i>	X?	X?				X	X	LC	
Orange Leaf-nosed bat	<i>Rhinonictis aurantia</i>						X		NT	
Yellow-bellied Sheath-tailed Bat	<i>Saccolaimus flaviventris</i>	P	P	X			X	X	LC	
Bare-rumped Sheath-tailed Bat	<i>Saccolaimus saccolaimus nudicluniatus</i>								NT	
Little Broad-nosed Bat	<i>Scotorepens greyii</i>	X?	X?	X			X	X	LC	
Common Sheath-tailed Bat	<i>Taphozous georgianus</i>	X?	X?				X	X	LC	



Common Name	Scientific Name	GHD (ALL)	GHD DRY	GHD WET	GHD May 2011	GHD Sept 2012	DLRM Fauna Atlas	Lane <i>et al.</i> 1990	NT status	E
Arnhem Sheath-tail-bat	<i>Taphozous kapalgensis</i>	X	X						LC	
Northern Cave Bat	<i>Vespadelus caurinus</i>	X	X				X	X	LC	
Inland Cave Bat	<i>Vespadelus finlaysoni</i>	X?	X?	X					LC	
Cattle*	<i>Bos indicus</i>	X	X		X	X	X	X	*	
Swamp Buffalo*	<i>Bubalus bubalis</i>	X		X			X	X	*	
Donkey*	<i>Equus asinus</i>	X	X					X	*	
Horse*	<i>Equus caballus</i>						X	X	*	
Cat*	<i>Felis catus</i>	X			X		X		*	
Black Rat*	<i>Rattus rattus</i>						X		*	
Pig*	<i>Sus scrofa</i>	X	X	X	X	X	X	X	*	
Birds										
Apostlebird	<i>Struthidea cinerea</i>						X		LC	
Australasian Figbird	<i>Sphecotheres vieilloti</i>						X		LC	
Australasian Grebe	<i>Tachybaptus novaehollandiae</i>	X	X			X	X	X	LC	
Australasian Pipit	<i>Anthus novaeseelandiae</i>	X			X		X		LC	
Australian Bustard	<i>Ardeotis australis</i>	X	X	X	X	X	X	X	NT	
Australian Darter	<i>Anhinga novaehollandiae</i>	X	X			X	X		LC	
Australian Hobby	<i>Falco longipennis</i>	X	X	X		X	X		LC	
Australian Kestrel	<i>Falco cenchroides</i>	X	X		X		X		LC	
Australian Magpie	<i>Cracticus tibicen</i>	X		X	X		X		LC	
Australian Owlet-nightjar	<i>Aegotheles cristatus</i>	X	X	X			X	X	LC	
Australian Pelican	<i>Pelicanus conspicillatus</i>	X		X		X	X		LC	
Australian Pratincole	<i>Stiltia isabella</i>						X		LC	



Common Name	Scientific Name	GHD (ALL)	GHD DRY	GHD WET	GHD May 2011	GHD Sept 2012	DLRM Fauna Atlas	Lane <i>et al.</i> 1990	NT status	E
Australian White Ibis	<i>Threskiornis molucca</i>	X		X		X	X		LC	
Azure Kingfisher	<i>Alcedo azurea</i>	X		X		Edith	X	X	LC	
Banded Honeyeater	<i>Certhionyx pectoralis</i>	X	X	X	Edith		X	X	LC	
Bar-breasted Honeyeater	<i>Ramsayornis fasciatus</i>	X			Edith		X	X	LC	
Barking Owl	<i>Ninox connivens</i>	X	X			X	X	X	LC	
Bar-shouldered Dove	<i>Geopelia humeralis</i>	X	X	X	X		X	X	LC	
Black Bittern	<i>Ixobrychus flavicollis</i>	X		X	X		X	X	LC	
Black Falcon	<i>Falco subniger</i>	X		X			X		LC	
Black Honeyeater	<i>Certhionyx niger</i>	X		X	X				LC	
Black Kite	<i>Milvus migrans</i>	X		X	X		X	X	LC	
Black-breasted Buzzard	<i>Hamirostra melanosternon</i>	X	X		X		X	X	LC	
Black-chinned Honeyeater	<i>Melithreptus gularis</i>						X	X	LC	
Black-eared Cuckoo	<i>Chrysococcyx osculans</i>						X	X	LC	
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>	X	X	X	X	X	X	X	LC	
Black-faced Woodswallow	<i>Artamus cinereus</i>	X	X	X	X		X	X	LC	
Black-fronted Dotterel	<i>Euseiornis melanops</i>	X			X	X	X	X	LC	
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	X	X	X	X	X	X	X	LC	
Black-shouldered Kite	<i>Elanus axillaris</i>	X			X		X		LC	
Black-tailed Treecreeper	<i>Climacteris melanura</i>	X	X	X	X		X	X	LC	
Black-winged Stilt	<i>Himantopus himantopus</i>	X				X			LC	
Blue-faced Honeyeater	<i>Entomyzon cyanotis</i>	X	X	X	X	X	X	X	LC	
Blue-winged Kookaburra	<i>Dacelo leachii</i>	X	X	X	X	X	X	X	LC	
Broad-billed Flycatcher	<i>Myiagra ruficollis</i>	X		X					LC	



Common Name	Scientific Name	GHD (ALL)	GHD DRY	GHD WET	GHD May 2011	GHD Sept 2012	DLRM Fauna Atlas	Lane <i>et al.</i> 1990	NT status	E
Brolga	<i>Grus rubicunda</i>	X	X		Edith	X	X		LC	
Brown Falcon	<i>Falco berigora</i>	X	X	X	X		X	X	LC	
Brown Goshawk	<i>Accipiter fasciatus</i>	X	X	X	X	X	X	X	LC	
Brown Honeyeater	<i>Lichmera indistincta</i>	X	X	X	X		X	X	LC	
Brown Quail	<i>Coturnix ypsilophora</i>	X	X	X		X	X		LC	
Brush Cuckoo	<i>Cacomantis variolosus</i>	X	X	X	X		X	X	LC	
Budgerigar	<i>Melopsittacus undulatus</i>						X	X	LC	
Buff-banded Rail	<i>Gallirallus philippensis</i>	X		X					LC	
Buff-sided Robin	<i>Poecilodryas cerviniventris</i>						X	X	LC	
Bush Stone-curlew	<i>Burhinus grallarius</i>	X	X	X	X	X	X	X	NT	
Cattle Egret	<i>Bubulcus ibis</i>	X	X			X	X		LC	
Channel-billed Cuckoo	<i>Scythrops novaehollandiae</i>	X	X				X	X	LC	
Chestnut-backed Button-quail	<i>Turnix castanotus</i>						X	X	DD	
Chestnut-breasted Mannikin	<i>Lonchura castaneothorax</i>	X	X	X	X		X	X	LC	
Cicadabird	<i>Coracina tenuirostris</i>						X		LC	
Clamorous Reed Warbler	<i>Acrocephalus stentoreus</i>	X			X				LC	
Cockatiel	<i>Nymphicus hollandicus</i>	X	X		X	X	X	X	LC	
Collared Sparrowhawk	<i>Accipiter cirrocephalus</i>	X	X		X		X	X	LC	
Comb-crested Jacana	<i>Irediparra gallinacea</i>	X	X			X			LC	
Common Bronzewing	<i>Phaps chalcoptera</i>	X				X	X	X	LC	
Crested Pigeon	<i>Ocyphaps lophotes</i>	X	X		X		X	X	LC	
Crested Shrike-tit (northern)	<i>Falcunculus frontatus whitei</i>	X?	X?				X	X	NT	
Crimson Finch	<i>Neochmia phaeton</i>	X	X	X	X	Edith	X	X	LC	



Common Name	Scientific Name	GHD (ALL)	GHD DRY	GHD WET	GHD May 2011	GHD Sept 2012	DLRM Fauna Atlas	Lane <i>et al.</i> 1990	NT status	E
Diamond Dove	<i>Geopelia cuneata</i>	X	X		Edith	X	X	X	LC	
Dollarbird	<i>Eurystomus orientalis</i>	X	X	X		X	X	X	LC	
Double-barred Finch	<i>Taeniopygia bichenovii</i>	X	X		X	Edith	X	X	LC	
Dusky Honeyeater	<i>Myzomela obscura</i>	X	X			X	X	X	LC	
Eastern Barn Owl	<i>Tyto javanica</i>						X	X	LC	
Eastern Great Egret	<i>Ardea alba modesta</i>	X	X	X		X	X	X	LC	
Eastern Koel	<i>Eudynamys orientalis</i>	X	X				X	X	LC	
Fairy Martin	<i>Petrochelidon ariel</i>						X		LC	
Flock Bronzewing	<i>Phaps histrionica</i>						X		NT	
Forest Kingfisher	<i>Todiramphus macleayii</i>						X	X	LC	
Fork-tailed Swift	<i>Apus pacificus</i>						X		LC	
Galah	<i>Eolophus roseicapilla</i>	X	X	X	X	X	X	X	LC	
Glossy Ibis	<i>Plegadis falcinellus</i>	X				X			LC	
Golden-headed Cisticola	<i>Cisticola exilis</i>	X	X	X		Edith	X	X	LC	
Gouldian Finch	<i>Erythrura gouldiae</i>	X			X		X	X	VU	
Great Bowerbird	<i>Chlamydera nuchalis</i>	X	X	X	X	X	X	X	LC	
Great Cormorant	<i>Phalacrocorax carbo</i>	X				X			LC	
Green Pygmy Goose	<i>Nettapus pulchellus</i>	X	X			X	X	X	LC	
Green-backed Gerygone	<i>Gerygone chloronota</i>	X	X				X	X	LC	
Grey Butcherbird	<i>Cracticus torquatus</i>	X	X		X		X	X	LC	
Grey Falcon	<i>Falco hypoleucos</i>						X	X	VU	
Grey Fantail	<i>Rhipidura albiscapa</i>						X	X	LC	
Grey Goshawk	<i>Accipiter novaehollandiae</i>	X	X				X	X	LC	



Common Name	Scientific Name	GHD (ALL)	GHD DRY	GHD WET	GHD May 2011	GHD Sept 2012	DLRM Fauna Atlas	Lane <i>et al.</i> 1990	NT status	E
Grey Shrike-thrush	<i>Colluricincla harmonica</i>	X	X	X	X	X	X		LC	
Grey Teal	<i>Anas gracilis</i>	X		X		X	X	X	LC	
Grey-crowned Babbler	<i>Pomatostomus temporalis</i>	X	X	X	X	X	X	X	LC	
Grey-fronted Honeyeater	<i>Lichenostomus plumulus</i>	X	X				X	X	LC	
Ground Cuckoo-shrike	<i>Coracina maxima</i>						X		LC	
Hardhead	<i>Aythya australis</i>						X	X	LC	
Helmeted Friarbird	<i>Philemon buceroides</i>	X		X	X	X	X	X	LC	
Hoary-headed Grebe	<i>Poliocephalus poliocephalus</i>						X	X	LC	
Hooded Parrot	<i>Psephotus dissimilis</i>	X			Edith		X	X	NT	
Hooded Robin (Mainland)	<i>Melanodryas cucullata picata/westralensis</i>						X	X	LC	
Horsfield's Bushlark	<i>Mirafra javanica</i>						X	X	LC	
Horsfield's Bronze Cuckoo	<i>Chrysococcyx basalis</i>	X	X				X		LC	
Intermediate Egret	<i>Ardea intermedia</i>	X	X	X		X	X	X	LC	
Jacky Winter	<i>Microeca fascinans</i>	X			X		X	X	LC	
Large-tailed Nightjar	<i>Caprimulgus macrurus</i>						X	X	LC	
Leaden Flycatcher	<i>Myiagra rubecula</i>	X	X	X	X	X	X	X	LC	
Lemon-bellied Flycatcher	<i>Microeca flavigaster</i>	X		X	X		X	X	LC	
Little Black Cormorant	<i>Phalacrocorax sulcirostris</i>	X				X	X	X	LC	
Little Bronze Cuckoo	<i>Chrysococcyx minutillus</i>						X	X	LC	
Little Button-quail	<i>Turnix velox</i>						X	X	LC	
Little Corella	<i>Cacatua sanguinea</i>	X	X				X	X	LC	
Little Eagle	<i>Hieraaetus morphnoides</i>						X	X	LC	
Little Egret	<i>Egretta garzetta</i>	X				X	X	X	LC	



Common Name	Scientific Name	GHD (ALL)	GHD DRY	GHD WET	GHD May 2011	GHD Sept 2012	DLRM Fauna Atlas	Lane <i>et al.</i> 1990	NT status	E
Little Friarbird	<i>Philemon citreogularis</i>	X	X	X			X	X	LC	
Little Pied Cormorant	<i>Microcarbo melanoleucos</i>	X				X	X	X	LC	
Little Woodswallow	<i>Artamus minor</i>	X		X			X	X	LC	
Long-tailed Finch	<i>Poephila acuticauda</i>	X	X	X	X	Edith	X	X	LC	
Magpie Goose	<i>Anseranas semipalmata</i>						X		LC	
Magpie-lark	<i>Grallina cyanoleuca</i>	X	X	X	X	X	X	X	LC	
Marsh Sandpiper	<i>Tringa stagnatilis</i>	X				X			LC	
Masked Finch	<i>Poephila personata</i>	X	X	X	X	Edith	X	X	LC	
Masked Lapwing	<i>Vanellus miles</i>	X	X		X	X	X	X	LC	
Masked Owl (northern)	<i>Tyto novaehollandiae kimberli</i>								VU	
Masked Woodswallow	<i>Artamus personatus</i>	X		X		X	X		LC	
Mistletoebird	<i>Dicaeum hirundinaceum</i>	X	X	X			X	X	LC	
Nankeen Night Heron	<i>Nycticorax caledonicus</i>	X				X	X	X	LC	
Northern Fantail	<i>Rhipidura rufiventris</i>	X		X	X	X	X	X	LC	
Northern Rosella	<i>Platycercus venustus</i>	X	X	X	X		X	X	LC	
Olive-backed Oriole	<i>Oriolus sagittatus</i>	X	X	X			X	X	LC	
Oriental Cuckoo	<i>Cuculus optatus</i>						X	X	LC	
Oriental Plover	<i>Charadrius veredus</i>								LC	
Oriental Pratincole	<i>Glareola maldivarum</i>								LC	
Pacific Baza	<i>Aviceda subcristata</i>	X	X				X		LC	
Pacific Black Duck	<i>Anas superciliosa</i>	X		X		X	X	X	LC	
Painted Honeyeater	<i>Grantiella picta</i>	X	X						VU	
Pale-vented Bush-hen	<i>Amauornis moluccana</i>						X		LC	



Common Name	Scientific Name	GHD (ALL)	GHD DRY	GHD WET	GHD May 2011	GHD Sept 2012	DLRM Fauna Atlas	Lane <i>et al.</i> 1990	NT status	E
Pallid Cuckoo	<i>Cacomantis pallidus</i>						X	X	LC	
Partridge Pigeon	<i>Geophaps smithii</i>						X		VU	
Peaceful Dove	<i>Geopelia striata</i>	X	X	X	X	X	X	X	LC	
Peregrine Falcon	<i>Falco peregrinus</i>						X	X	LC	
Pheasant Coucal	<i>Centropus phasianinus</i>	X	X	X	X		X	X	LC	
Pictorella Mannikin	<i>Heteromunia pectoralis</i>						X	X	NT	
Pied Butcherbird	<i>Cracticus nigrogularis</i>	X	X	X	X	X	X	X	LC	
Pied Cormorant	<i>Phalacrocorax varius</i>	X				X	X		LC	
Plumed Whistling Duck	<i>Dendrocygna eytoni</i>	X	X	X			X	X	LC	
Radjah Shelduck	<i>Tadorna radjah</i>	X	X		X	X	X		LC	
Rainbow Bee-eater	<i>Merops ornatus</i>	X	X	X	X	X	X	X	LC	
Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	X	X	X	X	X	X	X	LC	
Red Goshawk	<i>Erythrotriorchis radiatus</i>								VU	
Red-backed Button-quail	<i>Turnix maculosa</i>	X		X	X		X	X	LC	
Red-backed Fairy-wren	<i>Malurus melanocephalus</i>	X	X	X	X		X	X	LC	
Red-backed Kingfisher	<i>Todiramphus pyrrhopygius</i>	X		X	X		X	X	LC	
Red-browed Pardalote	<i>Pardalotus rubricatus</i>	X		X	X		X	X	LC	
Red-headed Honeyeater	<i>Myzomela erythrocephala</i>	X		X					LC	
Red-kneed Dotterel	<i>Erythronyx cinctus</i>	X				X	X		LC	
Red-tailed Black-cockatoo (Top End)	<i>Calyptorhynchus banksii macrorhynchus</i>	X	X	X	X	X	X	X	LC	
Red-winged Parrot	<i>Aprosmictus erythropterus</i>	X	X	X	X	X	X	X	LC	
Restless Flycatcher	<i>Myiagra inquieta</i>	X	X	X	X	X	X	X	LC	
Royal Spoonbill	<i>Platalea regia</i>	X	X			X	X		LC	



