Greater Bilby Recovery Summit 2015

Report and Interim Conservation Plan

an initiative of Save the Bilby Fund

SAVE THE BILBY FUND

Queensland Government

TARONGA CONSERVATION SOCIETY AUSTRALIA For the Wild

DWF Dreamworld Wildlife Foundation

Australian Government Department of the Environment

IUCN Species Survival Commission

CONSERVATION BREEDING SPECIALIST GROUP

Abstract

On March 10, 2015, 39 people from 29 organisations gathered in Queensland to forge a new plan for the recovery and conservation of the Greater Bilby. The workshop, facilitated by the IUCN SSC Conservation Breeding Specialist Group, was organised by the Save the Bilby Fund in partnership with the Queensland Department of Environment and Heritage Protection, the Taronga Conservation Society Australia, Dreamworld Wildlife Foundation and the Australian Government Department of the Environment. This report presents the agreed outcomes of the workshop including: a vision for the future of the Greater Bilby in the Australian landscape; the current challenges to achieving this; a proposed way forward for overcoming these challenges; and priority activities for the coming months.

Editors: Bradley, K., Lees, C., Lundie-Jenkins, G., Copley, P., Paltridge, R., Dziminski, M., Southgate, R., Nally, S., & Kemp, L.

June 2015

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Workshop facilitators

Caroline Lees, Erna Walraven, Paul Andrew, Simon Nally

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A contribution of the IUCN SSC Conservation Breeding Specialist Group

Citation: Bradley, K., Lees, C., Lundie-Jenkins, G., Copley, P., Paltridge, R., Dziminski, M., Southgate, R., Nally, S. & Kemp L. (Eds.) (2015). 2015 Greater Bilby Conservation Summit and Interim Conservation Plan: an Initiative of the Save the Bilby Fund. IUCN SSC Conservation Breeding Specialist Group, Apple Valley, MN

Foreword

The following report and interim conservation plan is the result of a four-day intensive planning workshop for the Greater Bilby (*Macrotis lagotis*) involving 39 individuals that I would consider to be experts in their particular fields and representative of 29 organisations involved directly with, or supporting recovery of this vulnerable, iconic Australian marsupial.

The Greater Bilby Recovery Summit held over the period 10-13 March 2015 was an initiative of the Save the Bilby Fund facilitated by the IUCN SSC Conservation Breeding Specialist Group (CBSG) and made possible with the support of the Taronga Conservation Society, the Dreamworld Wildlife Foundation and both the Queensland and Australian Governments.

The report has been written to capture the conversations, consensus views and recommendations that emerged from the Summit and with assistance from our government collaborators we hope to refine these outputs to generate an updated Commonwealth Recovery Plan for the species. This is likely to take some months of further work and consultation and in the meantime this document will serve as our interim plan of action.

I personally became interested in supporting bilby recovery over 20 years ago when considering conservation programs I could support through my various capacities within the zoological parks industry. I met Frank Manthey, co-founder of the Save the Bilby Fund in 2000 and was inspired by his passion and common sense approach, and shared his belief that if we were to save this species, we needed to engage the support of the community and look beyond government as bearing sole responsibility for recovery of our threatened species. Almost 15 years on, and despite considerable effort, improved public awareness and varying levels of support, sadly the consensus is that bilby numbers in the wild are still in decline and their range is still contracting.

This situation calls for a radical change in approach if we are to turn the tide and make the Greater Bilby the conservation success story I sincerely believe it can be, not just for the species itself but as an umbrella species and flagship for a range of less charismatic but equally important species facing the same threats in the wild. There should be no competition in conservation and success will come if we have all people pulling in the same direction, I am confident of this. We hope that through following CBSG's One Plan Approach and engaging the support of the committed and qualified individuals and organisations represented at the Greater Bilby Recovery Summit, we have drawn our "line in the sand" and begun a fresh approach to addressing threatening processes, engaging support and getting on with bringing the bilby back !!

I express my sincerest thanks and make personal note of the extraordinary contribution of Caroline Lees from CBSG Australasia in facilitating the Summit and preparation of the following report. Also to Simon Duffy, Erna Walraven and Paul Andrew from theTaronga Conservation Society, Al Mucci from the Dreamworld wildlife Foundation and the entire board of the Save the Bilby Fund for supporting this initiative. I greatly appreciate the input and contributions of Simon Nally, Geoff Lundie-Jenkins, Peter Copely, Rachel Paltridge, Rick Southgate, Manda Page and Tania Laity who have contributed significantly to the development of this report. I make special mention and extend my thanks again to Craig Doudle, Cheryl Buchanan and Rory O'Connor for representing the interests of Traditional Owners and sharing the cultural significance of these animals to their people and to each and every delegate for their commitment to the work undertaken during and support of the outcomes of the summit.

Sincerest appreciation,

Kev Bradley
Save the Bilby Fund
30/06/2015

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Thank you for your support!

30 November 2014

CONSERVATION BREEDING SPECIALIST GROUP

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Executive Summary

The Greater Bilby is an iconic threatened Australian mammal in continuing decline. It is of high spiritual importance to traditional owners across its current and former range.

During March 10-13, 2015, 39 individuals from 29 organisations met on Queensland's Gold Coast to discuss openly the challenges to Greater Bilby recovery and to forge consensus on a plan for the future of this species in the Australian landscape.

The event was an initiative of the Save the Bilby Fund, in partnership with the Queensland Department of Environment and Heritage Protection, the Taronga Conservation Society Australia, Dreamworld Wildlife Foundation and the Australian Government Department of the Environment. The workshop was designed and facilitated by the IUCN SSC Conservation Breeding Specialist Group (CBSG).

RECOMMENDED FOR COMPLETION BY JUNE 2016:

- National recovery coordinator & team appointed and operating.
- National recovery plan complete.
- Research program agreed and initiated.
- NESP Hub formally engaged.
- Protocol agreed for estimating abundance.
- Surveys initiated for occupancy and abundance.
- Key sites for management identified.
- Management plans for captive and fenced populations re-directed to support agreed national recovery goals.
- Single management unit in use program-wide.
- Inclusive forum organised for WA/NT indigenous ranger groups.
- Management of fire and predators initiated around at least two key sites in the southern part of the range.
- Currawinya restored as a thriving fenced sub-population for conservation support.
- Bilby case-study proposed for Threatened Species Summit.

Threats

Workshop participants recognised introduced predators, inappropriate fire regimes, and the impact of grazing and land-clearance as key threats to the continued survival of the bilby in the wild. It was recognised that these threats interact with each other in complex ways and with different regional emphases, affecting not only bilbies but many other declining species across Australia's deserts. Further to this, participants identified organisational arrangements limiting the effectiveness of recovery efforts through their impacts on coordination, engagement, resourcing and monitoring of recovery actions.

Recommendations

The interim plan for Greater Bilby recovery developed during the Summit is summarised in Figure 1 (overleaf). The following areas of activity were recommended for immediate attention. The first task of the new Recovery Team will be to shape these into a five-year recovery plan confirming priorities, time-lines and responsibilities:

Establishing a range of enabling mechanisms and processes: including installing a national coordinator, recovery team and recovery plan for the Greater Bilby; establishing a national research program to investigate a) where bilbies are found and in what numbers, and 2) effective predator, herbivore and fire management regimes for the recovery of declining desert wildlife species (including the Greater Bilby); developing a framework for coordinated national threatened species and threats management reporting, and an associated national data management system.

Engaging people: mobilising the support and knowledge of Traditional Owners in remote communities was considered to offer one of the greatest opportunities for sustained on-ground conservation action for the Greater Bilby across its range. In addition to this, formally engaging and coordinating the support of NGOs, zoos and government agencies, including the NESP Hub, was considered essential.

On-ground action at key sites: identifying key sites across the species' range and managing actively for bilby abundance, prioritising Queensland for immediate attention.

We envisage a future in which the Greater Bilby and its cultural significance are valued and embraced by all Australians. Together we engage through effective partnerships, providing the necessary frameworks to support a secure, viable and self-sustaining wild population.

We will mobilise these

CRITICAL RESOURCES

to ensure we have more people on the ground, with more resources and better information, making better decisions for conservation

- **Traditional Owners & remote communities**
- **Universities**
- **NESP Hub**
- **National & State Government agency staff**
- **NGOs & Zoos**

We will develop or make use of these

ENABLING TOOLS

to remove current obstacles, increase efficiency and maximise our chances of success

- **Gov. Indigenous Protected Area & Ranger Programs**
- **Agreed monitoring & survey methods**
- **A community engagement strategy**
- **Improved legislation**
- **A program of priority research**
- **A national framework for sharing, collating, analysing & reporting data**

ONE PLAN

coordinated by a

NATIONAL COORDINATOR & RECOVERY TEAM

- **Small sub-population fragments enlarged or re-connected**
- **Appropriate fire management in place**
- **Quality of release animals improved**
- **Grazing and land-use threats mitigated**

By realising these

GOALS

- **Meta-population management of wild, fenced and captive populations**
- **Stronger harmonised legislation (local, state, national)**
- **Effective predator management**

We will achieve these

OUTCOMES

- **2015 area of occupancy is extended & overall abundance is increased**
- **The wild population is sustained under low-levelmanagement**
- **Significance of the bilby to Traditional Owners is acknowledged and they are engaged as partners in the recovery program**
- **Meta-population management of wild, captive and fenced bilby populations provides adequate insurance against extinction**

Figure 1. Summary of the Summit-generated interim plan for Greater Bilby recovery and conservation

Introduction to the Summit

The Greater Bilby is a widely known and loved Australian icon which has suffered an ongoing decline in range and abundance since the introduction of exotic mammals to Australia. The species is now listed as vulnerable at a national level and as endangered in Queensland where as few as 300 individuals remain.

SUMMIT GOALS:

- To assemble a community of stakeholders from across Australia who are ready and able to take action for Greater Bilby conservation.
- To bring this community to a common understanding of the threats to and prognosis for the Greater Bilby across Australia.
- To develop a shared vision for the future of the Greater Bilby across Australia and a plan to guide its realisation.
- To agree, within this context, a plan of priority actions for the Greater Bilby in Queensland.
- To build a commitment to immediate action for this species and an enabling framework through which this can be sustained.

During the period March 10-13, 2015, 39 individuals from 29 organisations met on Queensland's Gold Coast to discuss openly the challenges to Greater Bilby recovery and to forge consensus on a plan for the future of this species in the Australian landscape.

The species currently persists in the wild as two isolated and internally fragmented sub-populations. Additional bilbies are maintained in fenced and protected areas, and in intensively managed captive facilities. In keeping with CBSG's *One Plan Approach* to conservation planning, the Summit brought together managers from across this spectrum to encourage a single, coherent response to conservation needs.

Outputs of the Summit are expected to form the basis for a review and revision of the *National Recovery Plan for the Greater Bilby* (Pavey, 2006) and to build on other recent work, notably that documented in *The Action Plan for Australian Mammals, 2012* (Woinarski *et al*., 2014).

The Greater Bilby Summit was an initiative of The Save the Bilby Fund, in partnership with the Queensland Department of Environment and Heritage Protection, the Taronga Conservation Society Australia, Dreamworld Wildlife Foundation and the Australian Government Department of the Environment. The workshop was facilitated by the IUCN SSC Conservation Breeding Specialist Group, which specialises in stakeholder-inclusive, science-based species conservation planning.

