Project Plan SP 2012-035

Conservation and management of the bilby (*Macrotis lagotis*) in the Pilbara

Animal Science

Project Core Team

Supervising Scientist	Martin Dziminski
Data Custodian	Martin Dziminski
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Project status as of May 4, 2016, 3:16 p.m.

Approved and active

Document endorsements and approvals as of May 4, 2016, 3:16 p.m.

Project Team	granted
Program Leader	granted
Directorate	granted
Biometrician	required
Herbarium Curator	not required
Animal Ethics Committee	not required

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Science and Conservation Division Program

Animal Science

Parks and Wildlife Service

Service 2: Conserving Habitats, Species and Ecological Communities

Project Staff

Role	Person	Time allocation (FTE)
Supervising Scientist	Martin Dziminski	1.0
Technical Officer	Fiona Carpenter	1.0
Research Scientist	Keith Morris	0.05

Related Science Projects

Nil

Proposed period of the project

June 1, 2012 – None

Relevance and Outcomes

Background

The bilby (Macrotis lagotis) is listed as Vulnerable by under the Commonwealth Environmental Protection and Biodiversity Conservation Act 1999 (EPBC, 1999), Schedule 1 - Fauna that is rare or is likely to become extinct under the Western Australian Wildlife Conservation Act 1950 (WA Minister of Environment, 2012) and internationally listed as Vulnerable on the IUCN Red List of Threatened Species (IUCN, 2012). The bilby once occurred over much of Australia (Marlow, 1958; Southgate, 1990a; Menkhorst, 1995; Abbott, 2001; Pavey, 2006), however a substantial reduction in numbers and distribution over the last 100 years (summarised in Pavey, 2006; DSEWPaC, 2012) has resulted in the bilby being listed as a threatened species. The decline in bilbies has been attributed to a number of threats working directly or in combination with each other. These threats are analysed in detail by Pavey (2006) and include mortality caused by inappropriate fire regimes (Southgate & Carthew, 2006, 2007; Southgate et al., 2007a), predation by feral cats and foxes (Paltridge, 2002), and the removal, degradation and fragmentation of habitat as a result of mining, pastoralism and other development activities (Southgate, 1990a; Pavey, 2006; DSEWPaC, 2012). The current distribution is now restricted to the Tanami Desert, Northern Territory (Johnson & Southgate, 1990), the Great Sandy and Gibson Deserts, the Pilbara and Kimberley in Western Australia (Friend, 1990), and an outlying population between Boulia and Birdsville in south-west Queensland (Gordon et al., 1990). Records of bilbies in the Pilbara region are mostly north of the Fortescue River (Figure 1) and likely a result of extensive pre-development surveys of rail corridors and other mining infrastructure in this area. Biological surveys recording evidence of bilbies in the Pilbara region are listed in Table 1. From the literature summarized in Table 2, suitable habitat for bilbies can be defined as level or undulating plains including watercourses and dune systems, composed of cracking clay, soil or sand that allows burrowing, with vegetation consisting of open-tussock Mitchell grass (in SW Queensland) or hummock grassland (spinifex), with low shrubland, usually Acacia dominated. Habitat which is steep and/or rocky which does not allow burrowing may be used for foraging if it is adjacent to suitable burrowing habitat. There are no published accounts of bilby habitat in WA. The decisive characteristic of suitable habitat for bilbies is the availability of a soil or sand substrate that enables the construction of burrows. A draft recovery plan was prepared in 2006 (Pavey, 2006), however this has yet to be finalised and approved by the relevant States, Northern Territory

and Commonwealth. The work proposed in this SPP is consistent with actions in the draft recovery plan. The Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) have developed a Policy Statement which aims to develop significant impact guidelines for actions which are likely to have a significant impact on the bilby. The Policy Statement was developed for the following reasons: There have been an increasing number of referrals under the EPBC Act relating to potential impacts on the abundance and distribution of the bilby in the Pilbara. Several assessment sections within DSEWPaC were having difficulty in relation to determining significant impacts on the bilby There were inconsistent decisions being made in relation to the level of impacts on the bilby There are different threats affecting the bilby across its range, and Mining pressures were intensifying in Western Australia. The bilby is thought to be still reasonably widespread in the Pilbara but this bioregion is under increased pressure from mining exploration and extraction activities resulting in the removal and degradation of bilby habitat, and increased exposure to introduced predators.