Common Name	Scientific Name	GHD (ALL)	GHD DRY	GHD WET	GHD May 2011	GHD Sept 2012	DLRM Fauna Atlas	Lane <i>et al.</i> 1990	NT status	E
Rufous Fantail	<i>Rhipidura rufifrons</i>								LC	
Rufous Owl	<i>Ninox rufa</i>						X	X	LC	
Rufous Songlark	<i>Cincloramphus mathewsi</i>						X	X	LC	
Rufous Whistler	<i>Pachycephala rufiventris</i>	X	X	X	X	X	X	X	LC	
Rufous-throated Honeyeater	<i>Conopophila rufogularis</i>						X	X	LC	
Sacred Kingfisher	<i>Todiramphus sanctus</i>	X	X	X	X	X	X	X	LC	
Sandstone Shrike-thrush	<i>Colluricincla woodwardi</i>						X	X	LC	
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>	X				X			LC	
Shining Flycatcher	<i>Myiagra alecto</i>	X	X				X	X	LC	
Silver-crowned Friarbird	<i>Philemon argenticeps</i>	X	X	X	X	X	X	X	LC	
Singing Honeyeater	<i>Lichenostomus virescens</i>						X	X	LC	
Sooty Tern	<i>Onychoprion fuscatus</i>						X		LC	
Southern Boobook	<i>Ninox novaeseelandiae</i>	X	X			X	X	X	LC	
Spangled Drongo	<i>Dicrurus bracteatus</i>						X		LC	
Spotted Harrier	<i>Circus assimilis</i>						X	X	LC	
Spotted Nightjar	<i>Eurostopodus argus</i>	X	X		X	X	X	X	LC	
Square-tailed Kite	<i>Lophoictinia isura</i>						X		NT	
Star Finch	<i>Neochmia ruficauda</i>						X	X	NT	
Straw-necked Ibis	<i>Threskiornis spinicollis</i>						X	X	LC	
Striated Pardalote	<i>Pardalotus striatus</i>	X	X	X	X	X	X	X	LC	
Sulphur-crested Cockatoo	<i>Cacatua galerita</i>	X	X	X	X	X	X	X	LC	
Swamp Harrier	<i>Circus approximans</i>						X		LC	
Tawny Frogmouth	<i>Podargus strigoides</i>	X	X	X			X	X	LC	



Common Name	Scientific Name	GHD (ALL)	GHD DRY	GHD WET	GHD May 2011	GHD Sept 2012	DLRM Fauna Atlas	Lane <i>et al.</i> 1990	NT status	E
Torresian Crow	<i>Corvus orru</i>	X	X	X	X	X	X	X	LC	
Tree Martin	<i>Petrochelidon nigricans</i>						X	X	LC	
Varied Lorikeet	<i>Psitteuteles versicolour</i>	X		X		X	X	X	LC	
Varied Sittella	<i>Daphoenositta chrysoptera</i>	X			X		X	X	LC	
Varied Triller	<i>Lalage leucomela</i>	X	X				X	X	LC	
Wandering Whistling Duck	<i>Dendrocygna arcuata</i>	X				X	X	X	LC	
Wedge-tailed Eagle	<i>Aquila audax</i>	X		X	X	X	X	X	LC	
Weebill	<i>Smicromis brevirostris</i>	X	X	X	X	X	X	X	LC	
Whiskered Tern	<i>Childonias hybridus</i>	X				X			LC	
Whistling Kite	<i>Haliastur sphenurus</i>	X	X	X	X	X	X	X	LC	
White-bellied Cuckoo-shrike	<i>Coracina papuensis</i>	X	X	X	X	X	X	X	LC	
White-bellied Sea-eagle	<i>Haliaeetus leucogaster</i>	X			X	X	X	X	LC	
White-breasted Woodswallow	<i>Artamus leucorhynchus</i>	X	X	X	X		X	X	LC	
White-browed Woodswallow	<i>Artamus superciliosus</i>						X		LC	
White-faced Heron	<i>Egretta novaehollandiae</i>	X	X	X		X	X	X	LC	
White-gaped Honeyeater	<i>Lichenostomus unicolor</i>	X	X	X			X	X	LC	
White-lined Honeyeater	<i>Meliphaga albilineata</i>						X		NT	
White-necked Heron	<i>Ardea pacifica</i>	X	X			X	X	X	LC	
White-throated Gerygone	<i>Gerygone olivacea</i>	X	X				X	X	LC	
White-throated Honeyeater	<i>Melithreptus albogularis</i>	X	X	X	X	X	X	X	LC	
White-winged Triller	<i>Lalage sueurii</i>	X	X	X	X		X	X	LC	
Willie Wagtail	<i>Rhipidura leucophrys</i>	X		X	X	X	X	X	LC	
Yellow Oriole	<i>Oriolus flavocinctus</i>	X	X			X	X	X	LC	



Common Name	Scientific Name	GHD (ALL)	GHD DRY	GHD WET	GHD May 2011	GHD Sept 2012	DLRM Fauna Atlas	Lane <i>et al.</i> 1990	NT status	E
Yellow-billed Spoonbill	<i>Platelea flavipes</i>						X	X	LC	
Yellow-rumped Mannikin	<i>Lonchura flaviprymna</i>						X	X	NT	
Yellow-throated Miner	<i>Manorina flavigula</i>						X	X	LC	
Yellow-tinted Honeyeater	<i>Lichenostomus flavescens</i>	X				X	X	X	LC	
Zebra Finch	<i>Taeniopygia guttata</i>						X		LC	
Unidentified Quail	<i>Coturnix sp.</i>	X	X						LC	
Reptiles										
Freshwater Crocodile	<i>Crocodylus johnstoni</i>	X	X		X	X?	X	X	LC	
Saltwater Crocodile	<i>Crocodylus porosus</i>	X?				X?			LC	
Northern Snapping Turtle	<i>Elsya dentata</i>						X	X	LC	
Short-necked Turtle	<i>Emydura victoriae</i>							X	LC	
Gilbert's Dragon	<i>Amphibolurus gilberti</i>	X	X	X	X		X	X	LC	
Chameleon Dragon	<i>Chelosania brunnea</i>						X	X	NT	
Frilled Lizard	<i>Chlamydosaurus kingii</i>						X	X	LC	
Ring-tailed Dragon	<i>Ctenophorus caudicinctus</i>	X	X				X	X	LC	
White-lipped Two-lined Dragon	<i>Diporiphora albilabris</i>	X	X	X					LC	
Arnhemland Two-lined Dragon	<i>Diporiphora arnhemica</i>						X	X	LC	
Robust Dragon	<i>Diporiphora bennettii</i>						X		LC	
Two-lined Dragon	<i>Diporiphora bilineata</i>	X	X	X	X		X		LC	
Yellow-sided Two-lined Dragon	<i>Diporiphora magna</i>	X	X				X		LC	
Northern Water Dragon	<i>Lophognathus temporalis</i>						X	X	LC	
Two-spined Rainbow Skink	<i>Carlia amax</i>	X	X	X	X	X	X	X	LC	
Slender Rainbow Skink	<i>Carlia gracilis</i>	X	X	X			X	X	LC	



Common Name	Scientific Name	GHD (ALL)	GHD DRY	GHD WET	GHD May 2011	GHD Sept 2012	DLRM Fauna Atlas	Lane <i>et al.</i> 1990	NT status	E
Striped Rainbow Skink	<i>Carlia munda</i>	X	X	X			X	X	LC	
Three-spined Rainbow Skink	<i>Carlia triacantha</i>	X		X	X		X	X	LC	
Metallic Snake-eyed Skink	<i>Cryptoblepharus metallicus</i>	X	X	X	X	X?	X		LC	
Arboreal Snake-eyed Skink	<i>Cryptoblepharus plagiocephalus</i>	X?	X?				X	X	LC	
Ctenotus (borealis)	<i>Ctenotus borealis</i>	X	X	X			X	X	LC	
Cogger's Ctenotus	<i>Ctenotus coggeri</i>						X	X	LC	
Ten-lined Ctenotus	<i>Ctenotus decaneurus</i>	X	X		X	X	X	X	LC	
Port Essington Ctenotus	<i>Ctenotus essingtonii</i>						X	X	LC	
Top End Lowlands Ctenotus	<i>Ctenotus hilli</i>	X	X						LC	
Plain Ctenotus	<i>Ctenotus inornatus</i>	X	X	X			X	X	LC	
Eastern Striped Skink	<i>Ctenotus robustus</i>	X	X	X	X		X	X	LC	
Spalding's Ctenotus	<i>Ctenotus spaldingi</i>	X		X					LC	
Scant-striped Ctenotus	<i>Ctenotus vertebralis</i>						X		LC	
Northern Bar-lipped Skink	<i>Eremiascincus isolepis</i>	X	X				X	X	LC	
Northern Dwarf Skink	<i>Menetia maini</i>	X	X				X	X	LC	
Red-tailed Snake-eyed Skink	<i>Morethia ruficauda</i>						X	X	LC	
Top End Fire-tailed Skink	<i>Morethia storri</i>	X	X				X		LC	
Ornate Snake-eyed Skink	<i>Notoscincus ornatus</i>						X	X	LC	
Northern Soil-crevice Skink	<i>Proablepharus tenuis</i>	X	X	X					LC	
Common Blue-tongued Lizard	<i>Tiliqua scincoides</i>						X	X	DD	
Burton's Legless Lizard	<i>Lialis burtonis</i>	X			X		X		LC	
Rusty-topped Delma	<i>Delma borea</i>						X		LC	
Excitable Delma	<i>Delma tincta</i>	X		X			X		LC	



Common Name	Scientific Name	GHD (ALL)	GHD DRY	GHD WET	GHD May 2011	GHD Sept 2012	DLRM Fauna Atlas	Lane <i>et al.</i> 1990	NT status	E
Northern Dtella	<i>Gehyra australis</i>	X	X	X		X	X	X	LC	
Northern Spotted Rock Dtella	<i>Gehyra nana</i>	X	X				X	X	LC	
Tree Dtella	<i>Gehyra variegata</i>	X	X						LC	
Sand-plain Gecko	<i>Lucasium stenodactylum</i>	X	X				X		LC	
Bynoe's Gecko	<i>Heteronotia binoei</i>	X	X	X	X		X	X	LC	
Marbled Velvet Gecko	<i>Oedura marmorata</i>						X	X	LC	
Zigzag Velvet Gecko	<i>Oedura rhombifer</i>	X	X						LC	
Beaked Gecko	<i>Rhynchoedura ornata</i>						X	X	LC	
Northern Spiny-tailed Gecko	<i>Strophurus ciliaris</i>	X	X				X		LC	
Ridge-tailed Monitor	<i>Varanus acanthurus</i>						X		LC	
Black-spotted Spiny-tailed Monitor	<i>Varanus baritji</i>	X	X				X	X	DD	
Long-tailed Rock Monitor	<i>Varanus glebopalma</i>						X		LC	
Sand Goanna	<i>Varanus gouldii</i>						X	X	LC	
Mertens' Water Monitor	<i>Varanus mertensi</i>	X		X	X	X	X	X	VU	
Mitchell's Water Monitor	<i>Varanus mitchelli</i>						X	X	VU	
Yellow-spotted Monitor	<i>Varanus panoptes</i>						X	X	VU	
Northern Ridge-tailed Monitor	<i>Varanus primordius</i>	X	X	X			X	X	NT	
Spotted Tree Monitor	<i>Varanus scalaris</i>	X	X	X			X	X	DD	
Black-tailed Monitor	<i>Varanus tristis</i>						X	X	LC	
Children's Python	<i>Antaresia childreni</i>	X		X			X	X	DD	
Black-headed Python	<i>Aspidites melanocephalus</i>	X	X		Edith			X	LC	
Water Python	<i>Liasis fuscus</i>	X		X					LC	
Olive Python	<i>Liasis olivaceus</i>	X			Edith		X	X	LC	



Common Name	Scientific Name	GHD (ALL)	GHD DRY	GHD WET	GHD May 2011	GHD Sept 2012	DLRM Fauna Atlas	Lane <i>et al.</i> 1990	NT status	E
Brown Tree Snake	<i>Boiga irregularis</i>	X	X	X	Edith		X	X	DD	
Common Tree Snake	<i>Dendrelaphis punctulata</i>	X	X	X			X		DD	
Keelback Snake	<i>Tropidonophus mairii</i>	X	X	X	X		X	X	LC	
Northern Death Adder	<i>Acanthophis praelongus</i>						X	X	NT	
Half-girdled Snake	<i>Brachyurophis semifasciatus</i>						X		LC	
Northern Small-eyed Snake	<i>Cryptophis pallidiceps</i>	X		X					LC	
Olive Whipsnake	<i>Demansia olivacea</i>	X	X				X		DD	
Papuan Whipsnake	<i>Demansia papuensis</i>	X	X		X		X		DD	
Orange-naped Snake	<i>Furnia ornata</i>	X	X	X				X	LC	
Mulga Snake	<i>Pseudechis australis</i>						X	X	NT	
Western Brown Snake	<i>Pseudonaja nuchalis</i>						X	X	LC	
Eastern Brown Snake	<i>Pseudonaja textilis</i>	X	X						LC	
Top End Blind Snake	<i>Ramphotyphlops guentheri</i>	X	X				X		LC	
Blind snake sp.	<i>Ramphotyphlops sp.</i>	X		X					-	
Little Spotted Snake	<i>Suta punctata</i>						X		LC	
Northern Bandy-bandy	<i>Vermicella multifasciata</i>						X	X	DD	
Amphibians										
Giant Frog	<i>Cyclorana australis</i>	X	X	X			X	X	DD	
Long-footed Frog	<i>Cyclorana longipes</i>	X	X	X					LC	
Northern Dwarf Tree Frog	<i>Litoria bicolor</i>	X	X	X			X	X	DD	
Common Green Tree Frog	<i>Litoria caerulea</i>	X	X	X			X	X	LC	
Copland's Rock Frog	<i>Litoria coplandi</i>						X	X	LC	
Peters' Frog	<i>Litoria inermis</i>	X	X	X		X	X	X	LC	



Common Name	Scientific Name	GHD (ALL)	GHD DRY	GHD WET	GHD May 2011	GHD Sept 2012	DLRM Fauna Atlas	Lane <i>et al.</i> 1990	NT status	E
Rockhole Frog	<i>Litoria meiriana</i>	X	X				X	X	LC	
Javelin Frog	<i>Litoria microbelos</i>	X		X					LC	
Striped Rocket Frog	<i>Litoria nasuta</i>	X	X	X				X	LC	
Pale Frog	<i>Litoria pallida</i>	X	X	X		X	X	X	LC	
Roth's Tree Frog	<i>Litoria rothi</i>	X	X	X			X	X	LC	
Red Tree Frog	<i>Litoria rubella</i>	X	X	X			X	X	LC	
Tornier's Frog	<i>Litoria tornieri</i>	X	X	X			X	X	LC	
Wotjulum Frog	<i>Litoria wotjulumensis</i>	X	X	X	X		X	X	LC	
Bilingual Frog	<i>Crinia bilingual</i>						X	X	LC	
Remote Froglet	<i>Crinia remota</i>	X	X	X					LC	
Marbled Frog	<i>Limnodynastes convexiusculus</i>	X	X	X					LC	
Northern Spadefoot Toad	<i>Notaden melanoscephus</i>	X	X	X					LC	
Ornate Burrowing Frog	<i>Platyplectrum ornatum</i>	X	X	X			X	X	DD	
Floodplain Toadlet	<i>Uperoleia inundata</i>	X	X?	X					LC	
Stonemason's Toadlet	<i>Uperoleia lithomoda</i>	X	X?	X					LC	
Cane Toad*	<i>Rhinella marina</i>	X	X	X	X	X	X		*	

* non-native species; CE = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; DD = Data Deficient; LC = Least Concern; X = species detected; X? = probable record, but species identification uncertain.