DAY 1: Welcome to Country and opening addresses

The workshop began with a Welcome to Country by the Yugambeh Language Group of the Gold Coast, represented by Rory O'Connor, Director of the Yugambeh Museum. The cultural significance of the Greater Bilby to traditional custodians across Australian homeland was emphasised and participants were tasked with becoming "kaialgumm", "champions" for the species.

Following the Welcome to Country, the Queensland Minister for Environment, Heritage, National Parks and the Great Barrier Reef, Dr Steven Miles, addressed the group and declared the workshop open. In his address the Minister reminded the group that bilbies and other threatened species are an important entry point to environmental issues for a great many people. The power that bilbies carry as a flagship can lead to good outcomes for many less charismatic species.

Kevin Bradley, CEO of the Save the Bilby fund welcomed and expressed his thanks to the participants and sponsors for supporting the Summit, and introduced Frank Manthey, Co-founder of the Save the Bilby fund. Frank spoke passionately about his experiences with Greater Bilby conservation and his vision for the recovery of the species across Australia. Both Kevin and Frank encouraged participants to embrace the Summit as an important and necessary process to focus current efforts, leverage support and provide a platform to turn things around for this species.

Participant introductions

Following the formal opening, participants were invited to introduce themselves, their affiliation and interest in the species.

Presentations

The following scene-setting presentations were given, aimed at bringing workshop participants to a shared understanding of the history and present status of the species and its conservation.

Peter Copley. An overview of the national status of the Greater Bilby and its conservation: including the biology, ecology, past & present distribution of the species, conservation threats, and a broad overview of national conservation progress.

Individual State representatives: Peter Copley (SA), Liana Joseph (Qld.), Manda Page (WA), Rachel Paltridge (for Simon Ward – NT), Mike Fleming (NSW). An overview of the current status of Greater Bilby conservation in each State: including current distribution and abundance estimates, priority issues and current and planned programs.

Leah Kemp & Katherine Moseby. Fenced populations: including current numbers, founder numbers and source, management successes and challenges.

Claire Ford. The Zoo and Aquarium Association (ZAA) captive program: including history, goals, current status and challenges.

Rick Southgate. A summary of a conceptual whole system Arid Zone approach based on long-term studies and monitoring of bilbies and other arid zone fauna. It highlighted that current recovery program efforts disproportionately favour high intensity forms of management. Whilst that approach has been effective the protection of extant wild populations will depend on the implementation of effective lower intensity forms of management. The recovery process should use a guiding logic to move from high intensity management to low intensity management.

Rachel Paltridge. Novel approaches to managing threats to wild bilbies. Including strategic management of predators and fire in specific habitats, and the positive impacts of Indigenous Land Management practices on the persistence of bilbies around Aboriginal Communities.

Tania Laity. An overview of the Species Observation System and the Species Profiles and Threats Database and the potential application of these map-supported systems to analyse patterns in the national distribution of bilbies and their habitat. Draft maps were presented to the summit for review and feedback.

Paul Andrew. A conservation-directed approach to management units for the Greater Bilby.

Caroline Lees. An Introduction to the IUCN SSC CBSG: including CBSG's place within the IUCN, its approach to species conservation planning and a brief tour of its tools and processes.

Invited address - the current political setting

The Federal Threatened Species Commissioner, Gregory Andrews, presented on the role of the Commissioner and the vision for threatened species work across Australia.

The Commissioner's role brings a new national focus to conservation efforts and is helping to address the growing number of native plants and animals in Australia facing extinction. The Commissioner is responsible for: identifying, developing and resourcing priority actions; raising community awareness and support; and developing policy and advice. This aligns well with the goals of the Bilby Summit to move forward with new directions and take a coordinated approach.

The Commissioner has a number of priorities for future work towards the vision for threatened species conservation across Australia. The highest and most immediate priority is feral cats and reducing their impact on native wildlife. Feral cats are the biggest threat to Australian mammal species and urgent practical action must be taken to prevent further declines. The Australian Government is interested in a variety of options for tackling feral cats including: eradicating feral cats from both offshore and mainland islands; increasing the area protected by feral free exclosures; and improving control techniques across Australia.

The Minister for the Environment, the Hon Greg Hunt MP, will be hosting a Threatened Species Summit in July 2015 to discuss issues such as those facing the Greater Bilby. The Summit will be chaired by the Threatened Species Commissioner. The summit will reinforce the new national focus on threatened species since the Government appointed the Threatened Species Commissioner and will open a dialogue between all parties involved in the protection of Australia's threatened species - scientists, government, land managers, community and business.

Visioning

The first task involved working to develop a collective vision or desired future state for the Greater Bilby in Australia. Participants were encouraged to think 25 years into the future and imagine a situation in which the bilby has been successfully recovered, to their satisfaction. They then spent a few minutes describing that situation, in the present tense. Next, participants worked in pairs, then in groups of four and finally in groups of eight, to discuss and consolidate their work. The resulting five written contributions were shared and discussed in plenary. A visioning group of four participants was assigned the task of combining the five contributions into a final inclusive statement for agreement by the wider group. The final version of this is provided on page 17.

Visioning group: Kevin Bradley, Jodi Buchecker, Craig Doudle, Simon Nally.

Analysis of threats, challenges and obstacles

Participants were asked to identify current and potential threats to the wild bilby population, and perceived challenges or obstacles to securing their sustained recovery. Participants were encouraged to frame their contributions in terms of expected impact on one or more of the following:

- bilby births and deaths
- fragmentation of the wild bilby population
- downward pressure on bilby numbers (i.e. reduced numbers or sustained low numbers)

Intensively managed populations in zoos and in larger and more remote fenced facilities have in the past played a supporting role in recovery in several States and will continue to do so into the future. In keeping with CBSG's One Plan Approach, the workshop provided an opportunity to discuss what it would take to optimise the conservation contribution of these facilities. With this in mind participants were also asked to identify those issues that might be expected to:

- reduce the recovery contribution of the fenced population
- reduce the recovery contribution of the captive (zoo based) population

Using the "Rule of Whys", participants worked to clarify the route through which each issue raised negative impacts on sustained recovery of the bilby, and to explain its underlying causes or drivers. Details of the threats, challenges and obstacles identified are provided on page 27.

Photo: Threats, challenges and obstacles to bilby recovery and conservation captured by participants at the Summit

DAY 2: Issue statements and data assembly

Issues were divided into subsets and assigned to four working groups:

- **Communities, Engagement and Governance:** Kevin Bradley, Cheryl Buchanan, Peter Copley, Dennis Gannaway, Geoff Lundie-Jenkins, Peggy Mucci, Vere Nicholson, Manda Page, Wolf Sievers,
- **Wild Population – Southern Range:** Paul Andrew, Catherine Crowden, Matt Gentle, Jean-Marc Hero, Liana Joseph, Greg Lollback, Martin McLoughlin, Chris Mitchell, Katherine Moseby, Rachael Paltridge, Mandy Paterson.
- **Wild Population – Northern Range:** Stuart Dawson, Craig Doudle, Martin Dziminsky, Malcolm Lindsay, Rick Southgate, Erna Walraven, Al Mucci.
- **Captive and Fenced Populations:** Jodi Buchecker, Aaron Fenner, Mike Fleming, Claire Ford, Camille Goldstone-Henry, Leah Kemp, Simon Nally, Lisa Steindler.

Working groups were charged with further discussing and analysing each issue in turn to produce a statement for each, describing clearly: **what the issue is; why it occurs; why it is a problem for the sustained recovery of the Greater Bilby.**

Once issues were characterised, groups took each one in turn and agreed what could be relied upon as fact, what is assumed, and what important data gaps exist. The outputs were brought to plenary and discussed. A full list of issue statements and accompanying analyses of fact, assumption and data gaps, begins on page 28.

DAY 3: Goals

On day 2 questions and issues had arisen in regard to a) small populations and likely minimum viable population sizes for the Greater Bilby and b) information sharing and centralised data resources. Two additional presentations were provided that touched on these themes:

A tool for for thinking about minimum viable population size (C. Lees): general guidance on likely minimum viable population sizes for the Greater Bilby, based on a combination of population genetics theory, on published rules of thumb developed from multi-species PVA analyses, and on unpublished PVA work for eastern barred bandicoots.

Tracking Greater Bilbies in the Kimberley (C. Doudle): a brief tour around a significant library of photographs and video footage of wild bilby behaviour, burrow systems, food items and other interacting species, catalogued with spatial and temporal detail. A summary of this presentation is attached as Appendix XI.

In addition, a draft of the consolidated vision statement was presented and discussed. Following this, for each issue, working groups developed goals. Goals were designed around future changes in state or condition that would be required to mitigate a threat or remove an obstacle. Groups were encouraged to include with each goal a target or measure, and a time-frame, to allow evaluation of progress. Goals were brought to plenary for discussion, grouping and prioritisation by the wider group. This grouping recognised the overlaps and linkages between the issues and goals developed by the separate working groups and provided a framework to consolidate like actions developed during the subsequent stages of the summit.

A total of 11 grouped "goal themes" were identified for prioritisation. Using sticky dots, participants were asked to prioritise them according to 1) expected impact on achieving the vision and 2) urgency. A full description of the goals developed and the results of prioritisation begins on page 48.

With a draft of the vision and the goals available on the wall, participants identified a small number "ideal outcomes" or "high-level" goals to chart in direct, operational terms, the outcomes required to achieve the vision (see page 17). These serve to bridge a gap between the issue-directed goals developed by individual working groups, and the aspirational vision statement.

Actions

For each goal, working groups were asked to develop at least one action – a next step towards achieving the goal that could be taken by someone present at the workshop. Action steps were required to be Specific, Measurable, Achievable, Relevant and Time-bound (S.M.A.R.T.). As a minimum, groups were tasked with providing, for each action step:

- a description of the action
- the name of a person (or participating organisation) present in the room who could potentially take or help to take responsibility for implementation
- a time line for completion of the action
- a measure or indicator by which progress with the action could be measured
- a list of necessary or potential collaborators or partners

Participants reported on and discussed their action steps with the wider group on DAY 4. A full list of action steps generated begins on page 52.

DAY 4: Mapping the transformation

Participants worked on Greater Bilby distribution maps to begin to develop a visual representation of the following information:

- what is the distribution of the Greater Bilby now?
- how many discrete sub-populations are there (i.e. isolated from all others)?
- where are they, and how do we estimate abundance?
- where and how are our conservation management resources currently deployed?

And for each of these questions:

- how would we like these to change over the next 25 years?
- how would we like them to look in 2040?

Participants discussed areas of difficulty with respect to assembling and representing this information, particularly in the areas of abundance estimation, assessing fragmentation and genetic exchange. Work on this will continue. Further details are provided on page 18.

Implementation

To be successful, on-ground implementation of the emerging plan will need to be undertaken by a coalition of individuals, communities and organisations including: Traditional Owner networks and remote communities, pastoralists and other landholders/managers, government agencies, NGOs, and universities. A common purpose, regular communication and reporting, and effective coordination of both action and resourcing, will be important.

Participants agreed that implementation of the emerging plan should be driven and coordinated by a dedicated bilby recovery coordinator, supported by a recovery team, with advice and support as needed from task-oriented working groups. Amongst other responsibilities the recovery coordinator would be charged with maintaining regular communication with the wider coalition of stakeholders, including the provision of regular status reports on plan progress.

The Save the Bilby Fund CEO, Kevin Bradley, was proposed by the group to act as an interim national bilby recovery coordinator until a national recovery team for the bilby has been reconstituted and the position of national coordinator has been resolved. Kevin stated that while he was comfortable contributing in this role, it would be contingent upon obtaining consent from the Save the Bilby Fund Board, for him to fill this role.