Aims

The aim of this project is to improve our understanding of the distribution, and demographics of bilbies in the Pilbara, and provide information to environmental regulators and resource development companies that will allow appropriate management to ensure the persistence of this species in the Pilbara.

Specifically, the objectives of this project are to:

1. Gather recent and historic records in order to understand and predict the distribution of bilbies in the Pilbara
2. Develop and implement a broad-scale survey technique
3. Develop a fine-scale population monitoring technique and implement long-term population monitoring
4. Understand the effects on demographics of bilby populations in the Pilbara

Expected outcome

Improved understanding of the distribution and conservation status of bilbies in the Pilbara
Information on which to base management decisions of populations in and around mining sites and other developments.
Improvement to national impact guidelines being developed for bilbies.
This project will provide a model for survey, monitoring and management of bilbies in other regions of WA.

Knowledge transfer

DSEWPaC - provide guidance with bilby survey and monitoring protocols and the development of impact guidelines.
Pilbara mining industry - provide information to resource development companies that will allow appropriate management of mining sites to ensure the persistence of bilby populations.
Consultants - provide information and guidance relating to bilby monitoring and survey protocols.
Other researchers - provide opportunities for more integrated and collaborative research projects to be undertaken, share knowledge with other participants.

Tasks and Milestones

Major Task
Milestones
Completion
Outputs
Collate current and historic distributional data

- Set up a database
- Complete search of all published and unpublished literature and interviews with landholders and managers
- Set up database as NatureMap theme and online user contributable input interface

Dec 2013

- Accurate database of bilby records in the Pilbara

- NatureMap theme as portal to database with online user contributable interface to keep database current

Model distribution of bilbies in the Pilbara

- Habitat model of bilbies in Pilbara completed and written up for publication

Dec 2013

- Publication in scientific journal

Develop broad-scale survey technique

- Select sites to trial survey techniques
- Compare survey techniques and select most efficient

2014

- Publication in scientific journal
- Survey protocols for DSEWPaC and DEC

Broad-scale survey of Pilbara

- Select areas to survey based on habitat modeling
- Selected areas surveyed
- Data imported into online database

2015-ongoing

- Publication in scientific journal
- Dataset available online via NatureMap theme portal

Develop fine-scale population monitoring technique

- Select sites to trial monitoring techniques
- Develop and test DNA extraction and PCR with developed bilby microsat primers from fecal samples
- Compare monitoring techniques and select most efficient

2014

- Publication in scientific journal
- Population monitoring protocols for DSEWPaC and DEC

Long-term population monitoring

- Select sites/functional populations for long-term monitoring
- Annual monitoring

2015-ongoing

- Annual technical report
- Periodic publications in scientific journals of the status of bilbies in the Pilbara
- Information for the basis of development and management decisions

Understand effects on demographics

- Determine population genetic structure of bilbies in the Pilbara and elsewhere
- Investigate potential impacts of mining activities and development on populations

2015+

- Publication in scientific journals
- Information for the basis of development and management decisions
- Protocols for bilby management on mining and other development sites

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Study design

Methodology

1. Collate current and historic distributional data

Current and historic records of bilbies in the Pilbara will be accessed from the following sources:

- Published literature
- "Grey" literature (including consultant and DEC reports)
- WA DEC, WAM and other national databases
- Liaison with DEC staff, ecologists, consultants and land holders/users

An online portal using a NatureMap Theme will be used to access the database of bilby records. This will be developed as an internal collaboration with DEC Science Applications. An online user-contributable data entry site will also be developed to provide the ability to maintain the database and keep it current with the addition of new records. This will be developed using the open source Atlas of Living Australia Biological Data Recording System (ALA, 2013) in collaboration with Gaia Resources and DEC Science Applications.