Appendix E

Fauna species (numbers of individuals per species) recorded during the dry and wet season baseline fauna surveys



Amphibians

Sub-group	Common Name	Scientific Name	Site																		Grand Total
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Other		
Dry season																					
Burrowing frogs	Giant Frog	<i>Cyclorana australis</i>			1	2	6	5			3	1	3	1	2	2	2			28	
	Long-footed Frog	<i>Cyclorana longipes</i>									1									1	
	Marbled Frog	<i>Limnodynastes convexiusculus</i>		1	1	1			2	4	8	2		1		1				21	
	Northern Spadefoot Toad	<i>Notaden melanoscapus</i>			4						12			1		1				18	
	Ornate Burrowing Frog	<i>Platyplectrum ornatum</i>		1	38			2		1	7	1	1	1	3					55	
	Toadlet sp.	<i>Uperoleia sp.</i>			1			10			3						8			22	
All				2	45	3	6	17	2	5	34	4	4	4	5	12	2			145	
Climbing frogs	Common Green Tree Frog	<i>Litoria caerulea</i>			2	12	1	1	13	6	1	15	9	1	14		1	1		77	
	Northern Dwarf Tree Frog	<i>Litoria bicolor</i>									11									11	
	Red Tree Frog	<i>Litoria rubella</i>	1	2	1	1	1	1		3		2	1		1		1			15	
	Roth's Tree Frog	<i>Litoria rothi</i>			3		1				1							1		6	
All			1	2	6	13	3	2	13	9	13	17	10	1	15		2	1	1	109	
Ground frogs	Pale Frog	<i>Litoria pallida</i>			1		6	6			2									15	
	Peters' Frog	<i>Litoria inermis</i>					2	1			7									10	
	Remote Froglet	<i>Crinia remota</i>						1			2									3	
	Rockhole Frog	<i>Litoria meiriana</i>						2												2	
	Striped Rocket Frog	<i>Litoria nasuta</i>					2	3												5	
	Tornier's Frog	<i>Litoria tornieri</i>						1												1	
	Wotjulum Frog	<i>Litoria wotjulumensis</i>			1			2			1	1								5	
	Cane Toad	<i>Rhinella marina</i>		1	16	26	22	8	5	11	2	7	7	6	5	8				124	
All				1	18	26	32	24	5	11	14	8	7	6	5	8				165	
Wet season																					



Sub-group	Common Name	Scientific Name	Site																		Grand Total
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Other		
Burrowing frogs	Floodplain Toadlet	<i>Uperoleia inundata</i>																	30	30	
	Giant Frog	<i>Cyclorana australis</i>				4									1				3	8	
	Long-footed Frog	<i>Cyclorana longipes</i>			1															1	
	Marbled Frog	<i>Limnodynastes convexiusculus</i>	15		5						2	1							6	29	
	Northern Spadefoot Toad	<i>Notaden melanoscaphus</i>	8			1				1						9	3	1	3	26	
	Ornate Burrowing Frog	<i>Platyplectrum ornatum</i>	3	1	6	1	1	5					1		2				1	21	
	Toadlet sp.	<i>Uperoleia sp.</i>	9		1													18	56	31	115
All			35	1	13	6	1	5		1	2	1	1		3	9	21	57	74	230	
Climbing frogs	Common Green Tree Frog	<i>Litoria caerulea</i>	1		2					1	1				1	2			2	10	
	Northern Dwarf Tree Frog	<i>Litoria bicolor</i>	10		10														1	21	
	Red Tree Frog	<i>Litoria rubella</i>	10		1	1									5				5	22	
	Roth's Tree Frog	<i>Litoria rothi</i>	4				5	1										1	3	14	
All			25		13	1	5	1		1	1				6	2		1	11	67	
Ground frogs	Javelin Frog	<i>Litoria microbelos</i>	25																	25	
	Pale Frog	<i>Litoria pallida</i>	6			2														8	
	Peters' Frog	<i>Litoria inermis</i>	10	1						1	1				2	1			5	21	
	Remote Froglet	<i>Crinia remota</i>		1	2		6	5										1	5	20	
	Striped Rocket Frog	<i>Litoria nasuta</i>	5							2								5	1	13	
	Tornier's Frog	<i>Litoria tornieri</i>																	2	2	
	Wotjulum Frog	<i>Litoria wotjulumensis</i>																	2	2	
	Cane Toad	<i>Rhinella marina</i>	14	6	22	7	12	4	7		14	5	4	7	10	7	10	10	53	192	
All			60	8	24	9	18	9	7	3	15	5	4	7	12	8	10	16	68	283	
Dry season	All frogs		1	5	69	42	41	43	20	25	61	29	21	11	25	20	4	1	1	419	
Wet season	All frogs		120	9	50	16	24	15	7	5	18	6	5	7	21	19	31	74	153	580	



Birds

			Site																		
Sub-group	Common Name	Scientific Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Other	Grand Total	
Dry season																					
Cuckoos	Brush Cuckoo	<i>Cacomantis variolosus</i>									3	1	1	1					2	8	
	Channel-billed Cuckoo	<i>Scythrops novaehollandiae</i>										1	1						1	3	
	Eastern Koel	<i>Eudynamys orientalis</i>	2		2		2	2		1	4	2	2	1	1		2	1	1	23	
	Horsfield's Bronze Cuckoo	<i>Chrysococcyx basalis</i>							1											1	
All			2		2		2	2	1	1	7	4	4	2	1		2	1	4	35	
Finches	Chestnut-breasted Mannikin	<i>Lonchura castaneothorax</i>																	20	20	
	Crimson Finch	<i>Neochmia phaeton</i>			2						1									3	
	Double-barred Finch	<i>Taeniopygia bichenovii</i>			3		1												1	5	
	Long-tailed Finch	<i>Poephila acuticauda</i>					3				4			1					1	9	
	Masked Finch	<i>Poephila personata</i>									5		1							6	
All				5		4					10		1	1					22	43	
Ground birds	Australian Bustard	<i>Ardeotis australis</i>							1		1								1	3	
	Brolga	<i>Grus rubicunda</i>														3				3	
	Brown Quail	<i>Coturnix ypsilophora</i>										2								2	
	Bush Stone-curlew	<i>Burhinus grallarius</i>			1				1	2							1			5	
	Golden-headed Cisticola	<i>Cisticola exilis</i>			1															1	
	Pheasant Coucal	<i>Centropus phasianinus</i>			1			1			4	2	2	1	1		1		1	14	
	Red-backed Fairy-wren	<i>Malurus melanocephalus</i>	5	1	7					1									1	15	
	Unidentified quail	<i>Coturnix sp.</i>																			
All			5	1	10			1	2	3	5	4	2	1	1	3	2		3	43	
Night birds	Australian Owlet-nightjar	<i>Aegotheles cristatus</i>	1										1							2	
	Barking Owl	<i>Ninox connivens</i>									2									2	



Sub-group	Common Name	Scientific Name	Site																	Grand Total
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Other	
	Southern Boobook	<i>Ninox novaeseelandiae</i>												1		1			1	3
	Spotted Nightjar	<i>Eurostopodus argus</i>				3										1				4
	Tawny Frogmouth	<i>Podargus strigoides</i>			2								1							3
	All		1		2	3					2		2	1		2			1	14
Parrots	Cockatiel	<i>Nymphicus hollandicus</i>	1	2	2		2	4	6	11	5	4		2	1	1	3	10		54
	Galah	<i>Eolophus roseicapilla</i>	5	7	3	2	2		3	3	4	1	3				1	2		36
	Little Corella	<i>Cacatua sanguinea</i>						1			1								1	3
	Northern Rosella	<i>Platycercus venustus</i>	2				2	2				2								8
	Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	10	5	8	2	9	7	3	7	8	4	4	1		3	3	5	1	80
	Red-tailed Black-cockatoo (Top End)	<i>Calyptorhynchus banksii macrorhynchus</i>		1	1	1		1	7	6	2	3	1		2	5	6	2	38	
	Red-winged Parrot	<i>Aprosmictus erythropterus</i>	4		4		4	1			4	3	1		1	1	1	1	1	26
	Sulphur-crested Cockatoo	<i>Cacatua galerita</i>		4	2		5	1		1	4	2				1			1	21
	All		22	18	20	5	25	16	13	29	32	18	11	4	2	8	13	24	6	266
Raptors	Australian Hobby	<i>Falco longipennis</i>						1												1
	Australian Kestrel	<i>Falco cenchroides</i>										1								1
	Black-breasted Buzzard	<i>Hamirostra melanosternon</i>																	1	1
	Brown Falcon	<i>Falco berigora</i>	2		1			1								1				5
	Brown Goshawk	<i>Accipiter fasciatus</i>			3		1					1								5
	Collared Sparrowhawk	<i>Accipiter cirrocephalus</i>								1										1
	Grey Goshawk	<i>Accipiter novaehollandiae</i>						1												1
	Pacific Baza	<i>Aviceda subcristata</i>					1	1				1								3
	Whistling Kite	<i>Haliastur sphenurus</i>			3		2	1				1							1	8
	All		2		7		4	5		1	4					1			2	26
Waterbirds	Australasian Grebe	<i>Tachybaptus novaehollandiae</i>																	1	1



Sub-group	Common Name	Scientific Name	Site																	Grand Total
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Other	
	Australian Darter	<i>Anhinga novaehollandiae</i>																	1	1
	Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>									2									2
	Cattle Egret	<i>Bubulcus ibis</i>																	1	1
	Comb-crested Jacana	<i>Irediparra gallinacea</i>																	1	1
	Eastern Great Egret	<i>Ardea alba modesta</i>									2								2	4
	Green Pygmy Goose	<i>Nettapus pulchellus</i>																	1	1
	Intermediate Egret	<i>Ardea intermedia</i>																	1	1
	Masked Lapwing	<i>Vanellus miles</i>																	1	1
	Plumed Whistling Duck	<i>Dendrocygna eytoni</i>	1	2	2				2		2									9
	Radjah Shelduck	<i>Tadorna radjah</i>									1								1	2
	Royal Spoonbill	<i>Platalea regia</i>									1								1	2
	White-faced Heron	<i>Egretta novaehollandiae</i>						1			1								2	4
	White-necked Heron	<i>Ardea pacifica</i>									1								1	2
	All		1	2	2			1	2		10								14	32
Woodland birds	Banded Honeyeater	<i>Certhionyx pectoralis</i>						1												1
	Bar-shouldered Dove	<i>Geopelia humeralis</i>			1		1				4			1					1	8
	Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>	1	3	1		4		1	2	1	1	3	1	3	1	1			23
	Black-faced Woodswallow	<i>Artamus cinereus</i>					4		1	4								2	1	12
	Black-tailed Treecreeper	<i>Climacteris melanura</i>										1	1	1		1				4
	Blue-faced Honeyeater	<i>Entomyzon cyanotis</i>	1			1	1	1		1	1									6
	Blue-winged Kookaburra	<i>Dacelo leachii</i>	4	2	2		3	5	1	2	5	5	3	2		1		2	1	38
	Brown Honeyeater	<i>Lichmera indistincta</i>			2						3									5
	Crested Pigeon	<i>Ocyphaps lophotes</i>						3												3
	Crested Shrike-tit (northern)	<i>Falcunculus frontatus whitei</i>															1	1		2



Sub-group	Common Name	Scientific Name	Site																	Grand Total
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Other	
	Diamond Dove	<i>Geopelia cuneata</i>		1					1											2
	Dollarbird	<i>Eurystomus orientalis</i>	1	5	2		3	3	1	2	1	20	2			1			2	43
	Dusky Honeyeater	<i>Myzomela obscura</i>			1		2				3		1							7
	Great Bowerbird	<i>Chlamydera nuchalis</i>			1		1			1	2	1		1	2				1	10
	Green-backed Gerygone	<i>Gerygone chloronota</i>			1															1
	Grey Butcherbird	<i>Cracticus torquatus</i>													1					1
	Grey Shrike-thrush	<i>Colluricincla harmonica</i>					2							1	1					4
	Grey-crowned Babbler	<i>Pomatostomus temporalis</i>	2		2	1				1		2	2		3	1			1	15
	Grey-fronted Honeyeater	<i>Lichenostomus plumulus</i>									1									1
	Leaden Flycatcher	<i>Myiagra rubecula</i>	1	1	1						1									4
	Little Friarbird	<i>Philemon citreogularis</i>					1			1	2									4
	Magpie-lark	<i>Grallina cyanoleuca</i>				1	1		3	2			4			3	1	2	1	18
	Mistletoebird	<i>Dicaeum hirundinaceum</i>						1			2		1	1		1				6
	Olive-backed Oriole	<i>Oriolus sagittatus</i>								1	4			1					1	7
	Painted Honeyeater	<i>Grantiella picta</i>														1				1
	Peaceful Dove	<i>Geopelia striata</i>		1	2		3		1	4	3	5	5	3	1					28
	Pied Butcherbird	<i>Cracticus nigrogularis</i>				4			2	1		1	1	1		2	2	2		16
	Rainbow Bee-eater	<i>Merops ornatus</i>		4	7		8	2			4	3	1	2		1			1	33
	Restless Flycatcher	<i>Myiagra inquieta</i>																1	1	2
	Rufous Whistler	<i>Pachycephala rufiventris</i>			4		4	5				1				1				15
	Sacred Kingfisher	<i>Todiramphus sanctus</i>		2	1		4	3			6	3	1			1	1	1	1	24
	Shining Flycatcher	<i>Myiagra alecto</i>					1													1
	Silver-crowned Friarbird	<i>Philemon argenticeps</i>	7	3	2	2	4	3	2	2	4	4	4	3	2	5	4	8	1	60
	Striated Pardalote	<i>Pardalotus striatus</i>									1		1							2
	Torresian Crow	<i>Corvus orru</i>	2	7	4				1	2	3	1				2	3	7	1	33



Sub-group	Common Name	Scientific Name	Site																	Grand Total
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Other	
	Varied Triller	<i>Lalage leucomela</i>	1																	1
	Weebill	<i>Smicrornis brevirostris</i>			1		2	1	3	2		4	3	1		1	1	1	1	21
	White-bellied Cuckoo-shrike	<i>Coracina papuensis</i>	5	5	3		3	4		2	3	4	6	1	2	2			1	41
	White-breasted Woodswallow	<i>Artamus leucorhynchus</i>																	2	2
	White-gaped Honeyeater	<i>Lichenostomus unicolor</i>			1		3	2			6								1	13
	White-throated Gerygone	<i>Gerygone olivacea</i>			1		1				1									3
	White-throated Honeyeater	<i>Melithreptus albogularis</i>	2	2		2			1		3	4	1	1		2			1	19
	White-winged Triller	<i>Lalage sueurii</i>	1	1		1			1	1	1	1		2						9
	Yellow Oriole	<i>Oriolus flavocinctus</i>			1		1	2			4									8
	All		24	38	44	9	60	36	19	31	69	61	40	23	15	27	14	27	20	557
Wet season																				
Cuckoos	Brush Cuckoo	<i>Cacomantis variolosus</i>			1				1					1					1	4
	All				1				1					1					1	4
Finches	Chestnut-breasted Mannikin	<i>Lonchura castaneothorax</i>							5										3	8
	Crimson Finch	<i>Neochmia phaeton</i>			7		2							1						10
	Long-tailed Finch	<i>Poephila acuticauda</i>			1		1							1	5	1			11	20
	Masked Finch	<i>Poephila personata</i>						1							1					2
	All				8		3	1	5					2	6	1			14	40
Ground birds	Australian Bustard	<i>Ardeotis australis</i>																	3	3
	Brown Quail	<i>Coturnix ypsilophora</i>													2					2
	Bush Stone-curlew	<i>Burhinus grallarius</i>																	3	3
	Golden-headed Cisticola	<i>Cisticola exilis</i>	9	3	4	3		1	8	5	3	2	1	2			5	1		47



Sub-group	Common Name	Scientific Name	Site																	Grand Total
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Other	
	Pheasant Coucal	<i>Centropus phasianinus</i>	3		1	2			1			4	1	1				1	1	15
	Red-backed Button-quail	<i>Turnix maculosa</i>		1					1	1			1					1		5
	Red-backed Fairy-wren	<i>Malurus melanocephalus</i>	3														1			4
	Unidentified quail	<i>Coturnix sp.</i>																		
	All		15	4	5	5		1	10	6	3	6	3	3		2	6	3	7	79
Night birds	Australian Owlet-nightjar	<i>Aegotheles cristatus</i>																	1	1
	Tawny Frogmouth	<i>Podargus strigoides</i>							1											1
	All								1										1	2
Parrots	Galah	<i>Eolophus roseicapilla</i>	2	5	3		8		1			1	4		3	2				29
	Northern Rosella	<i>Platycercus venustus</i>	1												2				2	5
	Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	12	11	11	1	10	4	3	1	3	2	1	2	3	3	9	14	1	91
	Red-tailed Black-cockatoo (Top End)	<i>Calyptorhynchus banksii macrorhynchus</i>	1		4				1		1		1				1	2		11
	Red-winged Parrot	<i>Aprosmictus erythropterus</i>	4	2		1		1				1		2					2	13
	Sulphur-crested Cockatoo	<i>Cacatua galerita</i>	1	1	2		1	4	2		1		2			1	1	3	1	20
	Varied Lorikeet	<i>Psitteuteles versicolour</i>	2	2			1			4		10	10	1	1	20			1	52
	All		23	21	20	2	20	9	7	5	5	14	18	5	9	26	11	19	7	221
Raptors	Australian Hobby	<i>Falco longipennis</i>										1								1
	Black Falcon	<i>Falco subniger</i>																	1	1
	Black Kite	<i>Milvus migrans</i>				2	1							2						5
	Brown Falcon	<i>Falco berigora</i>			1	1										1				3
	Brown Goshawk	<i>Accipiter fasciatus</i>		1																1
	Wedge-tailed Eagle	<i>Aquila audax</i>					1								2					3
	Whistling Kite	<i>Haliastur sphenurus</i>		1		2	1	1		1	3						2		1	12
	All			2	1	5	3	1		1	3	1		2	2	1	2		2	26
Waterbirds	Australian Pelican	<i>Pelicanus conspicillatus</i>				1														1