Editorial team

An editorial team was assigned to help develop the workshop report. In addition to CBSG and Save the Bilby Fund representatives the team included a representative from each working group and two representatives to help transition workshop outcomes into a national recovery plan revision.

- Caroline Lees (CBSG)
- Kevin Bradley (Save the Bilby Fund)
- Simon Nally & Peter Copley (National Recovery Planning)
- Rachel Paltridge (Southern Range WG)
- Martin Dziminsky (Northern Range WG)
- Geoff Lundie-Jenkins (Communities, Engagement, Governance WG)
- Leah Kemp (Captive and Fenced Populations WG)

Initial outputs

The following initial outputs of the Summit were agreed:

1) a proposal to adopt a single taxonomic unit for conservation management of the Greater Bilby was endorsed.
2) a final draft of the VISION statement was presented and, following amendments was endorsed by the group.
3) a DRAFT letter to the Threatened Species Commissioner describing the main findings of the Summit was presented, discussed, amended and endorsed.

Closing

Kevin Bradley officially closed the meeting and expressed his sincere thanks to the participants for their hard work and commitment in attending all sessions over the period of the Summit. He expressed particular thanks to the Summit sponsors: the Save the Bilby Fund, the Queensland Department of Environment and Heritage Protection, the Taronga Conservation Society Australia, Dreamworld Wildlife Foundation and the Australian Government Department of the Environment. He also thanked the facilitators, noting the efforts of Caroline Lees (CBSG) and Peggy Mucci (STBF) in assisting the organisation of the Summit over many months and contributing to the successful proceedings over the past four days. Kevin expressed his appreciation to Cheryl Buchanan, Craig Doudle and Rory O'Connor for representing the interests of Traditional Owners and for their input regarding cultural significance of the Greater Bilby to Aboriginal people. Cheryl Buchanan responded on behalf of her communities, expressing her thanks for the invitation to be involved and her commitment to assist the actions identified throughout the Summit given the significance of the species to Traditional Owners.

Participants worked in groups to develop key themes for inclusion in a 25-year VISION for greater bilbies. A small synthesising group drew the themes together to produce the following agreed VISION:

Vision

In 2040, the Greater Bilby and its cultural and spiritual significance to Traditional Owners is valued and embraced by all Australians and by the global community. Together we engage through effective partnerships providing legislative, management and stewardship frameworks that support a secure, viable and self-sustaining population of bilbies in the wild, across an extended range.

The following "ideal outcomes" or "high-level" goals were agreed by participants to clarify what needs to be achieved on the ground, in order for the VISION to be realised.

In pursuit of this 25-year VISION we aim to ensure:

Ideal Outcomes

The persistence of a wild population that requires only a low level of management.

No reduction in area of occupancy - compared to 2015.

An increase in area of occupancy - compared to 2015.

An increase in overall abundance - compared to 2015.

Formal acknowledgement of the cultural and spiritual significance of the bilby to Traditional Owners and their engagement as partners in the recovery program.

Adequate insurance against extinction in the wild through a sufficiently large, genetically diverse and well-coordinated meta-population which includes, for as long as is required, intensively managed populations as well as those living under wild conditions.

Figure 2. 25 Year Vision and Ideal Outcomes

Mapping the Transformation

The following maps were produced using the SPRAT (Species Profiles and Threats) database and are based on 3791 records in the Species Observation System sourced from NSW, SA, WA, Qld and NT governments and Australian museums. They provide tools to show a draft visual representation of the following information:

- What is the distribution of the Greater Bilby now?
- How many discrete sub-populations are there?
- Where are they, and how do we estimate abundance?
- Where and how are our conservation management resources currently deployed?

And for each of these questions:

- How would we like these to change over the next 25 years?
- How would we like them to look in 2040?

Further development of these representations will require additional work in the following areas:

Estimating abundance

Survey and opportunistic records enable mapping of the extent of occurrence of the Greater Bilby. While this approach is of some value at a broad scale it does not usually indicate where the species is patchily distributed or where it does not occur within the mapped extent of occurrence.

Area of occupancy can provide a more robust and informative representation of bilby prevalence at a broad scale and can be achieved by resurveying sites to determine how frequently sign is detected and where it is never detected. This can be achieved by rapidly sampling many widely spaced plots for tracks or diggings or by monitoring known burrow locations for activity. However, no single technique is suited to sampling the broad range of habitats currently occupied by the bilby; tracks are difficult to detect on soil in some habitats and burrows are difficult to find in areas where vegetation is denser.

Determining bilby abundance at a local scale is difficult. Capture-mark-recapture techniques using DNA markers with source material obtained from bilby scats has potential. Remote cameras may be deployed to estimate local probability of occupancy. Track and scat size can also be used to determine whether juveniles or only large male individuals are responsible for activity where signs of a population have been detected. The number of active burrows does not provide a reliable estimate of abundance and wild bilbies are extremely difficult to cage trap.

In summary, a number of different methods are in use for estimating abundance. Participants agreed that for the practical reasons outlined, any single approach to estimating bilby abundance would need to incorporate a range of methods. Currently no single approach to this has been agreed across practitioners. There was consensus of opinion by participants that wild bilby numbers continue to decline due to factors including the feral cat “pulse” event in Western Queensland and the apparent Northerly retreat of the Southern extent of range in the Northern Territory. Resolution of this issue was considered a priority.

Assessing isolation

During boom cycles, geographically isolated sub-populations may re-connect, or move into sufficiently close proximity to enable the exchange or movement of individuals between areas. This has implications for the viability and management needs of these sub-population fragments. Further discussion and additional information is required to assess the likelihood and potential frequency of such events. The metapopulation maps (Figures 3 & 4) were developed at the workshop in an attempt to define where core sub-populations of bilbies occur and a broader metapopulation boundary. This could be refined as more information becomes available.

Data collation and management

There is significant potential for this type of mapping and spatial analysis to support future research, monitoring and planning in relation to recovery and conservation of the bilby. These mapping tools will be most effective if able to integrate the most recent and accurate data from all sources and jurisdictions. Additional work is required across the range of the bilby to ensure all relevant data are collated and made available in this way.

Refer to Appendix X: Bilby Distribution Mapping. All data and maps (where agreed to by the custodians) will be included on the Greater Bilby Online Mapping resource hosted on the Australian Government Department of the Environment's website. The aim of this mapping resource is to provide a spatial tool to aid recovery planning actions and it is planned to be updated as new information or mapping becomes available. This includes data collected within states and territories that is not currently held within the State and Territory Government wildlife databases. There is scope to include other mapping products if more information and data become available for example, this could include predator distribution/ abundance, land cover over time, fire frequency, artificial watering points, translocations and survivorship rates etc.

Bilby habitat mapping

The potential bilby distribution shown in the following maps is a modelled distribution where the bilby is either known, or may occur. This distribution area is used by the Australian Government to identify areas which may be of importance for the Greater Bilby in the assessment of development proposals or other activities which may have an impact on the species. This potential distribution may be refined as more information becomes available.

The Geology and major vegetation subgroups maps (Figures 5-10) are to provide context for the identification of potentially suitable habitat for the Greater Bilby within its range. The weather station maps (Figures 11-13), when published on the Greater Bilby Mapping Resource, will provide links to Bureau of Meteorology recent and historical weather data on the Bureau's website. This information may be of use in determining or getting a better understanding of the impacts of locally severe weather events on bilby populations.

Mapping local capacity

The bilby persists in sparsely populated areas in which it is difficult and expensive to implement works beyond the capacity of local communities. The harsh environments and substantial distances render the use of non-local workers and resources inefficient, as transport and accommodation costs diminish the proportion invested in on-ground actions. In addition, local people, landholders and land managers are likely to have the best understanding of local constraints and are able to adapt activities to respond to local conditions. For these reasons, in the first instance, on-ground actions are likely to work best when primarily or largely undertaken in locations where capacity already exists. Note that under this decentralised style of delivery there is a need for over-arching quality coordination and monitoring to ensure that actions implemented are producing desired outcomes. The current situation is insufficient in this area as recognised in this report by the Community, Engagement & Governance group.

A map of potential areas for recovery actions (Figure 14) shows some areas where capacity may exist.

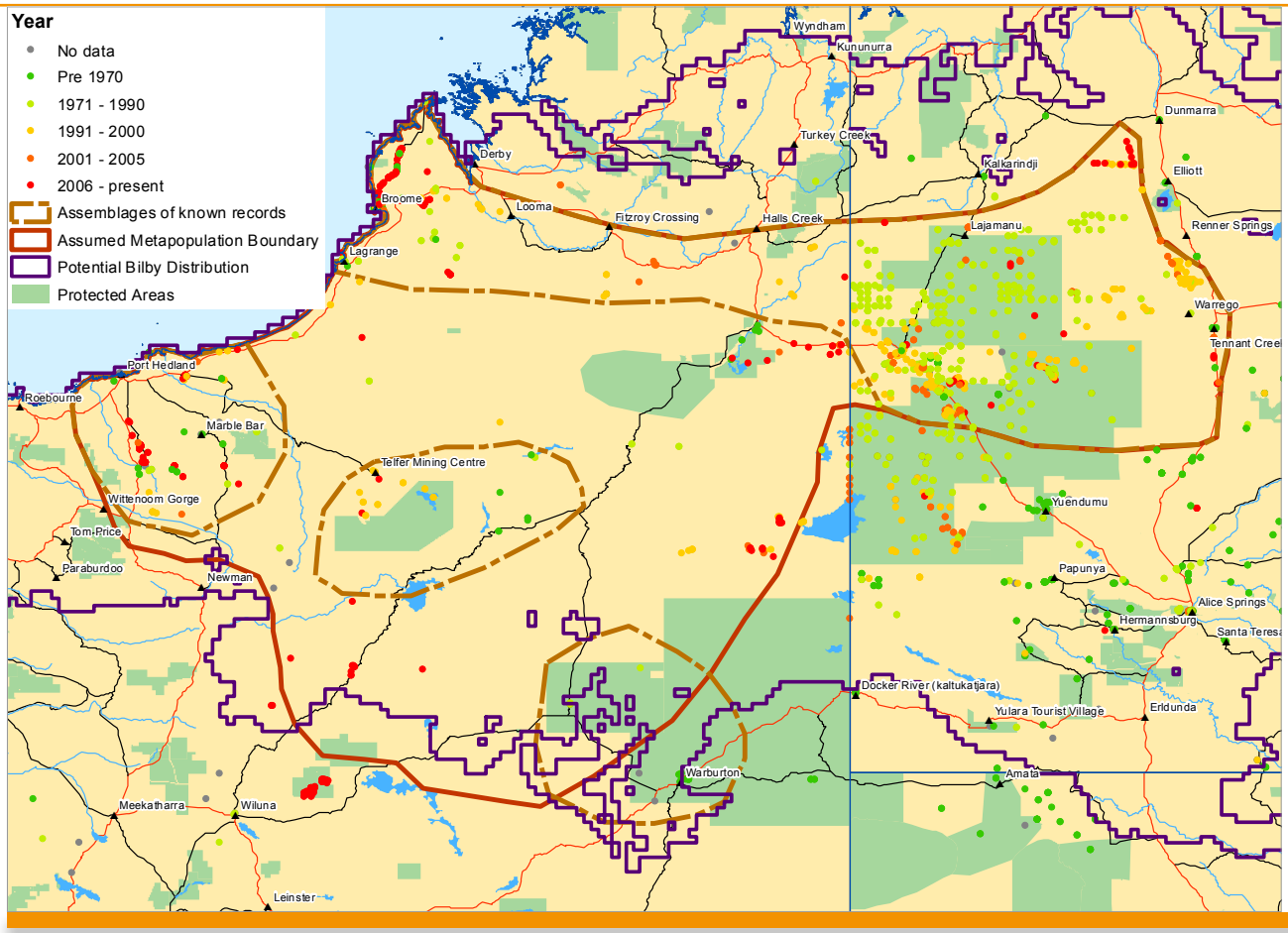


Figure 3. Metapopulation. Areas where defined populations of the Bilby occur (as defined by Summit participants for the purpose of management).