2. Model distribution of bilbies in the Pilbara

The distributional data gained from Section 1 will be used in conjunction with geology, regolith, soil, vegetation and climatic GIS layers to create a model of predicted distribution of bilbies in the Pilbara. Modelling will be completed using the software packages MaxEnt (Phillips *et al.*, 2004, 2006; Elith *et al.*, 2011) and ModEco (Guo & Liu, 2010).

3. Develop broad-scale survey technique

Three survey techniques for detecting the presence of bilbies were tested for efficiency and reliability by Southgate *et al.*(2005). Their evaluation of transect, plot, and aerial survey techniques for detecting bilby sign (tracks, diggings and burrows) determined that aerial survey using helicopters was the most reliable, and cost- and time-efficient method of detecting the presence of bilbies. This method will need to be evaluated in the Pilbara where vegetation characteristics in areas occupied by bilbies may be different to the Tanami Desert, where Southgate *et al.*(2005) conducted their study. If vegetation in areas that bilbies occupy is denser, it may reduce visibility of burrows from the air.

Remote sensing techniques may also have the potential of detecting bilby burrows in the landscape. LiDAR (Light Detection and Ranging) has recently been used to measure the height, shape and density of termite mounds across a landscape (Levick *et al.*, 2010) and detect old gold mine shaft entrances across a landscape (Utting *et al.*, 2010). This technique has the potential to be able to detect bilby burrow entrances across a landscape, through vegetation. A collaboration with Dr James Kellner (University of Maryland) has been initiated to trial the use of LiDAR in detecting burrows. Furthermore, the use of this technique extends beyond bilby burrows (eg rabbit burrows, boodie warrens) and has the potential to become an important land and pest management tool that DEC can benefit from.

Remote cameras can also be used as a tool for detecting the presence of species (Moen & Lindquist, 2006; Meek *et al.*, 2012; Smith & Coulson, 2012). Remote cameras will be trialed for their potential to detect the presence of bilbies. The number, distribution, spacing and length of camera deployment will be determined from a pilot study.

A minimum of 10 equal-sized areas that are known to have bilbies present (determined from Section 1 above and confirmed by ground-truthing) will be used to evaluate the three survey techniques described above. The number of detections of each monitoring technique per area will be recorded. A single factor repeated-measures ANOVA will be used to detect differences between techniques. The single factor (monitoring technique) has three levels, each measured at each site. Post hoc Tukey HSD tests will be used to identify differences between technique means. The size of the survey areas will be determined by a combination of the restrictions of time available for flights (both for helicopter and LiDAR aircraft).

The relative costs and efficiencies of each technique will be assessed using the method of Southgate *et al.*(2005) modified from Wiegart (1962).

4. Broad-scale survey of Pilbara

Once a survey technique has been determined from Section 3 above, it will be used to in a landscape-scale survey of the Pilbara. Areas for surveys will be targeted from the distribution modeling from Section 2. The number of survey sites across the Pilbara will need to be determined based on the costs of the selected technique from Section 3 above.

5. Develop fine-scale population monitoring technique

No reliable method of estimating bilby densities exists. Bilbies are trap-shy, are not consistently attracted to any form of bait, and reliably trapping an individual involves finding an occupied burrow and fencing it in with traps (Southgate *et al.*, 1995; Lavery & Kirkpatrick, 1997b; Moseby & O'Donnell, 2003). Therefore, bilbies are not suitable for efficient mark-release-recapture studies. The use of tracks is an unreliable indicator of numbers, especially when densities are high (Paltridge & Southgate, 2001; Southgate *et al.*, 2005b). Some surveys have made use of burrow counts (eg Burrows *et al.*, 2012), however the correlation between burrows and bilby numbers is poor (Southgate *et al.*, 1995; Lavery & Kirkpatrick, 1997b). A single bilby may use between three and 11 active burrows, sometimes up to 1 km apart, and may use up to 3 different burrows per night (Lavery & Kirkpatrick, 1997b; Moseby & O'Donnell, 2003). Therefore, although burrows and tracks are a good indicator of presence, they are poor indicators of densities.