Sub-group	Common Name	Scientific Name	Site																	Grand Total
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Other	
	Australian White Ibis	<i>Threskiornis molucca</i>																	1	1
	Azure Kingfisher	<i>Alcedo azurea</i>					1								2					3
	Black Bittern	<i>Ixobrychus flavicollis</i>			2															2
	Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>				1					1									2
	Buff-banded Rail	<i>Gallirallus philippensis</i>																	1	1
	Eastern Great Egret	<i>Ardea alba modesta</i>																	1	1
	Grey Teal	<i>Anas gracilis</i>																	3	3
	Intermediate Egret	<i>Ardea intermedia</i>																	1	1
	Pacific Black Duck	<i>Anas superciliosa</i>												1					11	12
	Plumed Whistling Duck	<i>Dendrocygna eytoni</i>	1						15		12									28
	White-faced Heron	<i>Egretta novaehollandiae</i>						1							1		1			3
	All		1		2	2	1	1	15		13			1	1	2	1		18	58
Woodland birds	Australian Magpie	<i>Cracticus tibicen</i>																	1	1
	Banded Honeyeater	<i>Certhionyx pectoralis</i>				2					1									3
	Bar-shouldered Dove	<i>Geopelia humeralis</i>	1	2	5		1	1	1	1	1	1	1	6	6	2			1	30
	Black Honeyeater	<i>Certhionyx niger</i>	1															1		2
	Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>	2	3	1	3	1		3			2	7	1	5	3		1	2	34
	Black-faced Woodswallow	<i>Artamus cinereus</i>						1	1								5		5	12
	Black-tailed Treecreeper	<i>Climacteris melanura</i>		1			1													2
	Blue-faced Honeyeater	<i>Entomyzon cyanotis</i>	1	10	1	2	2	2				1					1		1	21
	Blue-winged Kookaburra	<i>Dacelo leachii</i>	6	6	5	1		2	2			3	1			1		1		28
	Broad-billed Flycatcher	<i>Myiagra ruficollis</i>																	1	1
	Brown Honeyeater	<i>Lichmera indistincta</i>					2				3									5
	Dollarbird	<i>Eurystomus orientalis</i>	1	1	2		5	3			1		2	1		3			1	20
	Great Bowerbird	<i>Chlamydera nuchalis</i>	1				1					4			2					8



Sub-group	Common Name	Scientific Name	Site																	Grand Total
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Other	
	Grey Shrike-thrush	<i>Colluricincla harmonica</i>										1								1
	Grey-crowned Babbler	<i>Pomatostomus temporalis</i>	3	1	1	5			1			1	9	1	3	4				29
	Helmeted Friarbird	<i>Philemon buceroides</i>				2						1				2	1	1		7
	Leaden Flycatcher	<i>Myiagra rubecula</i>			2															2
	Lemon-bellied Flycatcher	<i>Microeca flavigaster</i>			1															1
	Little Friarbird	<i>Philemon citreogularis</i>	1			1								2	1	1				6
	Little Woodswallow	<i>Artamus minor</i>							1										1	2
	Magpie-lark	<i>Grallina cyanoleuca</i>					1	3	3				2	1	4			1	1	16
	Masked Woodswallow	<i>Artamus personatus</i>			1				5											6
	Mistletoebird	<i>Dicaeum hirundinaceum</i>		4	1			1					1							7
	Northern Fantail	<i>Rhipidura rufiventris</i>			1		1							2						4
	Olive-backed Oriole	<i>Oriolus sagittatus</i>												1						1
	Peaceful Dove	<i>Geopelia striata</i>	6	9	3		2	4	3		2	2	2	16	6	4	2	2		63
	Pied Butcherbird	<i>Cracticus nigrogularis</i>				1			2			1	2	1	3	5	4	3		22
	Rainbow Bee-eater	<i>Merops ornatus</i>	1	2	1		1	1				1		2	1					10
	Red-backed Kingfisher	<i>Todiramphus pyrrhopygius</i>			1															1
	Red-browed Pardalote	<i>Pardalotus rubricatus</i>									1				2					3
	Red-headed Honeyeater	<i>Myzomela erythrocephala</i>									1									1
	Restless Flycatcher	<i>Myiagra inquieta</i>									1	1							1	3
	Rufous Whistler	<i>Pachycephala rufiventris</i>			3		2	1						1	1					8
	Sacred Kingfisher	<i>Todiramphus sanctus</i>												1	1				1	3
	Silver-crowned Friarbird	<i>Philemon argenticeps</i>	7	5	1	5			1	1		4	4	4	5	5	10	6	1	59
	Striated Pardalote	<i>Pardalotus striatus</i>														1				1
	Torresian Crow	<i>Corvus orru</i>	4	3	3	6	1		2	1			2	5	2	2	12	13	2	58
	Weebill	<i>Smicrornis brevirostris</i>	2	2	1	5	1	1		1			2	1	1		3	3		23



Sub-group	Common Name	Scientific Name	Site																	Grand Total
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Other	
	White-bellied Cuckoo-shrike	<i>Coracina papuensis</i>	1	4	2	1	1		3	1	1		1	2	2	1	2			22
	White-breasted Woodswallow	<i>Artamus leucorhynchus</i>						1												1
	White-gaped Honeyeater	<i>Lichenostomus unicolor</i>			2		2	2			1			1						8
	White-throated Honeyeater	<i>Melithreptus albogularis</i>	3	5	4		2	3	2	4	11		8	6	3	2	2	2	1	58
	White-winged Triller	<i>Lalage sueurii</i>							1					1						2
	Willie Wagtail	<i>Rhipidura leucophrys</i>						2			1	1								4
	All		41	58	42	34	27	28	31	9	25	24	44	56	48	36	42	34	20	599
Dry Season	All birds		57	59	92	17	95	61	37	65	139	87	60	32	19	41	31	52	72	1016
Wet Season	All birds		80	85	79	48	54	41	70	21	49	45	65	70	66	68	62	56	70	1029

Mammals

* For microchiropteran bats, D = definite, P = probable.

Sub-group	Common Name	Scientific Name	Site																	Grand Total
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Other	
Dry season																				
Bats*	Black Flying-fox	<i>Pteropus alecto</i>			1											1				2
	20 kHz Group	<i>Saccolaimus/Chaerephon/Mormopterus</i>							P			P		P	P					4
	30 kHz Group	<i>Chalinolobus gouldii/Mormopterus</i>			P	P		P	P	P	P	P	P	P	P	P				11
	40 kHz Group	<i>Scotorepens/Chalinolobus nigrogriseus</i>	P		P	P	P	P	P	P	P	P	P	P	P	P	P	P		15



Sub-group	Common Name	Scientific Name	Site																Other	Grand Total
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16		
	Yellow-bellied Sheath-tailed Bat	<i>Saccolaimus flaviventris</i>	P		P	P		P	P		P	P				P	P	P		10
	Arnhem Sheath-tail-bat	<i>Taphozous kapalgensis</i>	D					D		D			D					D		5
	Common Sheath-tail-bat	<i>Taphozous georgianus</i>			P															1
	Northern Freetail Bat	<i>Chaerephon jobensis</i>	D		D	D	D	D	D	D			D	D	D	D		D		13
	Beccari's Free-tail Bat	<i>Mormopterus beccarii</i>							P					P	P	P				4
	Northern Bentwing Bat/Forest Pipistrelle	<i>Miniopterus orianae/Pipistrellus adamsi</i>	P				P	P	P	P	P	P		P				P		9
	Gould's Wattled Bat	<i>Chalinolobus gouldii</i>							P				P							2
	Northern Cave Bat	<i>Vespadelus caurinus</i>			D	D				D	D									4
	Inland Cave Bat	<i>Vespadelus finlaysoni</i>			P	P	P	P	P		P			P	P			P		9
	Large-footed Myotis	<i>Myotis macropus</i>								P	P									2
	Pygmy Long-eared Bat	<i>Nyctophilus walkeri</i>											P					P		2
	Long-eared Bat	<i>Nyctophilus sp</i>						P			P									2
	All		5	0	8	6	4	8	9	7	9	5	6	7	6	6	3	6	0	95
Large carnivores	Dingo	<i>Canis lupus</i>							1	1	1									3
	All								1	1	1									3
Macropods	Agile Wallaby	<i>Macropus agilis</i>			5					1	1									7
	Antilopine Wallaroo	<i>Macropus antilopinus</i>	1					1	1	4		1								8
	Euro	<i>Macropus robustus</i>												1						1
	All		1		5			1	1	5	1	1		1						16



Sub-group	Common Name	Scientific Name	Site																	Grand Total
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Other	
Non-native mammals	Cattle	<i>Bos indicus</i>								1										1
	Donkey	<i>Equus asinus</i>											1							1
	Pig	<i>Sus scrofa</i>			3		1		1	1	1	1	1							9
All					3		1		1	2	1	1	2							11
Small mammals	Common Planigale	<i>Planigale maculata</i>								1										1
	Pale Field-rat	<i>Rattus tunneyi</i>			2		2													4
	Western Chestnut Mouse	<i>Pseudomys nanus</i>										1								1
	Unidentified Mammal Species 1 (rodent)																			
All					2		2			1		1								6
Wet season																				
Bats	40 kHz Group	<i>Scotorepens/Chalinolobus nigrogriseus</i>					P	P						P						3
	Beccari's Free-tail Bat	<i>Mormopterus beccarii</i>	D				D	D	D		D			D			D	D		8
	Gould's Wattled Bat	<i>Chalinolobus gouldii</i>	D	D			D	D			D			D						6
	Hoary Wattled Bat	<i>Chalinolobus nigrogriseus</i>	D	D					D		D						D	D		6
	Inland Cave Bat	<i>Vespadelus finlaysoni</i>					D	D			D			D						4
	Little Broad-nosed Bat	<i>Scotorepens greyii</i>	D						D		D						D	D		5
	Northern Bentwing Bat	<i>Miniopterus schreibersii orianae</i>	D	D					D											3
	Northern Bentwing Bat/Forest Pipistrelle	<i>Miniopterus orianae/Pipistrellus adamsi</i>					P	P						P						3



Sub-group	Common Name	Scientific Name	Site																	Grand Total
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Other	
	Northern Freetail Bat	<i>Chaerephon jobensis</i>	D	D			D	D	D					D						6
	Yellow-bellied Sheath-tailed Bat	<i>Saccolaimus flaviventris</i>		D			D	D						D			D	D		6
	All		6	5			7	7	5		5			7			4	4		50
Large carnivores	Dingo	<i>Canis lupus</i>			1				1										2	4
	All				1				1										2	4
Macropods	Agile Wallaby	<i>Macropus agilis</i>							1									1	1	3
	Antilopine Wallaroo	<i>Macropus antilopinus</i>																2		2
	All								1									3	1	5
Non-native mammals	Buffalo	<i>Bubalus bubalis</i>			1														1	2
	Pig	<i>Sus scrofa</i>		1	3															4
	All		1	4															1	6
Small mammals	Delicate Mouse	<i>Pseudomys delicatulus</i>												1						1
	Pale Field-rat	<i>Rattus tunneyi</i>					3													3
	Unidentified Mammal Species 2 (rodent)																			
	All						3							1						4
Dry	All mammals		6		18	6	7	9	12	16	12	8	8	8	6	6	3	6		133
Wet	All mammals		6	6	5		10	7	7		5			8			4	7	4	69



Reptiles

Sub-group	Common Name	Scientific Name	1	2	3	4	5	6	7	8	9	Site 10	11	12	13	14	15	16	Other	Grand Total
Crocodyles	Freshwater Crocodile	<i>Crocodylus johnstoni</i>						5											1	6
	All							5											1	6
Dragons	Gilbert's Dragon	<i>Amphibolurus gilberti</i>	1	1			1	1	1	2	2	1		1		2				13
	Ring-tailed Dragon	<i>Ctenophorus caudicinctus</i>							1											1
	Two-Lined Dragon	<i>Diporiphora bilineata</i>							2	5		1								8
	White-lipped Two-lined Dragon	<i>Diporiphora albilabris</i>															3	5		8
	Yellow-sided Two-lined Dragon	<i>Diporiphora magna</i>		1	1					1		1	1		1					6
	All		1	2	1		1	1	4	8	2	3	1	1	1	2	3	5		36
Geckos	Bynoe's Gecko	<i>Heteronotia binoei</i>	4		1	4	1			1	1	2		4	4	1		1		24
	Northern Dtella	<i>Gehyra australis</i>	3	4		2	3	1	4	5	2	11	7	1	1	15		2		61
	Northern Spiny-tailed Gecko	<i>Strophurus ciliaris</i>								2		1	2		2	1				8
	Northern Spotted Rock Dtella	<i>Gehyra nana</i>				1			1					1						3
	Sand-plain Gecko	<i>Lucasium stenodactylum</i>											1			1				2
	Tree Dtella	<i>Gehyra variegata</i>														1				1
	Zigzag Velvet Gecko	<i>Oedura rhombifer</i>			2															2
	All		7	4	3	7	4	1	5	8	3	14	10	6	7	19		3		101
Monitors	Black-spotted Spiny-tailed Monitor	<i>Varanus baritji</i>				1									1					2
	Northern Ridge-tailed Monitor	<i>Varanus primordius</i>	2						1	1			2				3			9
	Spotted Tree Monitor	<i>Varanus scalaris</i>												1						1
	All		2			1			1	1			2	1	1		3			12



Sub-group	Common Name	Scientific Name	Site																Grand Total
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Skinks	Ctenotus (borealis)	<i>Ctenotus borealis</i>		1	1		2		1					1		1			7
	Eastern Striped Skink	<i>Ctenotus robustus</i>		1								1							2
	Metallic Snake-eyed Skink	<i>Cryptoblepharus metallicus</i>	1		4	1			1		1				1				9
	Northern Bar-lipped Skink	<i>Eremiascincus isolepis</i>										1							1
	Northern Dwarf Skink	<i>Menetia maini</i>	1											1			1	1	4
	Northern Soil-crevice Skink	<i>Proablepharus tenuis</i>						1											1
	Plain Ctenotus	<i>Ctenotus inornatus</i>			1		2				4								7
	Slender Rainbow Skink	<i>Carlia gracilis</i>			4		7	5			2	1							19
	Striped Rainbow Skink	<i>Carlia munda</i>	4	6	8	1	3	3	3	6	3	4	2	3	1				47
	Ten-lined Ctenotus	<i>Ctenotus decaneurus</i>	1			1			5								5	2	14
	Top End Fire-tailed Skink	<i>Morethia storri</i>														1			1
	Top End Lowlands Ctenotus	<i>Ctenotus hilli</i>														2			2
	Two-spined Rainbow Skink	<i>Carlia amax</i>				3	1		4			1	1	3	3				16
All			7	8	18	6	15	9	14	6	10	8	3	8	5	4	6	3	130
Snakes	Black Headed Python	<i>Aspidites melanocephalus</i>											1						1
	Brown Tree Snake	<i>Boiga irregularis</i>			1							1			1				3
	Common Tree Snake	<i>Dendrelaphis punctulata</i>																1	1
	Eastern Brown Snake	<i>Pseudonaja textilis</i>																1	1
	Keelback	<i>Tropidonophus mairii</i>					1	5											6
	Olive Whipsnake	<i>Demansia olivacea</i>		1	1			1											3
	Orange-naped Snake	<i>Furnia ornata</i>						1											1
	Papuan Whipsnake	<i>Demansia papuensis</i>			2		1	1											4
	Top End Blind Snake	<i>Ramphotyphlops guentheri</i>							1										1



Sub-group	Common Name	Scientific Name	1	2	3	4	5	6	7	8	9	Site	10	11	12	13	14	15	16	Other	Grand Total
	All			1	4		2	8	1				1	1		1				2	21
Dragons	Gilbert's Dragon	<i>Amphibolurus gilberti</i>			1								2								3
	Two-Lined Dragon	<i>Diporiphora bilineata</i>		2	1															1	4
	White-lipped Two-lined Dragon	<i>Diporiphora albilabris</i>	1																1		2
	All		1	2	2								2						1	1	9
Geckos	Bynoe's Gecko	<i>Heteronotia binoei</i>											1		1			2	6		10
	Northern Dtella	<i>Gehyra australis</i>											1				9				10
	All												2		1		9	2	6		20
Monitors	Mertens' Water Monitor	<i>Varanus mertensi</i>																		1	1
	Northern Ridge-tailed Monitor	<i>Varanus primordius</i>	4			2			1	2			1	1			1	4	6		22
	Spotted Tree Monitor	<i>Varanus scalaris</i>														1					1
	All		4			2			1	2			1	1		1	1	4	6	1	24
Pygopods	Excitable Delma	<i>Delma tincta</i>			1																1
	All				1																1
Skinks	Ctenotus (borealis)	<i>Ctenotus borealis</i>								1											1
	Eastern Striped Skink	<i>Ctenotus robustus</i>	1	10	5								2				2				20
	Metallic Snake-eyed Skink	<i>Cryptoblepharus metallicus</i>													2		2				4
	Northern Soil-crevice Skink	<i>Proablepharus tenuis</i>			1																1
	Plain Ctenotus	<i>Ctenotus inornatus</i>		3	1		6	5			4										19
	Slender Rainbow Skink	<i>Carlia gracilis</i>					2				2										4
	Spalding's Ctenotus	<i>Ctenotus spaldingi</i>		2									1		1	5	4				13
	Striped Rainbow Skink	<i>Carlia munda</i>	5	3	14			2	6	1	1			1	2	2					37