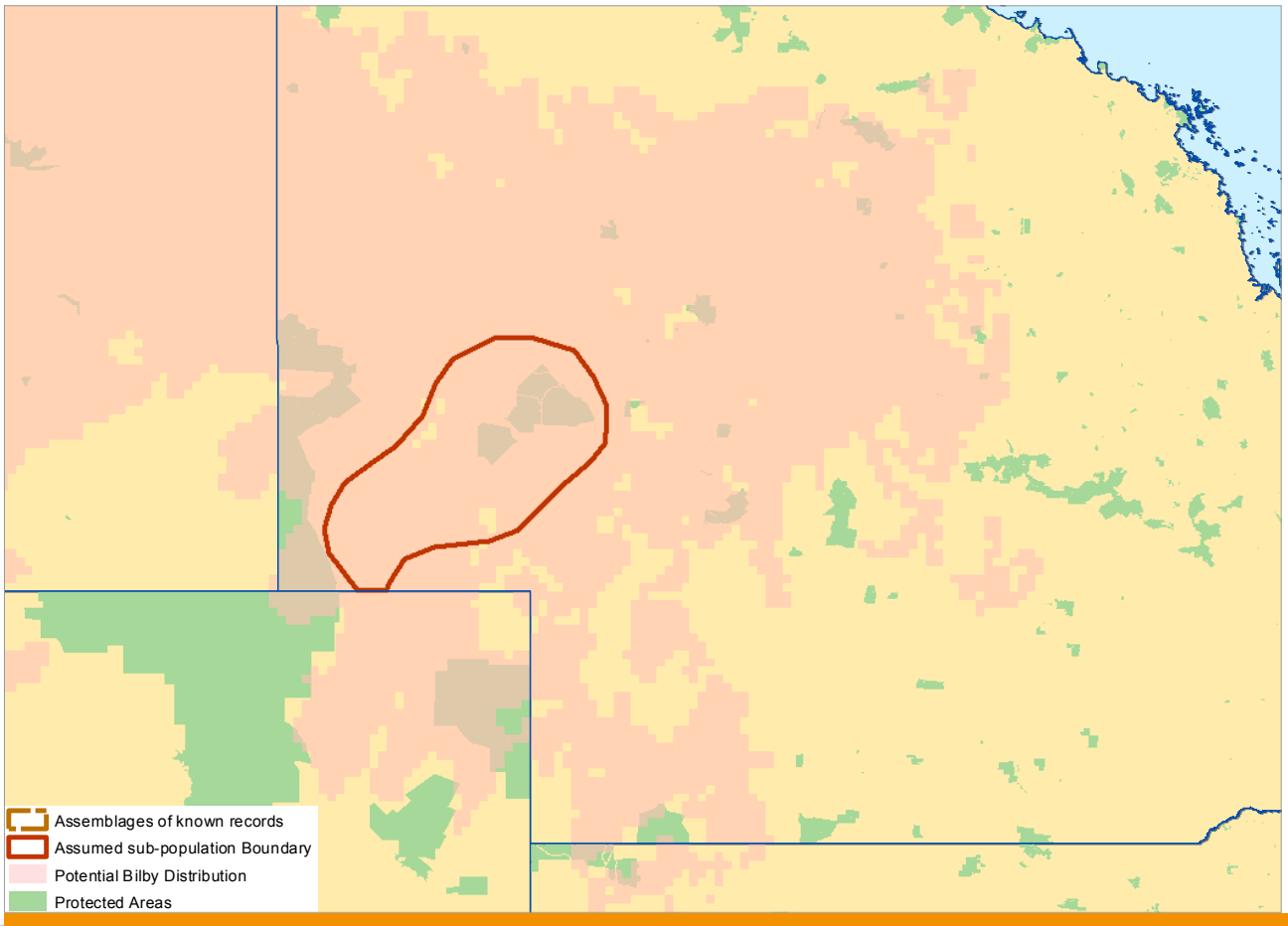


Figure 4. Queensland Bilby Sub-population

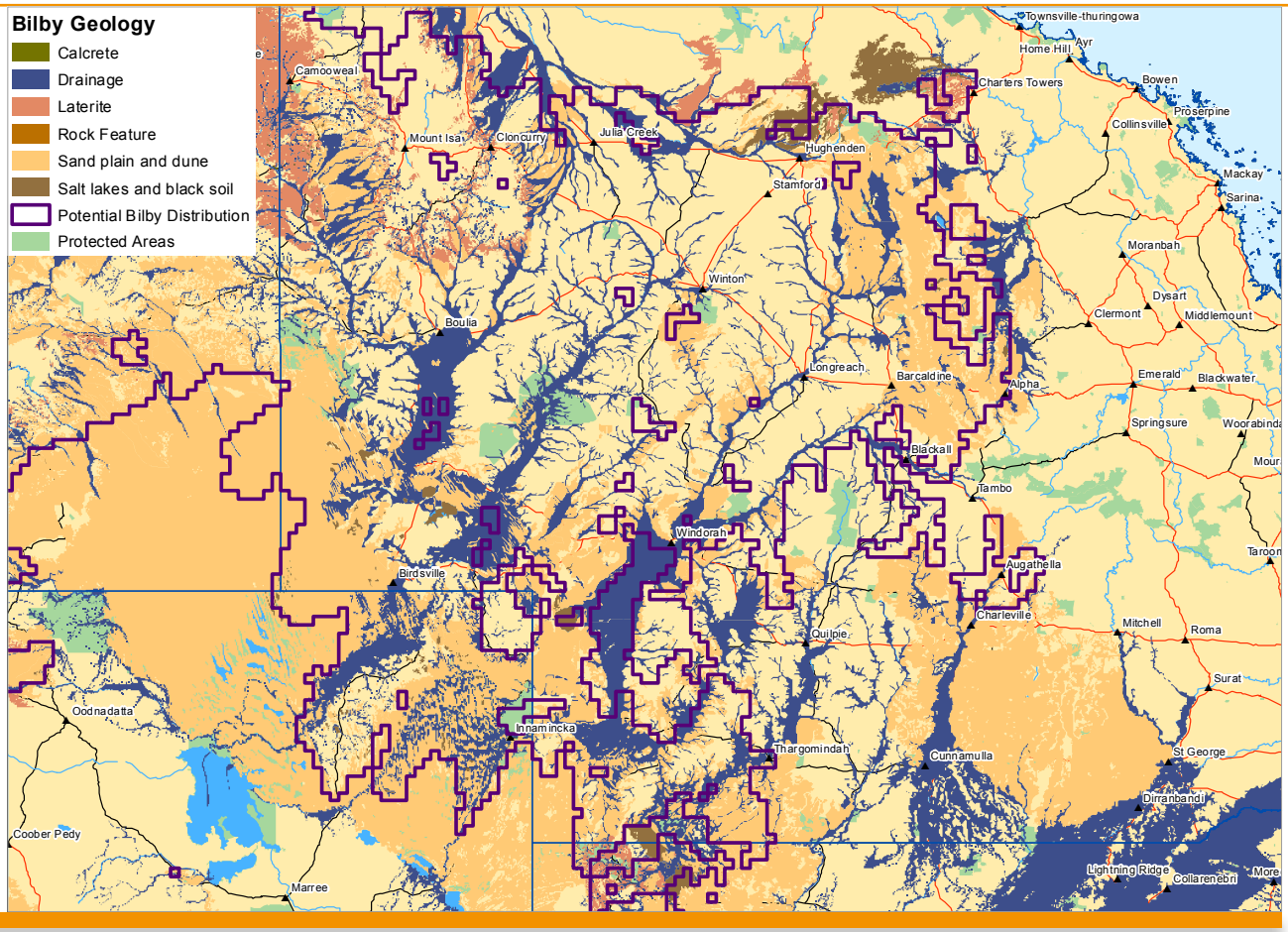


Figure 5. Bilby Geology EAST. Geology mapping for the eastern range of the Bilby based on Geoscience Australia 1:1 million geology mapping, categorised as per Southgate (2006) geology classes

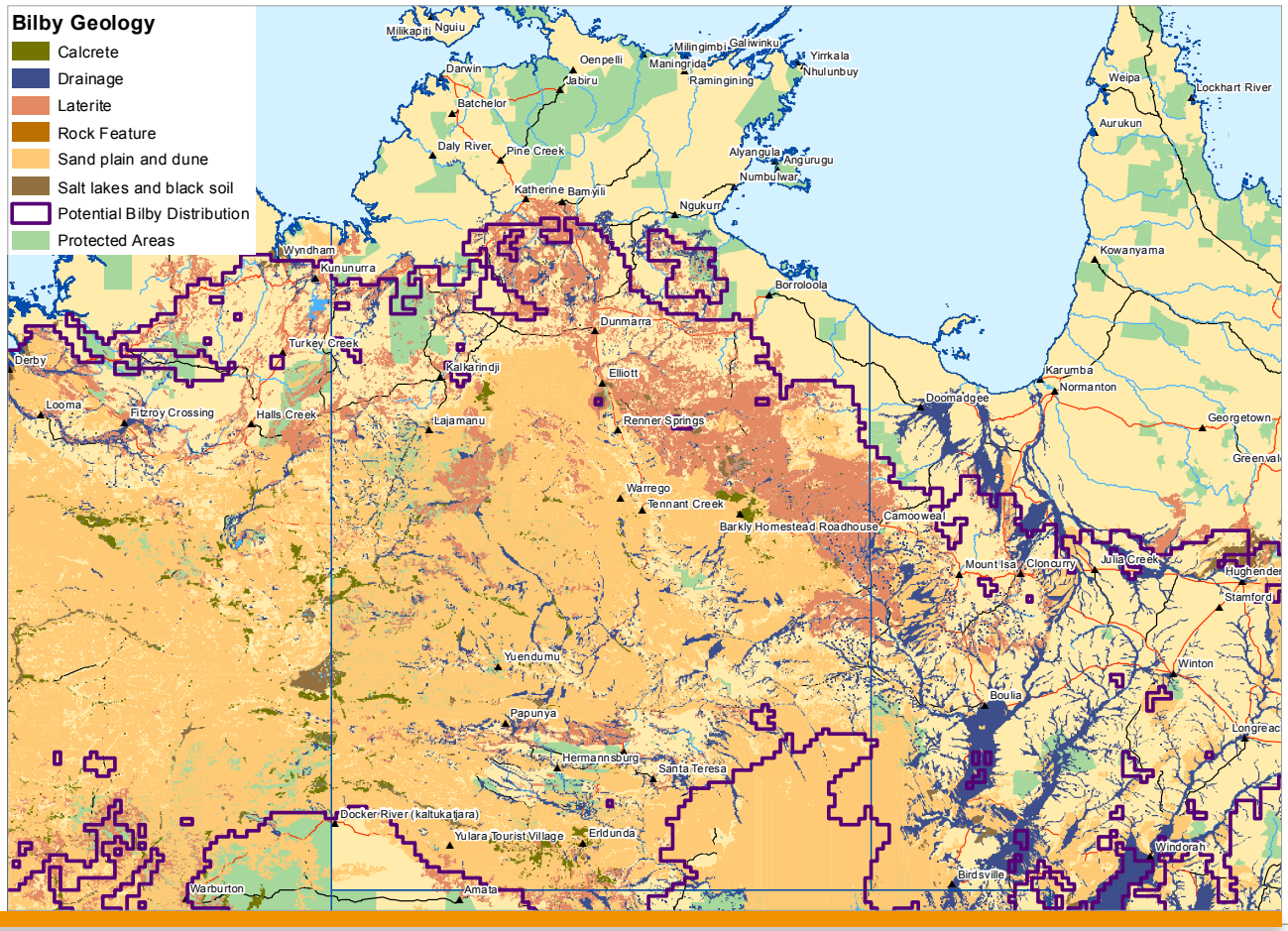


Figure 6. Bilby Geology NT. Geology mapping for the Northern Territory range of the Bilby based on Geoscience Australia 1:1 million geology mapping, categorised as per Southgate (2006) geology classes.