Reliable techniques exist for the extraction of DNA from bilby scats (Smith *et al.*, 2009), and polymorphic microsatellite markers have been developed for bilbies (Moritz *et al.*, 1997; Smith *et al.*, 2009) that are useful for both identifying individuals as well as population genetics. Distance sampling is a reliable technique of measuring densities whilst accounting for detectability (Buckland *et al.*, 2001, 2004). Using distance sampling to record the density of scats, coupled with genotyping of scats to exclude recounts of scats belonging to the same individual, will enable accurate estimation of densities. Three techniques of quantitatively sampling bilby scats will be evaluated: a) line transects with observers walking; b) line transects with observers on quad bikes; and, c) quadrat searches. The length of transects and size of quadrats will need to be determined, however a pilot study of foot transects in an area with bilbies yielded 2-3 samples per km; as a rule of thumb, 60 - 80 observations are required for reliable estimation of the detection function (Buckland *et al.*, 2001). Quad bike transects could have the advantage of covering more ground but possible at reduced detectability.

The experimental design for comparison of the three monitoring techniques will be identical as described in Section 3. Again, the relative costs and efficiencies of each technique will be assessed using the method of Southgate *et al.*(2005) modified from Wiegart (1962).

Genotyping scats will involve DNA extraction using commercially available faecal DNA kits, PCR multiplexing primers with fluorescent labels to reduce costs of both PCR and fragment analysis. Alleles will be scored using the GeneMapper (Applied Biosystems) software package.

6. Long-term population monitoring

Once the most reliable and efficient monitoring technique is determined from Section 5, it is the intent that the majority of populations used in Section 5 will become part of the long-term annual monitoring program. The exact number of populations to be monitored will be determined from Section 4.

It is important to note that some evidence suggests bilby populations can move across the landscape in response to or a combination of resources, predators and fire (Southgate & Carthew, 2007; Southgate *et al.*, 2007a). Average dispersal rates of individuals have been recorded at 2.3 km year^{-1} and one population was recorded having moved 10.5 km during a 3 year period (Southgate & Possingham, 1995). Therefore, monitoring populations may not be restricted to a particular physical location, rather "following" and monitoring populations, where populations may need to be found again using the technique determined in Section 3. In such cases, population genetics can be used to confirm that it is the same population being monitored, since genotypes from previous years will be available for analyses using software such as STRUCTURE (Falush *et al.*, 2003) and GESTE (Foll & Gaggiotti, 2006).

7. Understand effects on demographics

As described above, genetic data will be readily available from Section 6, therefore scope exists for extensive population genetics analyses using the software packages already mentioned. Furthermore, barriers to gene flow such as rail corridors can be tested using the program PARTITION (Dawson & Belkhir, 2001).

Once population monitoring is established (Section 6), the monitoring other variables that the populations are exposed to will be developed. The variables to be monitored may include:

- Resources (abundance of food sources)
- Densities of predators
- Intensity of livestock grazing
- Fire frequency and intensity
- Proximity to mining infrastructure and other development

Techniques for monitoring these variables will be developed and implemented as the project progresses.

Once data is gained on populations, Population Viability Analyses (PVA) will be used to predict population trends using the VORTEX software (Miller & Lacy, 2005; Lacy *et al.*, 2012). Future investigations into life history parameters will be considered in order to increase the robustness of PVA and detect differences in life history parameters to Eastern bilby populations (NT, QLD). This will be planned and implemented as the project progresses.

Biometrician's Endorsement

required

Data management

No. specimens

Nil.

Herbarium Curator's Endorsement

not required

Animal Ethics Committee's Endorsement

not required

Data management

Distributional data will be uploaded into the Bilby database as detailed in Section 22.1 above. Experimental data (evaluation of survey and monitoring techniques and genetic data) will be held on MS EXCEL spreadsheets (for ease of analysis) established for this project. Data will be backed up on the Woodvale server.

Budget

Consolidated Funds

Source	Year 1	Year 2	Year 3
FTE Scientist			
FTE Technical			
Equipment			
Vehicle			
Travel			
Other			
Total			

External Funds

Source	Year 1	Year 2	Year 3
Salaries, Wages, OVertime			
Overheads			
Equipment			
Vehicle			
Travel			
Other			
Total			