Sub-group	Common Name	Scientific Name	Site																	Grand Total
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Other	
	Three-spined Rainbow Skink	<i>Carlia triacantha</i>													1	1				2
	Two-spined Rainbow Skink	<i>Carlia amax</i>							1	1		1	2		3	2				10
	All		6	18	21		8	7	7	3	9	2	3	5	11	11				111
Snakes	Brown Tree Snake	<i>Boiga irregularis</i>			2														2	4
	Children's Python	<i>Antaresia childreni</i>				3													4	7
	Common Tree Snake	<i>Dendrelaphis punctulata</i>				1														1
	Keelback	<i>Tropidonophus mairii</i>						1						2					3	6
	Northern Small-eyed Snake	<i>Cryptophis pallidiceps</i>					1												1	2
	Orange-naped Snake	<i>Furnia ornata</i>			1														1	2
	Water Python	<i>Liasis fuscus</i>																	1	1
	Blind snake sp.	<i>Ramphotyphlops sp.</i>																		
	All				3	4	1	1						2					12	23
Dry	All reptiles		17	15	26	14	22	24	25	23	15	26	17	16	15	25	12	11	3	306
Wet	All reptiles		11	20	27	6	9	8	8	5	9	7	4	8	12	21	6	13	14	188



All groups combined

										Site								
Season	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Other	Grand Total
Dry	81	79	206	79	165	137	94	129	228	150	106	67	65	93	50	70	76	1874
Wet	217	120	161	70	97	71	92	31	81	58	74	93	99	108	103	150	241	1866
All	298	199	367	149	262	208	186	160	309	208	180	160	164	201	153	220	317	3740



Appendix F

Detailed results of statistical analysis



Canonical Discriminant Functions Analyses (CDA) for fauna

Analysis 1 – All fauna (mammals, birds, reptiles, frogs) combined.

Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	.983 ^a	54.0	54.0	.704
2	.494 ^a	27.2	81.2	.575
3	.311 ^a	17.1	98.3	.487
4	.031 ^a	1.7	100.0	.172

a. First 4 canonical discriminant functions were used in the analysis.

Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 4	.250	34.672	28	.180
2 through 4	.495	17.560	18	.485
3 through 4	.740	7.518	10	.676
4	.970	.755	4	.944

Standardized Canonical Discriminant Function Coefficients

	Function			
	1	2	3	4
Amphibians	.010	1.083	.578	.156
Birds	.948	-.579	-.132	-.576
Mammals	.100	.399	-.851	.790
Reptiles	.011	-.813	.788	.390

Structure Matrix

	Function			
	1	2	3	4
Birds	.995	-.008	.024	-.096
Amphibians	.561	.610*	.528	.189
Mammals	.480	.062	-.342	.806*
Reptiles	.274	-.382	.517	.715*

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions

Variables ordered by absolute size of correlation within function.

*. Largest absolute correlation between each variable and any discriminant function

Functions at Group Centroids

Veg comm	Function			
	1	2	3	4
1	.703	.577	-.322	.258
2	1.719	.474	.205	-.116
4	-1.036	.391	.768	.036
6	.213	-.959	.116	-.014
9	.043	-.838	-.579	-.059
10	-.244	.184	.264	-.240
11	-.319	-.455	.325	.195
16	-1.079	.626	-.777	-.060



Functions at Group Centroids

Veg comm	Function			
	1	2	3	4
1	.703	.577	-.322	.258
2	1.719	.474	.205	-.116
4	-1.036	.391	.768	.036
6	.213	-.959	.116	-.014
9	.043	-.838	-.579	-.059
10	-.244	.184	.264	-.240
11	-.319	-.455	.325	.195
16	-1.079	.626	-.777	-.060

Unstandardized canonical discriminant functions evaluated at group means

Analysis 2 – Mammals only (categorised by sub-groups).

Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	1.861 ^a	48.5	48.5	.807
2	1.402 ^a	36.5	85.0	.764
3	.375 ^a	9.8	94.8	.522
4	.165 ^a	4.3	99.1	.376
5	.034 ^a	.9	100.0	.181

a. First 5 canonical discriminant functions were used in the analysis.

Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 5	.088	40.128	35	.253
2 through 5	.251	22.785	24	.533
3 through 5	.604	8.328	15	.910
4 through 5	.830	3.071	8	.930
5	.967	.549	3	.908

Standardized Canonical Discriminant Function Coefficients

	Function				
	1	2	3	4	5
bats	-.729	.705	-.403	-.254	.310
nn mammals	.805	.255	.215	-.724	.125
carnivores	.564	.104	-.638	.678	-.520
macropods	.058	-.023	.615	.478	.806
small mammal	-.420	.613	.344	.484	-.618

Structure Matrix

	Function				
	1	2	3	4	5
bats	-.206	.677 [*]	-.523	-.064	.471
nn mammals	.630	.633 [*]	.230	-.384	.026
small mammal	-.103	.541	.613 [*]	.164	-.542
carnivores	.508	.346	-.575 [*]	.532	.096
macropods	.229	.279	.265	.554	.702 [*]

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions

Variables ordered by absolute size of correlation within function.



Structure Matrix

	Function				
	1	2	3	4	5
bats	-.206	.677*	-.523	-.064	.471
nn mammals	.630	.633*	.230	-.384	.026
small mammal	-.103	.541	.613*	.164	-.542
carnivores	.508	.346	-.575*	.532	.096
macropods	.229	.279	.265	.554	.702*

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions

Variables ordered by absolute size of correlation within function.

*. Largest absolute correlation between each variable and any discriminant function

Functions at Group Centroids

Veg comm	Function				
	1	2	3	4	5
1	-1.166	.715	.479	.265	-.145
2	-.276	1.344	-.521	-.237	-.062
4	-.784	-.562	-.579	-.406	-.168
6	-1.292	.057	-.090	.109	.347
9	1.588	-.010	-.750	.457	.000
10	.358	-.889	.125	-.560	.038
11	2.214	1.302	.853	-.201	.079
16	.167	-1.462	.311	.211	-.053

Unstandardized canonical discriminant functions evaluated at group means

Analysis 3 – Birds only (categorised by sub-groups).

Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	2.519 ^a	48.1	48.1	.846
2	1.415 ^a	27.0	75.0	.765
3	.576 ^a	11.0	86.0	.605
4	.393 ^a	7.5	93.5	.531
5	.285 ^a	5.4	99.0	.471
6	.046 ^a	.9	99.8	.209
7	.009 ^a	.2	100.0	.092

a. First 7 canonical discriminant functions were used in the analysis.

Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 7	.040	74.288	56	.051
2 through 7	.139	45.350	42	.334
3 through 7	.336	25.072	30	.722
4 through 7	.530	14.608	20	.798
5 through 7	.738	6.992	12	.858
6 through 7	.948	1.223	6	.976
7	.992	.196	2	.907

Standardized Canonical Discriminant Function Coefficients



	Function						
	1	2	3	4	5	6	7
cuckoos	.243	-.066	-.013	-.083	1.041	-.003	.321
finches	-.427	.061	-.260	.765	.239	1.148	-.303
ground birds	.691	.199	.294	.233	.422	.121	-.003
night birds	.266	.539	-.397	-.164	-.505	.184	.568
parrots	.043	-.563	.777	.149	-.498	.824	.093
raptors	-.960	-.129	.104	.001	.407	-.143	.491
waterbirds	.451	.478	.292	.573	-.363	-.476	.046
woodland birds	.025	.856	.064	-1.156	-.198	-.946	-.380

Structure Matrix

	Function						
	1	2	3	4	5	6	7
raptors	-.594*	.261	.458	.145	.150	-.191	.472
woodland birds	-.219	.654*	.432	-.442	.093	.209	-.276
finches	-.325	.647*	.034	.146	.169	.531	-.350
parrots	-.050	.073	.751*	-.306	-.156	.480	.191
ground birds	.400	.183	.427*	.096	.300	-.069	-.074
waterbirds	-.099	.505	.385	.605*	-.112	-.236	.153
cuckoos	.115	.201	.078	-.247	.528*	.333	.371
night birds	.145	.392	-.285	-.202	-.241	.340	.728*

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions

Variables ordered by absolute size of correlation within function.

*. Largest absolute correlation between each variable and any discriminant function

Functions at Group Centroids

Veg comm	Function						
	1	2	3	4	5	6	7
1	-3.146	-.368	.245	-.336	.102	.163	.043
2	-.198	2.010	.778	.646	.182	-.048	-.029
4	-.540	-.419	-1.046	.770	-.055	-.214	.071
6	-.058	.975	-.926	-.671	-.311	-.015	-.117
9	1.843	.589	-.260	-.334	.220	.223	.131
10	.657	-.613	.774	-.147	-.984	-.097	.031
11	.626	-.858	.416	-.533	.732	-.271	-.024
16	.816	-1.315	.019	.605	.115	.259	-.106

Unstandardized canonical discriminant functions evaluated at group means

Analysis 4 – Reptiles only (categorised by sub-groups).

Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	1.860 ^a	52.4	52.4	.806
2	1.030 ^a	29.0	81.5	.712
3	.365 ^a	10.3	91.8	.517
4	.222 ^a	6.3	98.0	.427
5	.069 ^a	2.0	100.0	.255

a. First 5 canonical discriminant functions were used in the analysis.



Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 5	.097	57.276	35	.010
2 through 5	.276	31.532	24	.139
– 3 through 5	.560	14.187	15	.511
4 through 5	.765	6.563	8	.584
5	.935	1.641	3	.650

Standardized Canonical Discriminant Function Coefficients

	Function				
	1	2	3	4	5
dragons	.742	-.967	.303	.325	.408
geckos	-.035	.823	-.037	-.753	.544
monitors	.615	.673	.079	.570	.035
skinks	-.417	.345	.868	.352	-.312
snakes	-.563	.440	-.381	.573	.513

Structure Matrix

	Function				
	1	2	3	4	5
monitors	.699*	.537	-.120	.397	-.226
skinks	-.348	.096	.920*	.129	.074
dragons	.200	-.373	.473	.113	.765*
geckos	.074	.295	.382	-.524	.698*
snakes	-.497	.006	-.213	.519	.663*

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions

Variables ordered by absolute size of correlation within function.

*. Largest absolute correlation between each variable and any discriminant function

Functions at Group Centroids

Veg comm	Function				
	1	2	3	4	5
1	-2.047	-.280	-.649	.203	.218
2	-1.478	-.784	.428	.035	-.082
4	.160	1.559	-.190	.360	-.136
6	-.604	1.136	.473	-.755	-.022
– 9	1.015	.415	.023	.558	.025
10	.436	-1.038	.423	.151	-.353
11	1.296	-.444	.459	-.048	.455
16	1.222	-.563	-.967	-.505	-.104

Unstandardized canonical discriminant functions evaluated at group means



Analysis 5 – Amphibians only (categorised by sub-groups).

Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	.874 ^a	55.4	55.4	.683
– 2	.557 ^a	35.3	90.7	.598
3	.147 ^a	9.3	100.0	.358

a. First 3 canonical discriminant functions were used in the analysis.

Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 3	.299	30.797	21	.077
– 2 through 3	.560	14.787	12	.253
3	.872	3.491	5	.625

Standardized Canonical Discriminant Function Coefficients

	Function		
	1	2	3
burrowing frogs	-.923	.738	.528
climbing frogs	.419	.428	-1.004
ground frogs	1.043	-.046	.586

Structure Matrix

	Function		
	1	2	3
ground frogs	.697*	.508	.507
burrowing frogs	-.147	.931*	.335
climbing frogs	.329	.786*	-.523

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions
Variables ordered by absolute size of correlation within function.

*. Largest absolute correlation between each variable and any discriminant function

Functions at Group Centroids

Veg comm	Function		
	1	2	3
1	1.907	-.152	.256
2	-.129	1.523	.056
4	-.334	.323	-.442
– 6	-1.033	-.204	.715
9	-.276	-.751	-.107
10	.415	-.072	-.086
11	-.213	-.156	-.129
16	-.337	-.512	-.264

Unstandardized canonical discriminant functions evaluated at group means



Multiple Linear Regression

Analysis 6a – All fauna; Method – Forward stepwise entry

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.739 ^a	.546	.514	10.107

a. Predictors: (Constant), Period since fire (yrs)

ANOVA^b

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1723.509	1	1723.509	16.871	.001 ^a
	Residual	1430.241	14	102.160		
	Total	3153.750	15			

a. Predictors: (Constant), Period since fire (yrs)

b. Dependent Variable: ALL FAUNA

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	51.241	3.934		13.026	.000
	Period since fire (yrs)	2.914	.709	.739	4.107	.001

a. Dependent Variable: ALL FAUNA

Excluded Variables^b

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	canopy height (m)	.032 ^a	.127	.901	.035	.535
	% canopy cover	.126 ^a	.629	.540	.172	.850
	Veg>3m	.024 ^a	.121	.905	.034	.879
	Veg<3m	-.056 ^a	-.299	.770	-.083	.993
	% veg (ground layer)	.118 ^a	.641	.532	.175	.994
	% litter	.026 ^a	.138	.892	.038	.991
	% bare	-.067 ^a	-.289	.777	-.080	.652
	% gravel	-.126 ^a	-.660	.521	-.180	.933
	# hollows	-.131 ^a	-.704	.494	-.192	.970

a. Predictors in the Model: (Constant), Period since fire (yrs)

b. Dependent Variable: ALL FAUNA

Analysis 6b – All fauna, period since fire excluded; Method – Forward stepwise entry

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.521 ^a	.272	.220	12.807

a. Predictors: (Constant), canopy height (m)



ANOVA^b

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	857.562	1	857.562	5.229	.038 ^a
	Residual	2296.188	14	164.013		
	Total	3153.750	15			

a. Predictors: (Constant), canopy height (m)

b. Dependent Variable: ALL FAUNA

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	38.947	11.257		3.460	.004
	canopy height (m)	1.783	.780	.521	2.287	.038

a. Dependent Variable: ALL FAUNA

Excluded Variables^b

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	% canopy cover	.157 ^a	.565	.582	.155	.707
	Veg>3m	.012 ^a	.044	.965	.012	.733
	Veg<3m	-.015 ^a	-.065	.949	-.018	.998
	% veg (ground layer)	.188 ^a	.815	.430	.220	.999
	% litter	.002 ^a	.010	.992	.003	.968
	% bare	.088 ^a	.280	.784	.077	.567
	% gravel	-.133 ^a	-.527	.607	-.145	.861
	# hollows	-.128 ^a	-.527	.607	-.145	.933

a. Predictors in the Model: (Constant), canopy height (m)

b. Dependent Variable: ALL FAUNA

Analysis 7 – Mammals; Method – Backward stepwise removal

Variables Entered/Removed^b

Model	Variables Entered	Variables Removed	Method
1	canopy height (m), % veg (ground layer), % gravel, Veg>3m, # hollows, Period since fire (yrs), % litter, Veg<3m, % bare, % canopy cover ^a		Enter
2		% canopy cover	Backward (criterion: Probability of F-to-remove >= .100).
3		% litter	as above
4		# hollows	as above
5		% bare	as above
6		% gravel	as above
7		Veg<3m	as above
8		% veg (ground layer)	as above
9		Veg>3m	as above
10		canopy height (m)	as above
11		Period since fire (yrs)	as above

a. All requested variables entered.