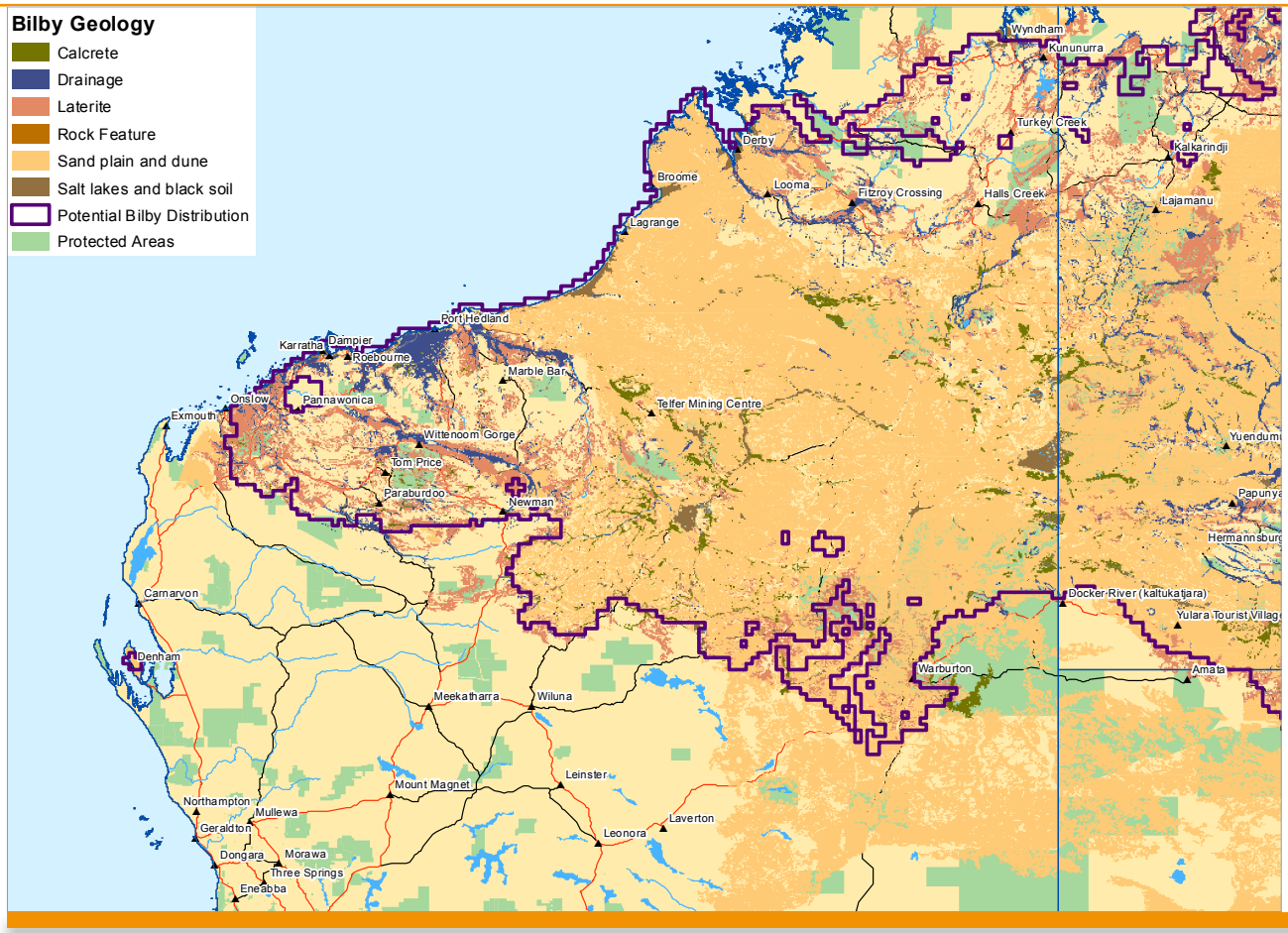


Figure 7. Bilby Geology WA. Geology mapping for the Western Australian range of the Bilby based on Geoscience Australia 1:1 million geology mapping, categorised as per Southgate (2006) geology classes.

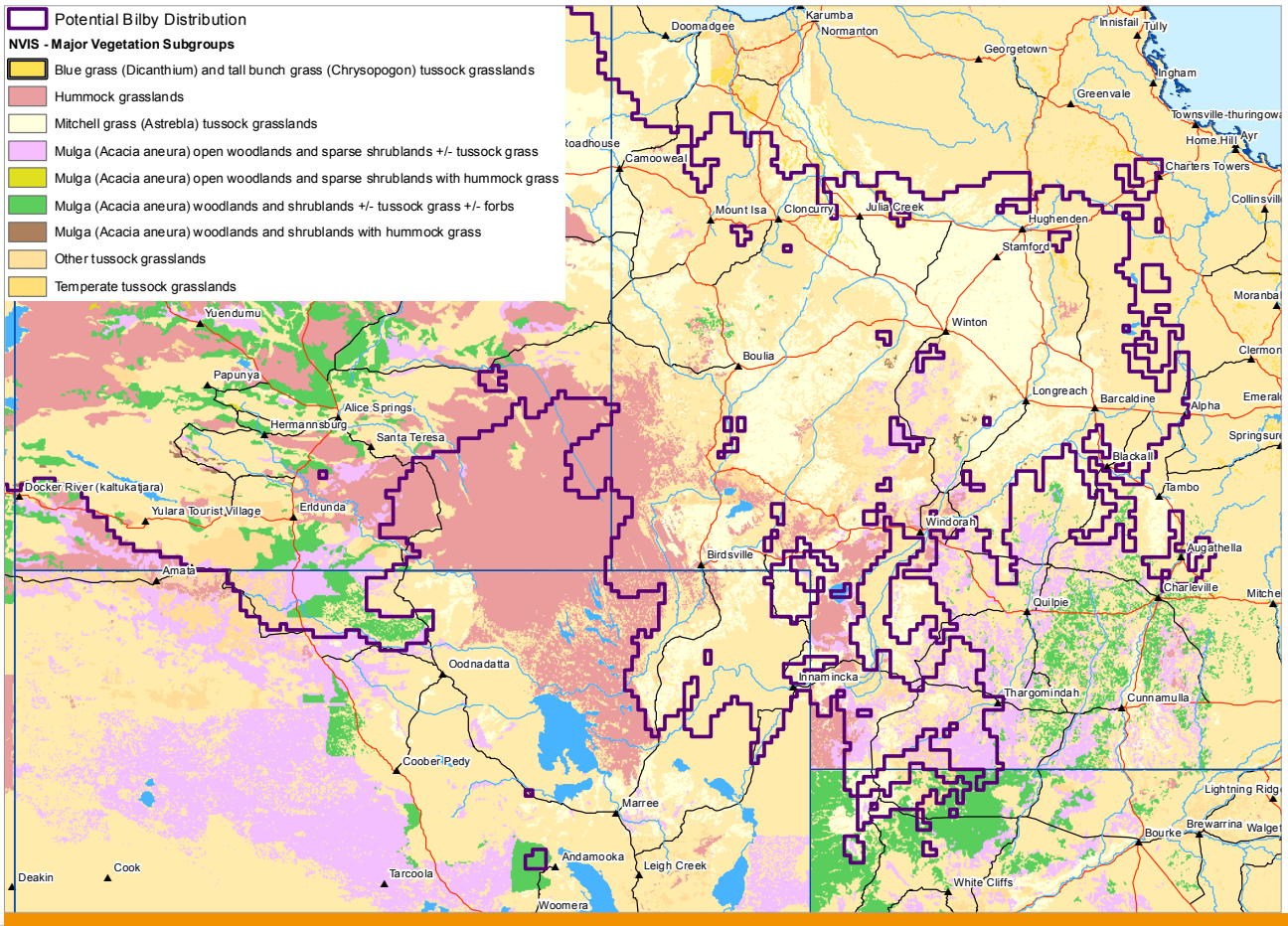


Figure 8. Bilby MVS EAST. Major Vegetation Subgroups within the National Vegetation Information System (NVIS) that contain potential Bilby Habitat – Eastern Australia.

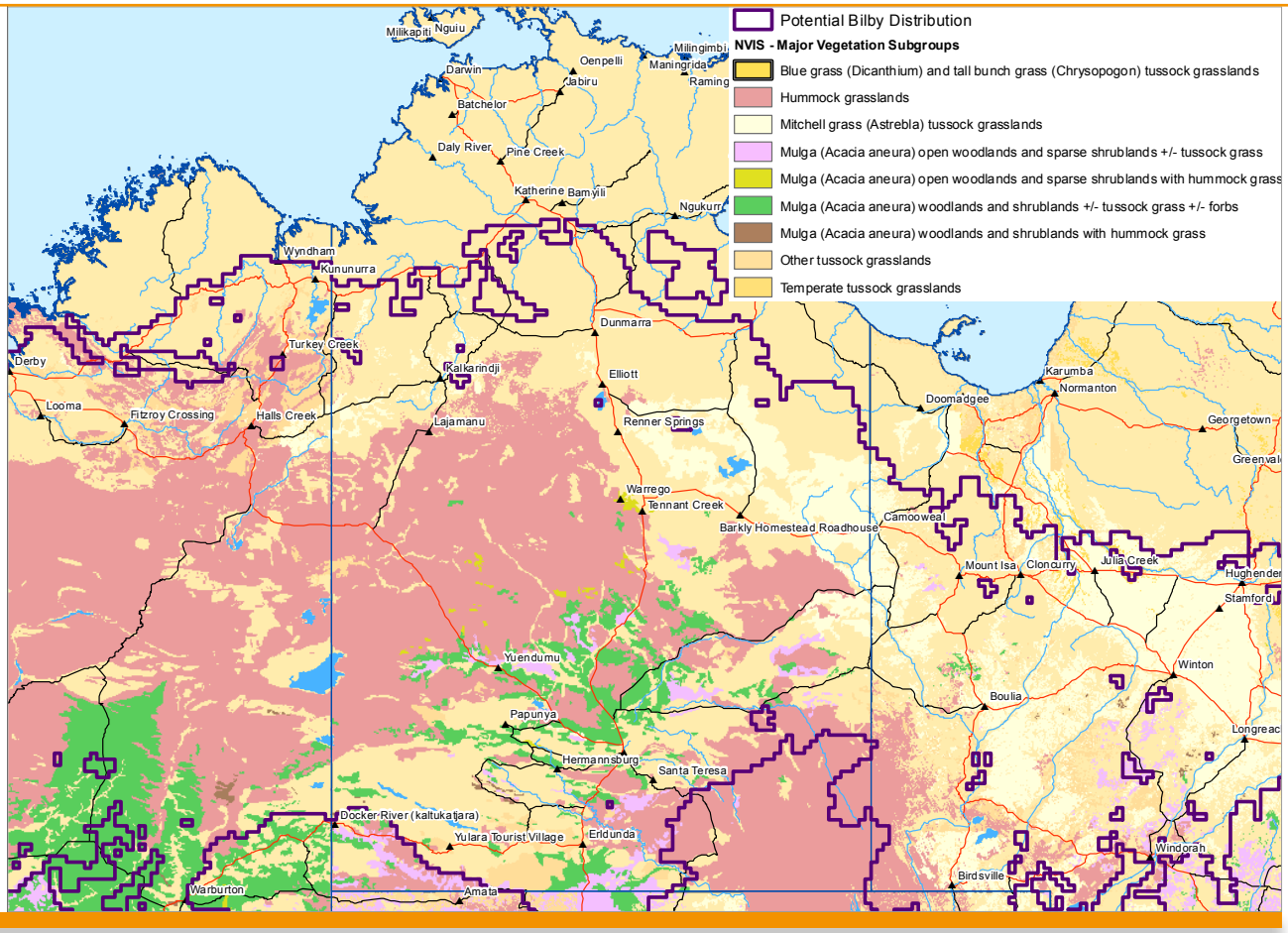


Figure 9. Bilby MVS NT. Major Vegetation Subgroups within the National Vegetation Information System (NVIS) that contain potential Bilby Habitat – Northern Territory.

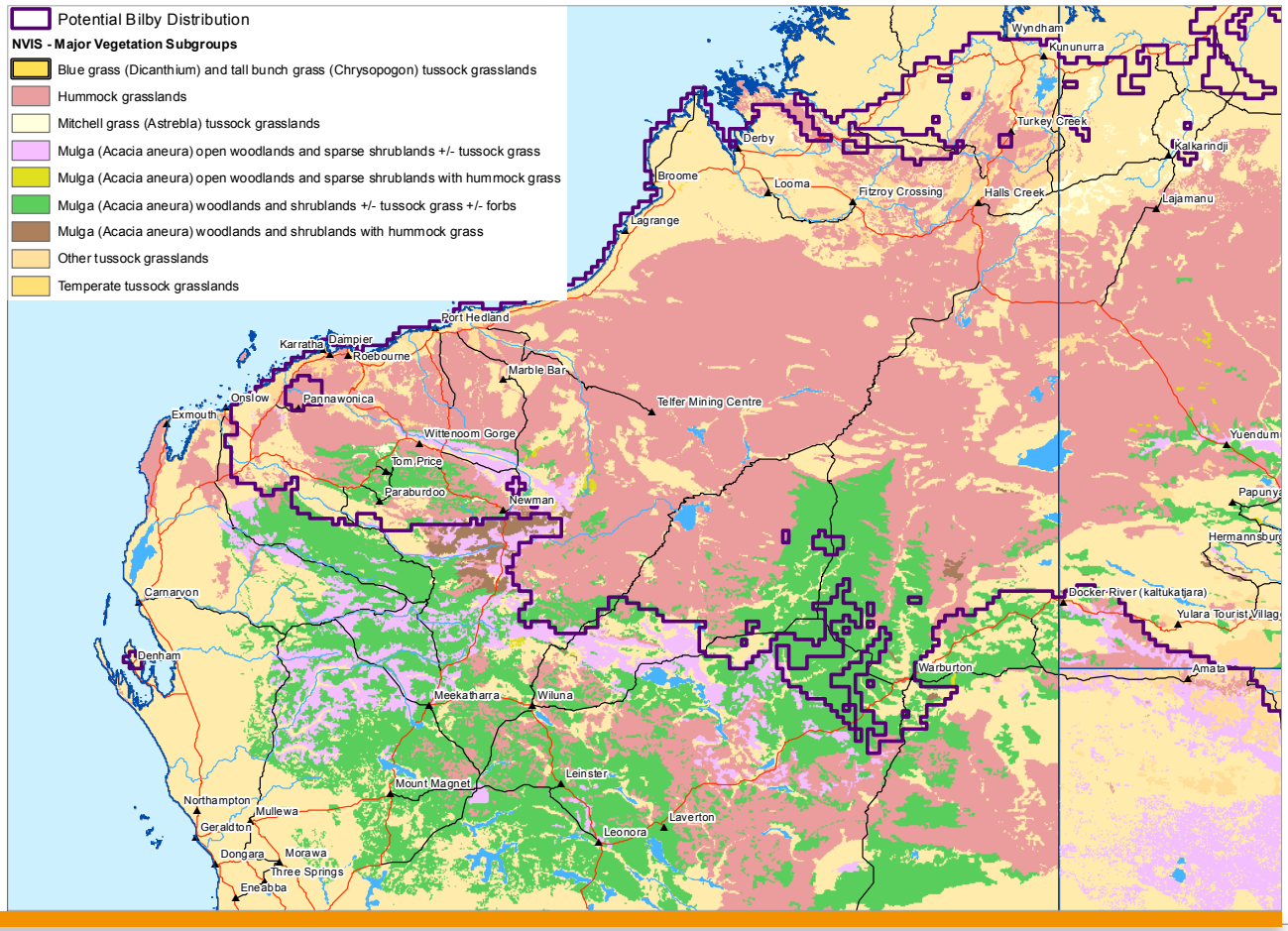


Figure 10. Bilby MVS WA. Major Vegetation Subgroups within the National Vegetation Information System (NVIS) that contain potential Bilby Habitat – Western Australia.

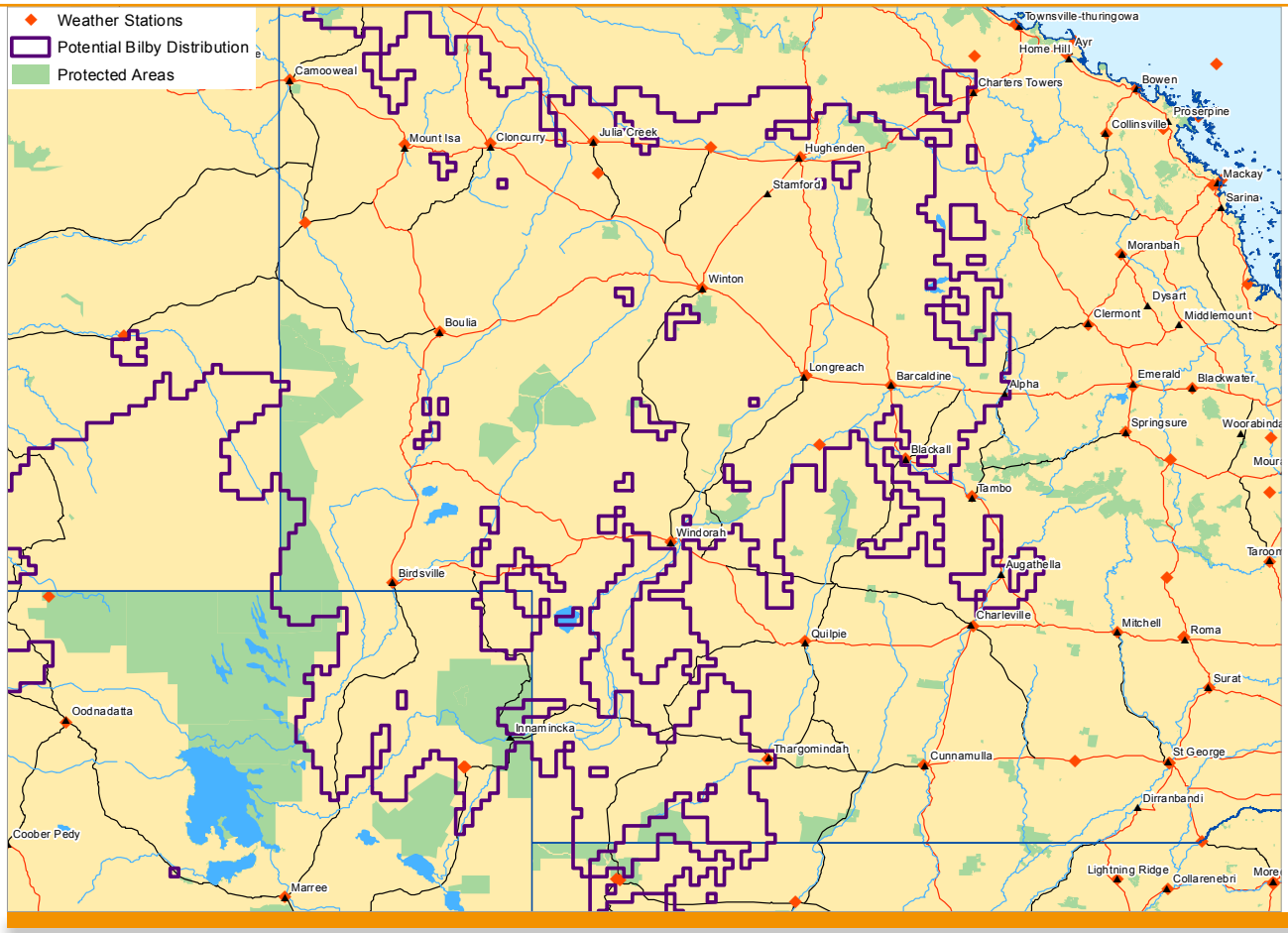


Figure 11. Bilby Weatherstations EAST. Bureau of Meteorology (BOM) weather stations – eastern Australia. These can be used to hyperlink to recent or long-term weather data for an area on the BOM website.