b. Dependent Variable: Mammals



Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.858 ^a	.737	.210	3.194
2	.853 ^b	.727	.318	2.968
3	.845 ^c	.715	.389	2.810
4	.837 ^d	.701	.440	2.690
5	.778 ^e	.606	.343	2.912
6	.702 ^f	.493	.239	3.135
7	.650 ^g	.422	.212	3.190
8	.586 ^h	.344	.180	3.255
9	.485 ⁱ	.236	.118	3.375
10	.391 ^j	.153	.092	3.424
11	.000 ^k	.000	.000	3.594

a. Predictors: (Constant), canopy height (m), % veg (ground layer), % gravel, Veg>3m, # hollows, Period since fire (yrs), % litter, Veg<3m, % bare, % canopy cover

b. Predictors: (Constant), canopy height (m), % veg (ground layer), % gravel, Veg>3m, # hollows, Period since fire (yrs), % litter, Veg<3m, % bare

c. Predictors: (Constant), canopy height (m), % veg (ground layer), % gravel, Veg>3m, # hollows, Period since fire (yrs), Veg<3m, % bare

d. Predictors: (Constant), canopy height (m), % veg (ground layer), % gravel, Veg>3m, Period since fire (yrs), Veg<3m, % bare

e. Predictors: (Constant), canopy height (m), % veg (ground layer), % gravel, Veg>3m, Period since fire (yrs), Veg<3m

f. Predictors: (Constant), canopy height (m), % veg (ground layer), Veg>3m, Period since fire (yrs), Veg<3m

g. Predictors: (Constant), canopy height (m), % veg (ground layer), Veg>3m, Period since fire (yrs)

h. Predictors: (Constant), canopy height (m), Veg>3m, Period since fire (yrs)

i. Predictors: (Constant), canopy height (m), Period since fire (yrs)

j. Predictors: (Constant), Period since fire (yrs)

k. Predictor: (constant)



ANOVAⁱ

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	142.749	10	14.275	1.399	.373 ^a
	Residual	51.001	5	10.200		
	Total	193.750	15			
2	Regression	140.885	9	15.654	1.777	.249 ^b
	Residual	52.865	6	8.811		
	Total	193.750	15			
3	Regression	138.472	8	17.309	2.192	.159 ^c
	Residual	55.278	7	7.897		
	Total	193.750	15			
4	Regression	135.874	7	19.411	2.683	.095 ^d
	Residual	57.876	8	7.234		
	Total	193.750	15			
5	Regression	117.406	6	19.568	2.307	.125 ^e
	Residual	76.344	9	8.483		
	Total	193.750	15			
6	Regression	95.444	5	19.089	1.942	.174 ^f
	Residual	98.306	10	9.831		
	Total	193.750	15			
7	Regression	81.779	4	20.445	2.008	.163 ^g
	Residual	111.971	11	10.179		
	Total	193.750	15			
8	Regression	66.607	3	22.202	2.095	.154 ^h
	Residual	127.143	12	10.595		
	Total	193.750	15			
9	Regression	45.635	2	22.817	2.003	.175 ⁱ
	Residual	148.115	13	11.393		
	Total	193.750	15			
10	Regression	29.587	1	29.587	2.523	.135 ^j
	Residual	164.163	14	11.726		
	Total	193.750	15			
11	Regression	.000	0	.000	.	. ^k
	Residual	193.750	15	12.917		
	Total	193.750	15			



ANOVA¹

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	142.749	10	14.275	1.399	.373 ^a
	Residual	51.001	5	10.200		
	Total	193.750	15			
2	Regression	140.885	9	15.654	1.777	.249 ^b
	Residual	52.865	6	8.811		
	Total	193.750	15			
3	Regression	138.472	8	17.309	2.192	.159 ^c
	Residual	55.278	7	7.897		
	Total	193.750	15			
4	Regression	135.874	7	19.411	2.683	.095 ^d
	Residual	57.876	8	7.234		
	Total	193.750	15			
5	Regression	117.406	6	19.568	2.307	.125 ^e
	Residual	76.344	9	8.483		
	Total	193.750	15			
6	Regression	95.444	5	19.089	1.942	.174 ^f
	Residual	98.306	10	9.831		
	Total	193.750	15			
7	Regression	81.779	4	20.445	2.008	.163 ^g
	Residual	111.971	11	10.179		
	Total	193.750	15			
8	Regression	66.607	3	22.202	2.095	.154 ^h
	Residual	127.143	12	10.595		
	Total	193.750	15			
9	Regression	45.635	2	22.817	2.003	.175 ⁱ
	Residual	148.115	13	11.393		
	Total	193.750	15			
10	Regression	29.587	1	29.587	2.523	.135 ^j
	Residual	164.163	14	11.726		
	Total	193.750	15			
11	Regression	.000	0	.000	.	. ^k
	Residual	193.750	15	12.917		
	Total	193.750	15			

a. Predictors: (Constant), canopy height (m), % veg (ground layer), % gravel, Veg>3m, # hollows, Period since fire (yrs), % litter, Veg<3m, % bare, % canopy cover

b. Predictors: (Constant), canopy height (m), % veg (ground layer), % gravel, Veg>3m, # hollows, Period since fire (yrs), % litter, Veg<3m, % bare

c. Predictors: (Constant), canopy height (m), % veg (ground layer), % gravel, Veg>3m, # hollows, Period since fire (yrs), Veg<3m, % bare

d. Predictors: (Constant), canopy height (m), % veg (ground layer), % gravel, Veg>3m, Period since fire (yrs), Veg<3m, % bare

e. Predictors: (Constant), canopy height (m), % veg (ground layer), % gravel, Veg>3m, Period since fire (yrs), Veg<3m

f. Predictors: (Constant), canopy height (m), % veg (ground layer), Veg>3m, Period since fire (yrs), Veg<3m

g. Predictors: (Constant), canopy height (m), % veg (ground layer), Veg>3m, Period since fire (yrs)

h. Predictors: (Constant), canopy height (m), Veg>3m, Period since fire (yrs)

i. Predictors: (Constant), canopy height (m), Period since fire (yrs)

j. Predictors: (Constant), Period since fire (yrs)

k. Predictor: (constant)

l. Dependent Variable: Mammals



Coefficients^a

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	15.348	5.352		2.868	.035
% canopy cover	-.110	.258	-.229	-.427	.687
Veg>3m	.251	.161	.924	1.560	.180
Veg<3m	-.115	.059	-.906	-1.954	.108
% veg (ground layer)	.101	.057	.854	1.778	.135
% litter	-.146	.260	-.202	-.561	.599
% bare	-.180	.115	-.830	-1.565	.178
% gravel	-.094	.051	-.660	-1.843	.125
# hollows	-.478	.702	-.238	-.681	.526
Period since fire (yrs)	.803	.345	.822	2.327	.067
canopy height (m)	-.443	.349	-.523	-1.272	.259
2 (Constant)	14.603	4.704		3.105	.021
Veg>3m	.193	.080	.710	2.412	.052
Veg<3m	-.103	.049	-.815	-2.127	.077
% veg (ground layer)	.093	.050	.788	1.865	.111
% litter	-.124	.237	-.172	-.523	.619
% bare	-.163	.100	-.751	-1.625	.155
% gravel	-.086	.044	-.600	-1.959	.098
# hollows	-.440	.647	-.219	-.679	.522
Period since fire (yrs)	.777	.316	.795	2.461	.049
canopy height (m)	-.470	.319	-.554	-1.471	.192
3 (Constant)	14.704	4.449		3.305	.013
Veg>3m	.189	.075	.695	2.507	.041
Veg<3m	-.096	.044	-.757	-2.181	.066
% veg (ground layer)	.083	.044	.705	1.902	.099
% bare	-.142	.087	-.655	-1.631	.147
% gravel	-.091	.040	-.635	-2.244	.060
# hollows	-.334	.582	-.166	-.574	.584
Period since fire (yrs)	.769	.299	.787	2.575	.037
canopy height (m)	-.541	.273	-.638	-1.980	.088
4 (Constant)	13.274	3.527		3.764	.006
Veg>3m	.186	.072	.686	2.589	.032
Veg<3m	-.098	.042	-.775	-2.340	.047
% veg (ground layer)	.097	.035	.819	2.732	.026
% bare	-.122	.077	-.563	-1.598	.149
% gravel	-.091	.039	-.635	-2.345	.047
Period since fire (yrs)	.725	.277	.743	2.624	.030
canopy height (m)	-.523	.260	-.618	-2.015	.079
5 (Constant)	12.552	3.787		3.314	.009
Veg>3m	.140	.071	.515	1.962	.081
Veg<3m	-.070	.041	-.550	-1.694	.124
% veg (ground layer)	.084	.037	.709	2.244	.051
% gravel	-.055	.034	-.386	-1.609	.142
Period since fire (yrs)	.577	.282	.591	2.047	.071
canopy height (m)	-.607	.276	-.716	-2.202	.055
6 (Constant)	9.449	3.509		2.693	.023
Veg>3m	.139	.077	.511	1.808	.101
Veg<3m	-.050	.042	-.393	-1.179	.266



	% veg (ground layer)	.065	.038	.554	1.712	.118
	Period since fire (yrs)	.592	.304	.606	1.950	.080
	canopy height (m)	-.501	.288	-.591	-1.738	.113
7	(Constant)	8.201	3.405		2.409	.035
	Veg>3m	.106	.073	.390	1.455	.173
	% veg (ground layer)	.033	.027	.282	1.221	.248
	Period since fire (yrs)	.598	.309	.612	1.938	.079
	canopy height (m)	-.472	.292	-.557	-1.615	.135
8	(Constant)	10.041	3.115		3.224	.007
	Veg>3m	.104	.074	.384	1.407	.185
	Period since fire (yrs)	.647	.312	.662	2.072	.061
	canopy height (m)	-.504	.297	-.594	-1.697	.115
9	(Constant)	10.004	3.230		3.097	.008
	Period since fire (yrs)	.644	.324	.659	1.988	.068
	canopy height (m)	-.333	.281	-.394	-1.187	.257
10	(Constant)	6.502	1.333		4.879	.000
	Period since fire (yrs)	.382	.240	.391	1.588	.135
11	(Constant)	8.125	.898		9.043	.000

a. Dependent Variable: Mammals

Excluded Variables^k

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
2	% canopy cover	-.229 ^a	-.427	.687	-.188	.184
3	% canopy cover	-.170 ^b	-.345	.742	-.139	.191
	% litter	-.172 ^b	-.523	.619	-.209	.423
4	% canopy cover	-.151 ^c	-.324	.756	-.121	.192
	% litter	-.102 ^c	-.341	.743	-.128	.469
	# hollows	-.166 ^c	-.574	.584	-.212	.486
5	% canopy cover	.060 ^d	.124	.904	.044	.210
	% litter	.036 ^d	.115	.911	.041	.515
	# hollows	.023 ^d	.077	.940	.027	.578
	% bare	-.563 ^d	-1.598	.149	-.492	.301
6	% canopy cover	.279 ^e	.580	.576	.190	.235
	% litter	-.148 ^e	-.499	.630	-.164	.622
	# hollows	-.095 ^e	-.317	.758	-.105	.624
	% bare	-.087 ^e	-.247	.810	-.082	.450
	% gravel	-.386 ^e	-1.609	.142	-.473	.761
7	% canopy cover	.393 ^f	.848	.417	.259	.251
	% litter	-.038 ^f	-.131	.899	-.041	.685
	# hollows	-.154 ^f	-.523	.612	-.163	.647
	% bare	.000 ^f	.001	1.000	.000	.472
	% gravel	-.264 ^f	-1.058	.315	-.317	.837
	Veg<3m	-.393 ^f	-1.179	.266	-.349	.457
8	% canopy cover	.401 ^g	.849	.414	.248	.251
	% litter	.124 ^g	.498	.628	.149	.946
	# hollows	-.267 ^g	-1.114	.289	-.318	.932
	% bare	-.075 ^g	-.217	.832	-.065	.489
	% gravel	-.221 ^g	-.863	.407	-.252	.851
	Veg<3m	.014 ^g	.054	.958	.016	.929
	% veg (ground layer)	.282 ^g	1.221	.248	.345	.982
9	% canopy cover	.457 ^h	1.693	.116	.439	.706
	% litter	.072 ^h	.281	.783	.081	.967



	# hollows	-.277 ⁿ	-1.112	.288	-.306	.933
	% bare	.055 ⁿ	.158	.877	.046	.529
	% gravel	-.257 ⁿ	-.981	.346	-.273	.861
	Veg<3m	.096 ⁿ	.383	.708	.110	.992
	% veg (ground layer)	.277 ⁿ	1.145	.275	.314	.983
	Veg>3m	.384 ⁿ	1.407	.185	.376	.733
10	% canopy cover	.251 ⁱ	.938	.365	.252	.850
	% litter	.025 ⁱ	.097	.925	.027	.991
	# hollows	-.208 ^j	-.825	.424	-.223	.970
	% bare	-.110 ^j	-.349	.733	-.096	.652
	% gravel	-.154 ^j	-.592	.564	-.162	.933
	Veg<3m	.102 ^j	.400	.695	.110	.993
	% veg (ground layer)	.304 ^j	1.258	.231	.329	.994
	Veg>3m	.195 ^j	.732	.477	.199	.879
	canopy height (m)	-.394 ^j	-1.187	.257	-.313	.535
11	% canopy cover	.365 ^j	1.467	.164	.365	1.000
	% litter	.062 ^j	.231	.821	.062	1.000
	# hollows	-.270 ^j	-1.048	.313	-.270	1.000
	% bare	.159 ^j	.603	.556	.159	1.000
	% gravel	-.245 ^j	-.947	.360	-.245	1.000
	Veg<3m	.135 ^j	.508	.619	.135	1.000
	% veg (ground layer)	.333 ^j	1.322	.207	.333	1.000
	Veg>3m	.308 ^j	1.210	.246	.308	1.000
	canopy height (m)	.056 ^j	.210	.837	.056	1.000
	Period since fire (yrs)	.391 ^j	1.588	.135	.391	1.000

a. Predictors in the Model: (Constant), canopy height (m), % veg (ground layer), % gravel, Veg>3m, # hollows, Period since fire (yrs), % litter, Veg<3m, % bare

b. Predictors in the Model: (Constant), canopy height (m), % veg (ground layer), % gravel, Veg>3m, # hollows, Period since fire (yrs), Veg<3m, % bare

c. Predictors in the Model: (Constant), canopy height (m), % veg (ground layer), % gravel, Veg>3m, Period since fire (yrs), Veg<3m, % bare

d. Predictors in the Model: (Constant), canopy height (m), % veg (ground layer), % gravel, Veg>3m, Period since fire (yrs), Veg<3m

e. Predictors in the Model: (Constant), canopy height (m), % veg (ground layer), Veg>3m, Period since fire (yrs), Veg<3m

f. Predictors in the Model: (Constant), canopy height (m), % veg (ground layer), Veg>3m, Period since fire (yrs)

g. Predictors in the Model: (Constant), canopy height (m), Veg>3m, Period since fire (yrs)

h. Predictors in the Model: (Constant), canopy height (m), Period since fire (yrs)

i. Predictors in the Model: (Constant), Period since fire (yrs)

j. Predictor: (constant)

k. Dependent Variable: Mammals

Analysis 8a – Birds; Method – Forward stepwise entry

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.755 ^a	.571	.540	5.910

a. Predictors: (Constant), Period since fire (yrs)



ANOVA^b

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	650.003	1	650.003	18.612	.001 ^a
	Residual	488.935	14	34.924		
	Total	1138.938	15			

a. Predictors: (Constant), Period since fire (yrs)

b. Dependent Variable: Birds

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	28.333	2.300		12.318	.000
	Period since fire (yrs)	1.789	.415	.755	4.314	.001

a. Dependent Variable: Birds

Excluded Variables^b

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	% canopy cover	-.163 ^a	-.852	.410	-.230	.850
	Veg>3m	-.235 ^a	-1.286	.221	-.336	.879
	Veg<3m	-.039 ^a	-.214	.834	-.059	.993
	% veg (ground layer)	.199 ^a	1.145	.273	.303	.994
	% litter	.071 ^a	.391	.702	.108	.991
	% bare	-.072 ^a	-.320	.754	-.088	.652
	% gravel	-.097 ^a	-.522	.610	-.143	.933
	# hollows	-.157 ^a	-.875	.398	-.236	.970
	canopy height (m)	.036 ^a	.145	.887	.040	.535

a. Predictors in the Model: (Constant), Period since fire (yrs)

b. Dependent Variable: Birds

Analysis 8b – Birds, period since fire excluded; Method – Forward stepwise entry

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.535 ^a	.286	.235	7.623

a. Predictors: (Constant), canopy height (m)

ANOVA^b

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	325.427	1	325.427	5.600	.033 ^a
	Residual	813.510	14	58.108		
	Total	1138.938	15			

a. Predictors: (Constant), canopy height (m)

b. Dependent Variable: Birds



Coefficients^a

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	20.735	6.701		3.094	.008
canopy height (m)	1.098	.464	.535	2.367	.033

a. Dependent Variable: Birds

Excluded Variables^b

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	% canopy cover	-.191 ^a	-.700	.497	-.190	.707
	Veg>3m	-.300 ^a	-1.149	.271	-.304	.733
	Veg<3m	.002 ^a	.010	.992	.003	.998
	% veg (ground layer)	.270 ^a	1.215	.246	.319	.999
	% litter	.048 ^a	.201	.844	.056	.968
	% bare	.084 ^a	.269	.792	.074	.567
	% gravel	-.102 ^a	-.405	.692	-.112	.861
	# hollows	-.154 ^a	-.645	.530	-.176	.933

a. Predictors in the Model: (Constant), canopy height (m)

b. Dependent Variable: Birds

Analysis 9 – Reptiles; Method – Backward stepwise removal

Variables Entered/Removed^b

Model	Variables Entered	Variables Removed	Method
1	canopy height (m), % veg (ground layer), % gravel, Veg>3m, # hollows, Period since fire (yrs), % litter, Veg<3m, % bare, % canopy cover ^a	.	Enter
2	.	Period since fire (yrs)	Backward (criterion: Probability of F-to-remove >= .100).
3	.	# hollows	
4	.	% veg (ground layer)	
5	.	Veg>3m	
6	.	canopy height (m)	
7	.	% litter	
8	.	% gravel	
9	.	% bare	
10	.	Veg<3m	
11	.	% canopy cover	

a. All requested variables entered.

b. Dependent Variable: Reptiles



Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.573 ^a	.328	-1.015	4.592
2	.573 ^b	.328	-.680	4.192
3	.572 ^c	.327	-.442	3.884
4	.570 ^d	.325	-.265	3.639
5	.569 ^e	.324	-.127	3.434
6	.560 ^f	.314	-.029	3.281
7	.502 ^g	.252	-.020	3.266
8	.439 ^h	.193	-.009	3.249
9	.416 ⁱ	.173	.046	3.159
10	.346 ^j	.120	.057	3.141
11	.000 ^k	.000	.000	3.235

a. Predictors: (Constant), canopy height (m), % veg (ground layer), % gravel, Veg<3m, # hollows, Period since fire (yrs), % litter, Veg<3m, % bare, % canopy cover

b. Predictors: (Constant), canopy height (m), % veg (ground layer), % gravel, Veg<3m, # hollows, % litter, Veg<3m, % bare, % canopy cover

c. Predictors: (Constant), canopy height (m), % veg (ground layer), % gravel, Veg<3m, % litter, Veg<3m, % bare, % canopy cover

d. Predictors: (Constant), canopy height (m), % gravel, Veg<3m, % litter, Veg<3m, % bare, % canopy cover

e. Predictors: (Constant), canopy height (m), % gravel, % litter, Veg<3m, % bare, % canopy cover

f. Predictors: (Constant), % gravel, % litter, Veg<3m, % bare, % canopy cover

g. Predictors: (Constant), % gravel, Veg<3m, % bare, % canopy cover

h. Predictors: (Constant), Veg<3m, % bare, % canopy cover

i. Predictors: (Constant), Veg<3m, % canopy cover

j. Predictors: (Constant), % canopy cover

k. Predictor: (constant)

ANOVA^l

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	51.510	10	5.151	.244	.972 ^a
	Residual	105.427	5	21.085		
	Total	156.938	15			
2	Regression	51.478	9	5.720	.325	.936 ^b
	Residual	105.460	6	17.577		
	Total	156.938	15			
3	Regression	51.315	8	6.414	.425	.873 ^c
	Residual	105.622	7	15.089		
	Total	156.938	15			
4	Regression	51.021	7	7.289	.551	.777 ^d
	Residual	105.917	8	13.240		
	Total	156.938	15			
5	Regression	50.833	6	8.472	.719	.645 ^e
	Residual	106.104	9	11.789		
	Total	156.938	15			
6	Regression	49.277	5	9.855	.915	.509 ^f



	Residual	107.661	10	10.766		
	Total	156.938	15			
7	Regression	39.574	4	9.893	.927	.483 ^g
	Residual	117.364	11	10.669		
	Total	156.938	15			
8	Regression	30.273	3	10.091	.956	.445 ^h
	Residual	126.664	12	10.555		
	Total	156.938	15			
9	Regression	27.180	2	13.590	1.362	.290 ⁱ
	Residual	129.758	13	9.981		
	Total	156.938	15			
10	Regression	18.778	1	18.778	1.903	.189 ^j
	Residual	138.159	14	9.869		
	Total	156.938	15			
11	Regression	.000	0	.000		. ^k
	Residual	156.938	15	10.463		
	Total	156.938	15			

a. Predictors: (Constant), canopy height (m), % veg (ground layer), % gravel, Veg>3m, # hollows, Period since fire (yrs), % litter, Veg<3m, % bare, % canopy cover

b. Predictors: (Constant), canopy height (m), % veg (ground layer), % gravel, Veg>3m, # hollows, % litter, Veg<3m, % bare, % canopy cover

c. Predictors: (Constant), canopy height (m), % veg (ground layer), % gravel, Veg>3m, % litter, Veg<3m, % bare, % canopy cover

d. Predictors: (Constant), canopy height (m), % gravel, Veg>3m, % litter, Veg<3m, % bare, % canopy cover

e. Predictors: (Constant), canopy height (m), % gravel, % litter, Veg<3m, % bare, % canopy cover

f. Predictors: (Constant), % gravel, % litter, Veg<3m, % bare, % canopy cover

g. Predictors: (Constant), % gravel, Veg<3m, % bare, % canopy cover

h. Predictors: (Constant), Veg<3m, % bare, % canopy cover

i. Predictors: (Constant), Veg<3m, % canopy cover

j. Predictors: (Constant), % canopy cover

k. Predictor: (constant)

l. Dependent Variable: Reptiles

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	13.065	7.695		1.698	.150
	% canopy cover	.160	.371	.370	.433	.683
	Veg>3m	.027	.231	.112	.118	.911
	Veg<3m	-.052	.084	-.456	-.616	.565
	% veg (ground layer)	.011	.082	.108	.140	.894
	% litter	.203	.374	.312	.543	.611
	% bare	-.055	.166	-.280	-.330	.755
	% gravel	-.062	.074	-.481	-.841	.439
	# hollows	.096	1.009	.053	.095	.928
	Period since fire (yrs)	-.019	.496	-.022	-.039	.970
	canopy height (m)	-.103	.501	-.134	-.205	.846
2	(Constant)	13.196	6.322		2.087	.082
	% canopy cover	.158	.333	.364	.474	.652



	Veg>3m	.029	.206	.120	.143	.891
	Veg<3m	-.053	.076	-.461	-.692	.515
	% veg (ground layer)	.011	.074	.106	.152	.885
	% litter	.202	.340	.310	.593	.575
	% bare	-.057	.138	-.294	-.417	.691
	% gravel	-.063	.066	-.486	-.950	.379
	# hollows	.085	.887	.047	.096	.927
	canopy height (m)	-.110	.423	-.144	-.260	.803
3	(Constant)	13.484	5.160		2.613	.035
	% canopy cover	.155	.308	.358	.504	.630
	Veg>3m	.031	.190	.128	.165	.874
	Veg<3m	-.053	.070	-.462	-.749	.478
	% veg (ground layer)	.009	.066	.087	.140	.893
	% litter	.191	.299	.294	.640	.542
	% bare	-.063	.115	-.322	-.546	.602
	% gravel	-.062	.061	-.482	-1.020	.342
	canopy height (m)	-.103	.385	-.135	-.266	.798
4	(Constant)	13.431	4.821		2.786	.024
	% canopy cover	.172	.267	.395	.643	.538
	Veg>3m	.019	.156	.076	.119	.908
	Veg<3m	-.045	.039	-.393	-1.151	.283
	% litter	.215	.231	.330	.929	.380
	% bare	-.056	.097	-.285	-.577	.580
	% gravel	-.059	.054	-.462	-1.098	.304
	canopy height (m)	-.119	.344	-.156	-.346	.738
5	(Constant)	13.275	4.378		3.033	.014
	% canopy cover	.197	.148	.455	1.333	.215
	Veg<3m	-.043	.034	-.377	-1.273	.235
	% litter	.211	.216	.325	.976	.354
	% bare	-.052	.087	-.267	-.601	.562
	% gravel	-.057	.048	-.445	-1.186	.266
	canopy height (m)	-.118	.324	-.155	-.363	.725
6	(Constant)	12.242	3.181		3.848	.003
	% canopy cover	.181	.134	.416	1.343	.209
	Veg<3m	-.043	.032	-.378	-1.337	.211
	% litter	.179	.189	.275	.949	.365
	% bare	-.069	.071	-.353	-.979	.351
	% gravel	-.056	.046	-.434	-1.213	.253
7	(Constant)	12.243	3.167		3.866	.003
	% canopy cover	.190	.134	.438	1.424	.182
	Veg<3m	-.036	.031	-.319	-1.162	.270
	% bare	-.066	.070	-.339	-.946	.364
	% gravel	-.040	.043	-.309	-.934	.371
8	(Constant)	10.361	2.430		4.265	.001
	% canopy cover	.199	.132	.459	1.503	.159
	Veg<3m	-.030	.030	-.259	-.975	.349
	% bare	-.032	.060	-.165	-.541	.598
9	(Constant)	10.283	2.358		4.360	.001
	% canopy cover	.162	.110	.373	1.470	.165
	Veg<3m	-.027	.029	-.233	-.917	.376
10	(Constant)	8.818	1.726		5.109	.000
	% canopy cover	.150	.109	.346	1.379	.189
11	(Constant)	10.938	.809		13.526	.000

a. Dependent Variable: Reptiles



Excluded Variables^k

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
2	Period since fire (yrs)	-.022 ^a	-.039	.970	-.018	.422
3	Period since fire (yrs)	-.008 ^b	-.015	.988	-.006	.456
	# hollows	.047 ^b	.096	.927	.039	.466
4	Period since fire (yrs)	-.009 ^c	-.020	.985	-.007	.456
	# hollows	.026 ^c	.059	.954	.022	.507
	% veg (ground layer)	.087 ^c	.140	.893	.053	.249
5	Period since fire (yrs)	-.019 ^d	-.045	.965	-.016	.476
	# hollows	.036 ^d	.092	.929	.032	.542
	% veg (ground layer)	.038 ^d	.074	.943	.026	.323
	Veg>3m	.076 ^d	.119	.908	.042	.207
6	Period since fire (yrs)	-.071 ^e	-.196	.849	-.065	.581
	# hollows	-.001 ^e	-.004	.997	-.001	.584
	% veg (ground layer)	.082 ^e	.177	.863	.059	.351
	Veg>3m	.069 ^e	.115	.911	.038	.207
	canopy height (m)	-.155 ^e	-.363	.725	-.120	.415
7	Period since fire (yrs)	-.007 ^f	-.021	.984	-.007	.603
	# hollows	-.134 ^f	-.423	.681	-.133	.738
	% veg (ground layer)	.242 ^f	.616	.552	.191	.465
	Veg>3m	.004 ^f	.006	.995	.002	.210
	canopy height (m)	.016 ^f	.042	.968	.013	.500
	% litter	.275 ^f	.949	.365	.288	.816
8	Period since fire (yrs)	-.064 ^g	-.188	.854	-.057	.625
	# hollows	-.091 ^g	-.292	.776	-.088	.754
	% veg (ground layer)	.105 ^g	.281	.784	.084	.522
	Veg>3m	-.148 ^g	-.264	.797	-.079	.231
	canopy height (m)	-.010 ^g	-.027	.979	-.008	.503
	% litter	.146 ^g	.531	.606	.158	.943
	% gravel	-.309 ^g	-.934	.371	-.271	.620
9	Period since fire (yrs)	-.126 ^h	-.445	.665	-.127	.848
	# hollows	-.018 ^h	-.063	.951	-.018	.894
	% veg (ground layer)	.108 ^h	.298	.770	.086	.522
	Veg>3m	-.209 ^h	-.396	.699	-.114	.245
	canopy height (m)	-.097 ^h	-.312	.760	-.090	.706
	% litter	.167 ^h	.638	.535	.181	.974
	% gravel	-.146 ^h	-.519	.613	-.148	.851
	% bare	-.165 ^h	-.541	.598	-.154	.725
10	Period since fire (yrs)	-.136 ⁱ	-.488	.634	-.134	.850
	# hollows	.046 ⁱ	.174	.864	.048	.962
	% veg (ground layer)	-.104 ⁱ	-.401	.695	-.110	1.000
	Veg>3m	-.315 ⁱ	-.632	.538	-.173	.265
	canopy height (m)	-.091 ⁱ	-.294	.773	-.081	.707
	% litter	.126 ⁱ	.490	.632	.135	.999
	% gravel	-.116 ⁱ	-.416	.684	-.115	.862
	% bare	-.111 ⁱ	-.372	.716	-.103	.749
	Veg<3m	-.233 ⁱ	-.917	.376	-.247	.986
11	Period since fire (yrs)	.018 ^j	.068	.947	.018	1.000
	# hollows	-.023 ^j	-.086	.932	-.023	1.000
	% veg (ground layer)	-.108 ^j	-.407	.690	-.108	1.000
	Veg>3m	.213 ^j	.817	.428	.213	1.000
	canopy height (m)	.123 ^j	.464	.650	.123	1.000
	% litter	.113 ^j	.425	.677	.113	1.000



% gravel	-.228 ^j	-.878	.395	-.228	1.000
% bare	.090 ^j	.337	.741	.090	1.000
Veg<3m	-.189 ^j	-.721	.483	-.189	1.000
% canopy cover	.346 ^j	1.379	.189	.346	1.000

- a. Predictors in the Model: (Constant), canopy height (m), % veg (ground layer), % gravel, Veg>3m, # hollows, % litter, Veg<3m, % bare, % canopy cover
b. Predictors in the Model: (Constant), canopy height (m), % veg (ground layer), % gravel, Veg>3m, % litter, Veg<3m, % bare, % canopy cover
c. Predictors in the Model: (Constant), canopy height (m), % gravel, Veg>3m, % litter, Veg<3m, % bare, % canopy cover
d. Predictors in the Model: (Constant), canopy height (m), % gravel, % litter, Veg<3m, % bare, % canopy cover
e. Predictors in the Model: (Constant), % gravel, % litter, Veg<3m, % bare, % canopy cover
f. Predictors in the Model: (Constant), % gravel, Veg<3m, % bare, % canopy cover
g. Predictors in the Model: (Constant), Veg<3m, % bare, % canopy cover
h. Predictors in the Model: (Constant), Veg<3m, % canopy cover
i. Predictors in the Model: (Constant), % canopy cover
j. Predictor: (constant)
k. Dependent Variable: Reptiles

Analysis 10a – Amphibians; Method – Forward stepwise entry

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.708 ^a	.501	.465	2.548

- a. Predictors: (Constant), Period since fire (yrs)

ANOVA^b

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	91.113	1	91.113	14.035	.002 ^a
Residual	90.887	14	6.492		
Total	182.000	15			

- a. Predictors: (Constant), Period since fire (yrs)
b. Dependent Variable: Amphibians

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	5.653	.992		5.700	.000
	Period since fire (yrs)	.670	.179	.708	3.746	.002

- a. Dependent Variable: Amphibians



Excluded Variables^b

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	% canopy cover	.230 ^a	1.134	.277	.300	.850
	Veg>3m	.211 ^a	1.052	.312	.280	.879
	Veg<3m	-.056 ^a	-.287	.779	-.079	.993
	% veg (ground layer)	-.200 ^a	-1.059	.309	-.282	.994
	% litter	-.180 ^a	-.947	.361	-.254	.991
	% bare	-.118 ^a	-.490	.632	-.135	.652
	% gravel	.118 ^a	.590	.565	.162	.933
	# hollows	.059 ^a	.300	.769	.083	.970
	canopy height (m)	.214 ^a	.817	.429	.221	.535

a. Predictors in the Model: (Constant), Period since fire (yrs)

b. Dependent Variable: Amphibians

Analysis 10b – Amphibians, without period since fire; Method – Forward stepwise entry

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.597 ^a	.356	.310	2.893

a. Predictors: (Constant), canopy height (m)

ANOVA^b

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	64.812	1	64.812	7.743	.015 ^a
	Residual	117.188	14	8.371		
	Total	182.000	15			

a. Predictors: (Constant), canopy height (m)

b. Dependent Variable: Amphibians

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.716	2.543		.675	.511
	canopy height (m)	.490	.176	.597	2.783	.015

a. Dependent Variable: Amphibians

Excluded Variables^b

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	% canopy cover	.208 ^a	.803	.436	.217	.707
	Veg>3m	.168 ^a	.658	.522	.180	.733
	Veg<3m	-.022 ^a	-.098	.923	-.027	.998
	% veg (ground layer)	-.129 ^a	-.586	.568	-.161	.999
	% litter	-.226 ^a	-1.038	.318	-.277	.968
	% bare	-.092 ^a	-.312	.760	-.086	.567
	% gravel	.173 ^a	.737	.474	.200	.861
	# hollows	.097 ^a	.424	.679	.117	.933

a. Predictors in the Model: (Constant), canopy height (m)

b. Dependent Variable: Amphibians



Appendix G

Remote surveillance cameras – detailed description of methods and results



Motion-triggered remote surveillance cameras have been used in an increasing number of surveys for fauna (particularly mammals) across Australia. They are now generally accepted as a realistic and viable means to test for presence and absence of some animals within a study site, as well as obtaining an estimate of detection probabilities against other survey methods for cryptic species.