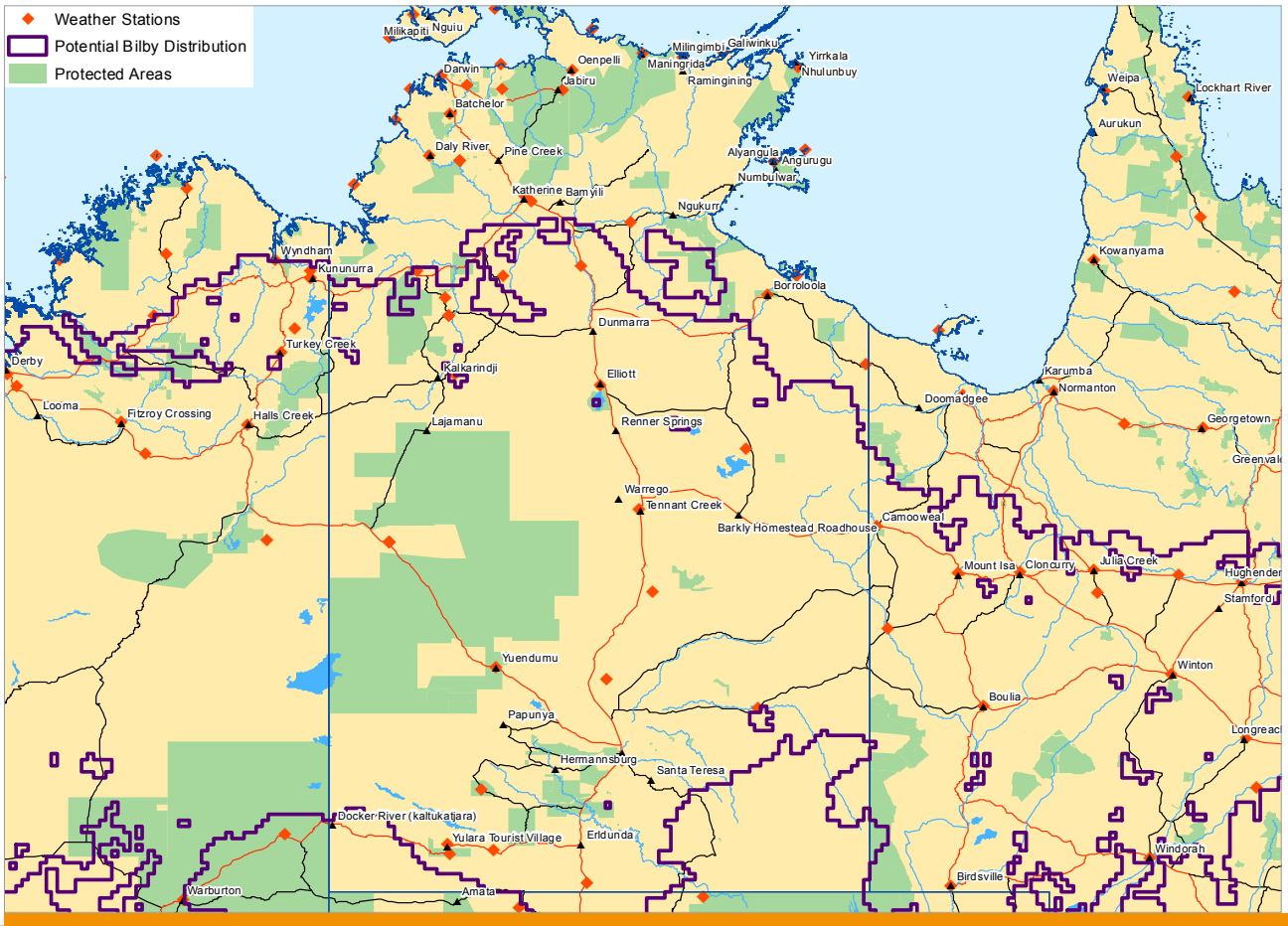


Figure 12. Bilby Weatherstations NT. Bureau of Meteorology (BOM) weather stations – Northern Territory. These can be used to hyperlink to recent or long-term weather data for an area on the BOM website.

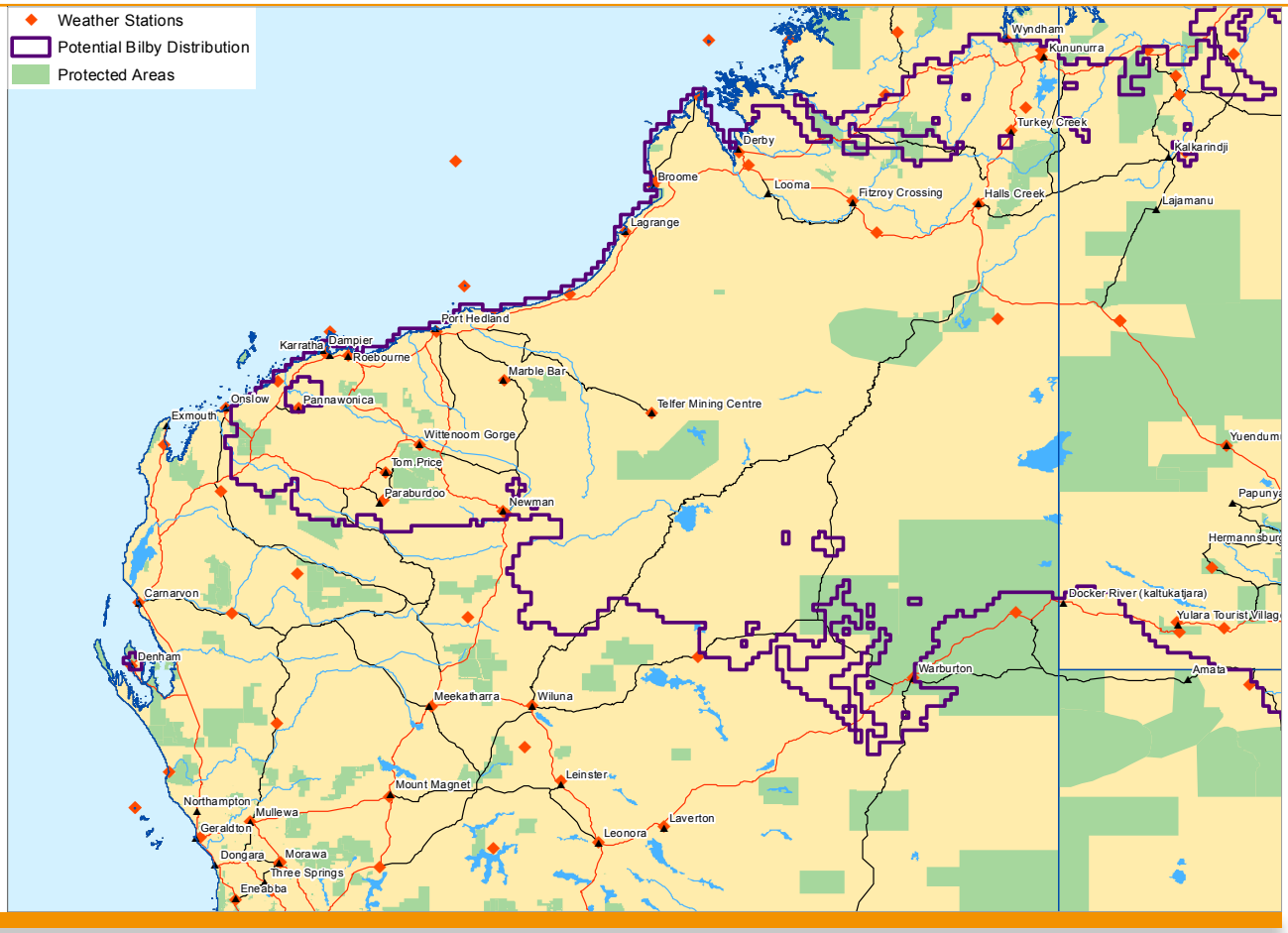


Figure 13. Bilby Weatherstations WA. Bureau of Meteorology (BOM) weather stations – Western Australia. These can be used to hyperlink to recent or long-term weather data for an area on the BOM website.

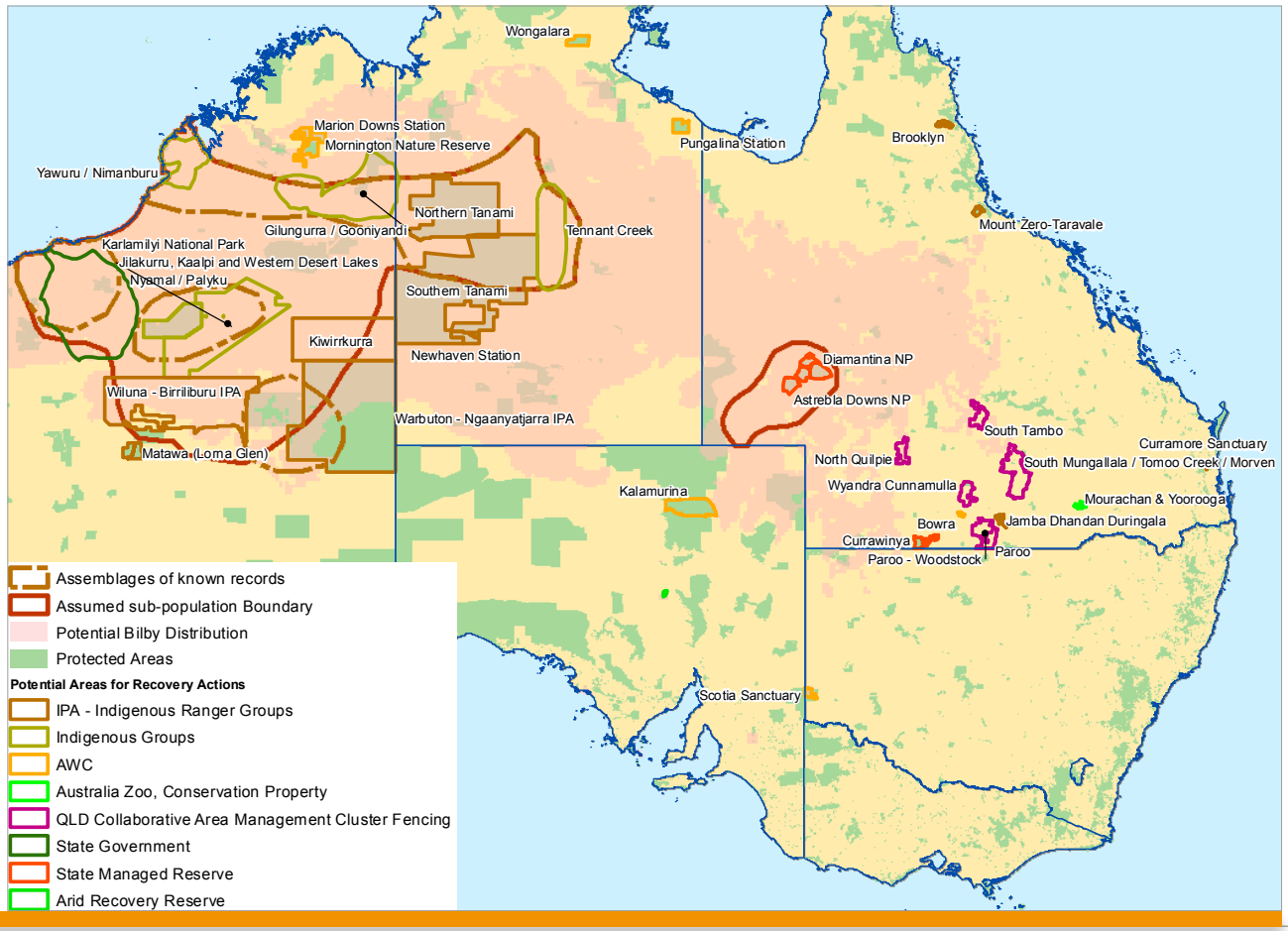


Figure 14. Potential areas for recovery actions. Areas where capacity may exist within the community to undertake recovery actions.

Threats, Challenges, Obstacles

Introduction

Participants worked to identify the threats, challenges and obstacles to achieving the VISION and its associated "Ideal Outcomes". Following an initial brainstorming session four working groups were formed to consider each issue identified in more detail, including *WHY* it poses a problem for bilby conservation and *WHY* it happens (or could happen in future). Human-mediated issues including introduced predators and competitors, land and resource use and fire management made up most of the issues identified. These issues are highly interdependent and could not usefully be partitioned for separate consideration. Instead, broad geographic partitions were used which were designed to reflect the varied nature, prevalence and intensity of these issues, in different regions of the bilby's range. To this end, two groups were formed to deal with ecology and land-use issues: one covering northern bilby country and one southern bilby country including Queensland. The rationale for the split was the presences of foxes as a significant threat in the southern region and the higher fire frequency in the north. This geographic delineation is illustrated in Figure 15. Recognising the past and current roles played by the captive and the fenced bilby populations in insurance and reintroduction, a third group was formed to discuss issues related to optimising their future contribution to recovery efforts. A fourth group was established to focus on enabling processes: engagement and support for the conservation work of remote communities; streamlining relevant local, State and Federal legislation; and increasing the potency of the species recovery process.