The operating units used for this project consist of a regular digital camera modified to respond to a sensor that detects changes in motion as an animal moves across the field of view. The camera and sensor are housed in a weatherproof case designed to allow operation in most conditions.

Five units were placed within potentially suitable habitat for northern quoll (*Dasyurus hallucatus*). Each unit was secured to a tree, and a clear line of sight was established toward bait, which is buried or smeared on rocks within range of the camera motion detectors. A mix of peanut butter, honey and oats was used as the bait.

The fauna cameras did not record a high diversity or abundance of fauna species (see Table A1 below). Five native birds, two native mammals (plus one exotic mammal) and one introduced amphibian were recorded for the survey.

Table A1 Fauna species recorded during the surveillance camera surveys at the Mine Site.

		Fauna camera No.				
		M1	M2	M3	M4	4S
		4	4	4	4	4
Common Name	Scientific Name					
Birds						
Pheasant coucal	<i>Centropus phasianinus</i>	1(1)				
Grey-crowned babbler	<i>Pomatostomus temporalis</i>		1(2)			
Northern rosella	<i>Platycercus venustus</i>			1(2)		
Great Bowerbird	<i>Chlamydera nuchalis</i>			1(1)		1(1)
Torresian crow	<i>Corvus orru</i>				1(2)	1(2)
Mammals						
Dingo	<i>Canis lupus dingo</i>	1(4)	1(1)			
Cat**	<i>Felis catus</i>			1(1)		
Euro	<i>Macropus robustus</i>			1(1)		
Amphibians						
Cane toad	<i>Rhinella marina</i>			1(1)		

A sample of images taken from remote cameras are provided below.



Plate 1 Nocturnal image of four dingos (*Canis lupus dingo*) visiting a bait station at M1.



Plate 2 Nocturnal image of feral cat (*Felis catus*) visiting a bait station at M3.



Plate 3 Diurnal image of northern rosellas (*Platycercus venustus*) at M3.



Plate 4 Diurnal image of grey-crowned babblers (*Pomatostomus temporalis*) at M3.



Appendix H

Assessments of risks of impacts on threatened species and the Mt Todd fauna



Evaluations of the significance of potential impacts on each species are based on the Commonwealth's *Significant Impacts Guidelines: Matters of National Environmental Significance* (the guidelines) as applied to critically endangered and endangered species (DEWHA 2009). This level of assessment is the most conservative set of guidelines provided under the EPBC (other than for species considered Extinct in the Wild), so equals or exceeds the guidelines for all species. Consequently, it is applied to each threatened species, regardless of the species' conservation status under federal or NT legislation.

Gouldian finch

Assessments of risks posed to the Yinberrie Hills Gouldian finch population are provided below. Assessments are based on the preceding discussion of possible sources of impact (section 6.1.5), and assessment of cumulative risk from all potential sources of impact. Impacts include a cumulative loss of possible foraging/breeding habitat in the study area, the estimated dust and noise levels, the wildfire environment, the exotic plants and animals documented, and the possibility of poisoning from mine tailings.

The analysis assumes mitigation actions planned for the project are implemented.

Risks to the Yinberrie Hills population of Gouldian finche

Source of risk	Likelihood of consequence	Severity of consequence	Risk
<i>Long-term decrease in the size of a population</i>			
Clearing of breeding/foraging habitat	Unlikely	Minor	Very Low
Dust levels generated by mining and processing ³	Possible	Major	High
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Unlikely	Moderate	Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Reduce the area of occupancy of the species</i>			
Clearing of breeding/foraging habitat	Unlikely	Minor	Very Low
Dust levels generated by mining and processing	Possible	Major	High
Noise levels generated by mining and processing	Rare	Minor	Very Low

³ Little information is available on the impacts of dust levels on wildlife in general. Nothing is known of its effects on the Gouldian finch. This assessment is based on the proposition that a negative impact on individual Gouldian finches is possible, this may be exacerbated by the presence of air sac mites in Gouldian finches (Tidemann *et al.* 1992) and given the absence of detailed information on the dispersion of dust in Gouldian finch habitats, the effects of differing concentrations of dust on Gouldian finches, and the status of other presumed breeding areas in the Yinberrie Hills, there is potential for a major impact at the population level. The area of occupancy of the species relates to impacts at the level of the species geographic range. A small loss of breeding habitat, as in this case, is unlikely to result in a range reduction.



Source of risk	Likelihood of consequence	Severity of consequence	Risk
Wildfire	Unlikely	Moderate	Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Unlikely	Minor	Very Low
<i>Adversely affect habitat critical to the survival of a species</i>			
Clearing of breeding/foraging habitat	Unlikely	Minor	Very Low
Dust levels generated by mining and processing	Possible	Major	High
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Unlikely	Moderate	Low
Poisoning from drinking tailings dam water	Unlikely	Minor	Very Low
Lowering and contamination of the water table	Unlikely	Minor	Very Low
<i>Fragment an existing population into two or more populations</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Unlikely	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline</i>			
Clearing of breeding/foraging habitat	Unlikely	Minor	Very Low
Dust levels generated by mining and processing	Possible	Moderate	Medium
Noise levels generated by mining and processing	Rare	Significant	Low
Wildfire	Rare	Significant	Low
Poisoning from drinking tailings dam water	Rare	Significant	Low
Lowering and contamination of the water table	Rare	Significant	Low
<i>Result in invasive species that are harmful to the Gouldian finch</i>			



Source of risk	Likelihood of consequence	Severity of consequence	Risk
Clearing of breeding/foraging habitat	Unlikely	Moderate	Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Unlikely	Moderate	Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Introduce disease that may cause the species to decline</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low



Crested shrike-tit (northern)

Assessments of risks posed to the Yinberrie Hills crested shrike-tit population are provided below. Assessments are based on the preceding discussion of possible sources of impact (section 6.1.5), and assessment of cumulative risk from all potential sources of impact. Impacts include a cumulative loss of 2.09% of possible foraging/breeding habitat in the study area, the estimated dust and noise levels, the wildfire environment, the exotic plants and animals documented, and the possibility of poisoning from mine tailings. The previous discussion indicates that none of these potential threats is significant and the study area is apparently little used by this species.

The analysis assumes mitigation actions planned for the project are implemented, and that the crested shrike-tit occurs in the study area at a frequency that might allow for some sort of impact, however minor.

Risks to the Yinberrie Hills population of crested shrike-tit (northern)

Source of risk	Likelihood of consequence	Severity of consequence	Risk
<i>Long-term decrease in the size of a population</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Unlikely	Minor	Very Low
Poisoning from drinking tailings dam water	Unlikely	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Reduce the area of occupancy of the species</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Adversely affect habitat critical to the survival of a species</i>			
Clearing of breeding/foraging habitat	Unlikely	Minor	Very Low
Dust levels generated by mining and processing	Unlikely	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low



Source of risk	Likelihood of consequence	Severity of consequence	Risk
Wildfire	Unlikely	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Fragment an existing population into two or more populations</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Unlikely	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Result in invasive species that are harmful to the crested shrike-tit</i>			
Clearing of breeding/foraging habitat	Possible	Minor	Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Unlikely	Moderate	Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Introduce disease that may cause the species to decline</i>			



Source of risk	Likelihood of consequence	Severity of consequence	Risk
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low

Partridge pigeon

Assessments of risks posed to the Yinberrie Hills partridge population are provided below. Assessments are based on the preceding discussion of possible sources of impact (section 6.1.5), and assessment of cumulative risk from all potential sources of impact. Impacts include a cumulative loss of 2.09% of possible foraging/breeding habitat in the study area, the estimated dust and noise levels, the wildfire environment, the exotic plants and animals documented, and the possibility of poisoning from mine tailings. The previous discussion indicates that none of these potential threats is significant.

The analysis assumes mitigation actions planned for the project are implemented, and that the partridge pigeon occurs in the study area at a frequency that might allow for some sort of impact, however minor.

Risks to the Yinberrie Hills population of partridge pigeon

Source of risk	Likelihood of consequence	Severity of consequence	Risk
<i>Long-term decrease in the size of a population</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Unlikely	Minor	Very Low
Poisoning from drinking tailings dam water	Unlikely	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Reduce the area of occupancy of the species</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Unlikely	Minor	Very Low



Source of risk	Likelihood of consequence	Severity of consequence	Risk
Wildfire	Unlikely	Minor	Very Low
Poisoning from drinking tailings dam water	Unlikely	Minor	Very Low
Lowering and contamination of the water table	Unlikely	Minor	Very Low
<i>Adversely affect habitat critical to the survival of a species</i>			
Clearing of breeding/foraging habitat	Unlikely	Minor	Very Low
Dust levels generated by mining and processing	Unlikely	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Unlikely	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Fragment an existing population into two or more populations</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Result in invasive species that are harmful to the partridge pigeon</i>			



Source of risk	Likelihood of consequence	Severity of consequence	Risk
Clearing of breeding/foraging habitat	Unlikely	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Unlikely	Moderate	Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Introduce disease that may cause the species to decline</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low

Painted honeyeater

Assessments of risks posed to the Yinberrie Hills painted honeyeater population are provided below. Assessments are based on the preceding discussion of possible sources of impact (section 6.1.5), and assessment of cumulative risk from all potential sources of impact. Impacts include a cumulative loss of 2.09% of possible foraging habitat in the study area, the estimated dust and noise levels, the wildfire environment, the exotic plants and animals documented, and the possibility of poisoning from mine tailings. The previous discussion indicates that none of these potential threats is significant and the study area is apparently little used by this species.

The analysis assumes mitigation actions planned for the project are implemented, and that the painted honeyeater occurs in the study area at a frequency that might allow for some sort of impact, however minor.

Risks to the Yinberrie Hills population of painted honeyeater

Source of risk	Likelihood of consequence	Severity of consequence	Risk
<i>Long-term decrease in the size of a population</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low



Source of risk	Likelihood of consequence	Severity of consequence	Risk
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Unlikely	Minor	Very Low
Poisoning from drinking tailings dam water	Unlikely	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Reduce the area of occupancy of the species</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Unlikely	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Adversely affect habitat critical to the survival of a species</i>			
Clearing of breeding/foraging habitat	Unlikely	Minor	Very Low
Dust levels generated by mining and processing	Unlikely	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Unlikely	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Fragment an existing population into two or more populations</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species</i>			



Source of risk	Likelihood of consequence	Severity of consequence	Risk
<i>is likely to decline</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Unlikely	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Result in invasive species that are harmful to the painted honeyeater</i>			
Clearing of breeding/foraging habitat	Unlikely	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Unlikely	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Introduce disease that may cause the species to decline</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low

Risks to the Yinberrie Hills population of Australian bustard

Source of risk	Likelihood of consequence	Severity of consequence	Risk
<i>Long-term decrease in the size of a population</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low



Source of risk	Likelihood of consequence	Severity of consequence	Risk
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Unlikely	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Reduce the area of occupancy of the species</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Unlikely	Minor	Very Low
Wildfire	Unlikely	Minor	Very Low
Poisoning from drinking tailings dam water	Unlikely	Minor	Very Low
Lowering and contamination of the water table	Unlikely	Minor	Very Low
<i>Adversely affect habitat critical to the survival of a species</i>			
Clearing of breeding/foraging habitat	Unlikely	Minor	Very Low
Dust levels generated by mining and processing	Unlikely	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Unlikely	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Fragment an existing population into two or more populations</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low



Source of risk	Likelihood of consequence	Severity of consequence	Risk
<i>Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Result in invasive species that are harmful to the Australian bustard</i>			
Clearing of breeding/foraging habitat	Unlikely	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Introduce disease that may cause the species to decline</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low

Pale field-rat

Assessments of risks posed to the Yinberrie Hills pale field-rat population are provided below. Assessments are based on the preceding discussion of possible sources of impact (section 6.1.5), and assessment of cumulative risk from all potential sources of impact. Impacts include a cumulative loss of 2.09% of possible foraging/breeding habitat in the study area, the estimated dust and noise levels, the



wildfire environment and the exotic plants and animals documented. The previous discussion indicates that none of these potential threats is significant.

The analysis assumes mitigation actions planned for the project are implemented, and that the pale field-rat occurs in the study area at a frequency that might allow for some sort of impact, however minor.

Risks to the Yinberrie Hills population of pale field-rat

Source of risk	Likelihood of consequence	Severity of consequence	Risk
<i>Long-term decrease in the size of a population</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Reduce the area of occupancy of the species</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Unlikely	Minor	Very Low
Wildfire	Unlikely	Minor	Very Low
Poisoning from drinking tailings dam water	Unlikely	Minor	Very Low
Lowering and contamination of the water table	Unlikely	Minor	Very Low
<i>Adversely affect habitat critical to the survival of a species</i>			
Clearing of breeding/foraging habitat	Unlikely	Minor	Very Low
Dust levels generated by mining and processing	Unlikely	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Unlikely	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Fragment an existing population into two or more populations</i>			



Source of risk	Likelihood of consequence	Severity of consequence	Risk
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Result in invasive species that are harmful to the pale field-rat</i>			
Clearing of breeding/foraging habitat	Unlikely	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Introduce disease that may cause the species to decline</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Rare	Minor	Very Low



Source of risk	Likelihood of consequence	Severity of consequence	Risk
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low

Mertens' water monitor, Mitchell's water monitor and yellow-spotted monitor

Assessments of risks posed to the Yinberrie Hills populations of Mertens' water monitor, Mitchells' water monitor and yellow-spotted monitor are provided below. Assessments are based on the preceding discussion of possible sources of impact (section 6.1.5), and assessment of cumulative risk from all potential sources of impact. Impacts include a cumulative loss of 0% of possible foraging/breeding habitat in the study area, the estimated dust and noise levels, the wildfire environment, the exotic plants and animals documented, and the possibility of poisoning from mine tailings. The previous discussion indicates that none of these potential threats is significant.

The analysis assumes mitigation actions planned for the project are implemented, and that the Mertens' water monitor, Mitchells' water monitor and yellow-spotted monitor occur in the study area at a frequency that might allow for some sort of impact, however minor. Each of these monitors suffer from population declines associated with the exotic cane toad. Recovery of the populations is largely dependent on ongoing co-evolution between the would-be monitor predators and the would-be cane toad prey rather than any other factor, including the proposed Mt Todd gold mine.

Risks to the Yinberrie Hills population of Mertens' water monitor, Mitchell's water monitor and yellow spotted monitor

Source of risk	Likelihood of consequence	Severity of consequence	Risk
<i>Long-term decrease in the size of a population</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Reduce the area of occupancy of the species</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low



Source of risk	Likelihood of consequence	Severity of consequence	Risk
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Adversely affect habitat critical to the survival of a species</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Fragment an existing population into two or more populations</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Result in invasive species that are harmful to the species</i>			



Source of risk	Likelihood of consequence	Severity of consequence	Risk
Clearing of breeding/foraging habitat	Unlikely	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Introduce disease that may cause the species to decline</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low

Yinberrie Hills fauna

In the absence of a generally recognised set of criteria for assessing potential impacts on a local fauna as a whole, potential impacts on the community of fauna at the Yinberrie Hills are assessed according to the guidelines on significance of impacts on biological and ecological values of National Heritage places (DEWHA 2009).

Risks to the Yinberrie Hills fauna as a whole

Source of risk	Likelihood of consequence	Severity of consequence	Risk
<i>Modify or inhibit ecological processes in a National Heritage place</i>			
Clearing of breeding/foraging habitat	Unlikely	Minor	Very Low
Dust levels generated by mining and processing	Possible	Moderate	Medium
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Unlikely	Moderate	Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low



Source of risk	Likelihood of consequence	Severity of consequence	Risk
Lowering and contamination of the water table	Unlikely	Minor	Very Low
<i>Reduce the diversity or modify the composition of plant and animal species in a National Heritage place</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Possible	Major	High
Noise levels generated by mining and processing	Rare	Significant	Low
Wildfire	Rare	Moderate	Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Unlikely	Minor	VeryLow
<i>Fragment or damage habitat important for the conservation of biological diversity in a National Heritage place</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	VeryLow
<i>Cause a long-term reduction in rare, endemic or unique plant or animal populations or species in a National Heritage place</i>			
Clearing of breeding/foraging habitat	Unlikely	Minor	Very Low
Dust levels generated by mining and processing	Possible	Major	High
Noise levels generated by mining and processing	Rare	Significant	Low
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	VeryLow
Lowering and contamination of the water table	Rare	Minor	Very Low
<i>Fragment, isolate or substantially damage habitat for rare, endemic or unique animal populations or species in a National Heritage place</i>			
Clearing of breeding/foraging habitat	Rare	Minor	Very Low



Source of risk	Likelihood of consequence	Severity of consequence	Risk
Dust levels generated by mining and processing	Rare	Minor	Very Low
Noise levels generated by mining and processing	Rare	Minor	Very Low
Wildfire	Rare	Minor	Very Low
Poisoning from drinking tailings dam water	Rare	Minor	Very Low
Lowering and contamination of the water table	Rare	Minor	Very Low



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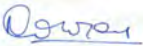
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