The following pages document the outputs of the four groups who worked to characterise each of the issues identified, their causes or drivers, their impact on bilby recovery and the current state of our knowledge – what do we know? What do we assume? What do we need to know in order to take effective action?

Figure 15. Illustration of the North (**N**) and South (**S**) partitioning of ecological and land-use threats.

Group 1: Wild Population - Northern Range

ISSUE: FIRE

A decision model linking fire, rainfall and the promotion of a key bilby plant food (*Yakirra*) has been developed. This indicates that hot fire followed by good rainfall produces abundant *Yakirra*. Cool season fires result in little production of *Yakirra* and fewer other key plant foods used by the bilby. There is uncertainty about whether this situation extends across the northern range of the bilby, particularly in the lancewood, pindan and woodland parts of Dampier Land. Some work in the Kimberley indicates that predation pressure from cats increases in recently burnt areas. There is uncertainty over how the scale, frequency and season of fires affects predation pressure. We assume that large- scale fires will decrease bilby numbers through decreased cover (causing an increase in predation efficiency), and through decreased habitat heterogeneity, which minimises long-term access to food as different food resources become available at different times. Also, as vegetation matures (i.e. ground cover approaches and exceeds 35%) these vast areas will become largely impenetrable to bilbies.

We know	We assume	We need to know
Smaller and more frequent fires increase habitat and resource diversity for bilbies.	High vegetation density inhibits bilby movement.	Whether fire management (low intensity, manipulative) to promote key plant foods etc., is more effective than higher intensity manipulative forms of management, at controlling the impact of predators.
Bilbies responded well to recent fires in the central and northern Tanami where fire is frequent.	Fire attracts predators, but also opens up vegetation.	Response of key bilby food resources and habitat to fire, over space and time.
Bilbies also persist in areas with low fire frequency, eg Gibson Desert, southern Tanami, SW Qld etc.	The scale and frequency of fires associated with the work on Mornington are typical for the southern Kimberley.	Whether fire plays a role in promoting key food resources in the Pindan and forested areas of the Kimberley/ Dampierland.
Hot fires, followed by good rainfall, promote key plant foods used by the bilby in spinifex deserts of Australia.		Does, and at what level does, ground vegetation density inhibit bilby movement, related to fire?
In the absence of plant food availability, bilbies become more reliant on dispersed invertebrate foods.		How are key invertebrate foods (eg. termites, root dwelling larvae) affected by fire regimes in the bilby's range?
Fire increases predation pressure in Mornington.		What are the dynamics of fire, cats, bilbies and herbivores over space and time?

ISSUE: LACK OF UNDERSTANDING OF VARIATION IN BILBY ECOLOGY

Bilbies are found in very different habitats across their range, for example: Tanami, Great Sandy Desert, drainage lines and granite areas in the Pilbara and "forested" areas in the Kimberley. We know some information about the ecology of bilbies from particular habitats. We don't know, however, if this information is consistent across bilbies residing in very different habitats. Understanding the differences will help us to understand the likely range-wide applicability and effectiveness of potential conservation approaches.

We know	We assume	We need to know
Some details of bilby ecology from other areas of Australia, mainly from the spinifex deserts of the Tanami Desert and Mitchell Grass plains of SW Qld. **Bilbies are found in a variety of totally different habitats - eg Tanami, Great Sandy Desert, drainage lines and granite areas in the Pilbara and "forested" areas in the Kimberley.** **Fire has different effects and behaviours in these different habitats.**	That what we know about bilby ecology in other areas/habitats is applicable to bilbies in totally different habitats.	How bilby ecology varies across different habitats particularly the northern Tanami, southern Kimberley and Dampier Land where bilbies occur. Can methods used for measuring abundance, occupancy and presence/absence provide valid and reliable comparisons across the different habitats? Where are the sources and sinks? How does geneflow and dispersal work between these different habitats and across the range of bilbies? Do predators affect bilbies differently in these different habitats?

ISSUE: CATS

Potentially, cats in bilby habitat increase mortality through predation and disease, decreasing bilby abundance and further dissecting/fragmenting sub-populations through local extinctions.

We know	We assume	We need to know
Cats co-occur with the bilby across its extant (wild) range. If cats were the key cause of bilby decline, the bilby would now be extinct.	Cat predation is a major factor in driving decline of bilbies.	Cat distribution, temporal occupancy and density levels that enable bilbies to persist especially spatially (eg habitat) and temporally (eg through seasons and climate).
Cats can prey on bilbies.	Synergies between cats and fire apply in other areas.	Interaction of cats and water points, do water points sustain larger numbers in arid areas or act as predator traps?
Synergies between cats and fire create increased predation in Mornington.	Linear clearings (roads) assist cat movements and facilitate increased predation.	The dynamics of interaction between cats and dingoes: do dingoes suppress cats? If so when and under what conditions?
Cats carry toxoplasmosis in other areas of Australia.	Free water availability enables cats to persist during dry/humid seasons.	Dynamics of cat predation on bilbies, e.g. spatial/temporal variation, tolerable cat predation for bilbies.
		Of lower priority than the above, does toxoplasmosis affect bilbies?

ISSUE: INTRODUCED HERBIVORES AND WATER POINTS

SUB-ISSUE: INTRODUCED HERBIVORES

Introduced herbivores will reduce bilby numbers through degradation of habitat via erosion, compaction and removal of vegetation cover, which decreases bilby access to food resources and burrow sites and through supporting higher predator numbers.

SUB-ISSUE: ARTIFICIAL WATER POINTS

Artificial water points will increase abundance of predators and introduced herbivores, decreasing bilby abundance by increasing or enabling persistence of predation, competition and habitat degradation.

We know	We assume	We need to know
Bilby distribution is associated with an absence or sparcity of stock/pastoralism and rabbits. **Pastoralism increases water points.** **Absence or low degree of pastoralism is associated with bilby persistence.** **Grazing affects vegetation. The effects of grazing are greater closer to water points.** **Pastoralists alter pre-european fire regimes.** **Fire and grazing interact to decrease vegetation quality, at Mornington.** **Herbivores target drainage lines, which is often prime bilby habitat, in the Pilbara and Tanami.**	The pattern of pastoralism/ mining (eg. water points, rubbish dumps, access roads, fire pattern change, refuge etc.) will increase predator abundance and persistence. Pastoral pressure is increasing in the Pilbara and parts of the Kimberley. Bilbies are absent from grazed drainage lines in the Pilbara due to the impact of grazing.	We need to disentangle the effect of stock grazing (i.e. degrading habitat/ reducing bilby food availability) from the effect of resources like artificial waters that increase predator abundance. In other words, is the negative effect of pastoralism on bilbies the result of damage caused by stock or by elevated predator pressure? The dynamics of grazing pressure on bilbies, spatially and temporally. Whether the interaction between fire and grazing affects bilbies. The interaction between bilbies, predators and herbivores around watering points, especially the potential influence of water point closure. Will removal of cattle restore habitat suitability, especially in identified core bilby habitat?

ISSUE: LAND CLEARING

SUB-ISSUE: BROAD-SCALE LAND CLEARING

Broad-scale land clearing decreases bilby numbers through direct loss of habitat, degraded habitat surrounding the clearing, increased predation and fragmentation of sub-populations.

SUB-ISSUE: LINEAR LAND CLEARING FOR TRACKS, ROAD AND RAIL

We are uncertain about the effects of linear land clearing for tracks, road and rail on bilby numbers. They could negatively affect bilby numbers through:

- habitat fragmentation leading to decreased dispersal and isolation of sub-population fragments, reducing the gene pool;
- increased mortality via increased access by predators; and road kill;
- effect on food resources through changed hydrology and fire patterns.

They can positively affect bilby numbers through:

- increased dispersal allowing resource access and enhanced connection between sub-population fragments;
- increased fire heterogeneity leading to increased access to resources.

We know	We assume	We need to know
Road and rail traffic causes mortality. **Land clearing causes habitat loss and surrounding degradation through changes to hydrology and weeds.** **We know dingoes, foxes and cats utilise tracks, roads and rail lines, and are attracted to other cleared areas.** **Roads and rails are a barrier to dispersal in other species.**	Clearing stops fire.	When and where do bilbies prefer to use roads, and how is this related to vegetation cover? Does disturbance around roads attracts bilbies, eg regrowth or ease of burrowing? Is road kill a significant cause of mortality for bilbies in different areas? What mitigation/management measures are effective for decreasing negative impacts, eg road kill, and allowing movements? Are rail/roads barriers to bilby dispersal/gene flow? How does land clearing affect bilby food resources, eg burrowing insects? How does linear land clearing affect pyrodiversity?

ISSUE: FOXES

Foxes expanding into bilby habitat will increase mortality through predation, decreasing bilby abundance.

We know	We assume	We need to know
There is little overlap between fox and bilby distributions. **There are some foxes in N Australia, coasts and towns.** **Foxes kill bilbies.** **Foxes utilise coastal food resources and their distribution extends further north along the coast than it does inland. However, fox distribution is known to have extended northward in the Tanami Desert since the 1980s**	With the lack of overlap between fox and bilby distributions it is assumed that foxes are the most significant predator affecting bilbies. Water points aid expansion inland and help them to persist. Roads aid fox expansion.	Fox occupancy levels at which bilbies can persist. Distribution, and whether foxes are expanding their range northward and eastward from the coast. What factors are limiting fox distribution? The reasons why fox abundance is scarce/absent in non-sandy desert parts of their southern range eg. SW Qld , Matawa. If fox abundance/persistence increases with an increase in resources associated with mining caps/communities/ pastoral stations eg. greater free water availability, scavenging opportunities, access tracks, refuge areas.

ISSUE: DINGOES

There is uncertainty about the effects of dingoes in bilby habitat. Do they decrease cat abundance? Do they predate on and decrease bilby numbers?

We know	We assume	We need to know
Dingoes co-occur with the bilby across extant (wild) range. If dingoes were the key cause of bilby decline, the bilby would now be extinct. **Dingoes prey on bilbies.** **They use tracks to move.** **They need permanent water sources.**	Dingoes limit or exclude cats.	Dingo occupancy levels at which the bilby can persist. Do dingoes supress/exclude cats? Do dingoes have a significant effect on bilby abundance?

ISSUE: WEEDS

There is uncertainty over how bilby numbers will be affected by weeds. We know that there could be declines that result from weeds encouraging changes in fire season, intensity and area, and potentially through competitive exclusion of some preferred plant species.

We know	We assume	We need to know
?	Buffel grass invasion will alter fire pattern and affect the abundance/ distribution of key food-producing plant species eg. *Yakirra australiense, Cyperus bulbosus*. Couch grass along drainage lines may also be a threat.	The implication of weed spread, particularly Buffel grass, on habitat suitability for the bilby.

ISSUE: CLIMATE CHANGE

Changes to climate will affect bilby boom and bust cycles through variation in rainfall and fire, therefore affecting food resources, habitat quality, competition with herbivores and predator distribution.

We know	We assume	We need to know
That the bilby (and its food resources) have reasonably high tolerance to high temperature and humidity (i.e. occurrence in Kimberley), temperate conditions (previous occurrence in southern Aust.) and arid conditions (occurrence in central Aust.)	That fox and rabbit distribution is constrained by high temperature/humidity.	More clearly understand the relationship/distribution of threatening species and rainfall, temperature and humidity. The likely change in distribution of foxes (cats and dingoes, cane toads etc) and rabbits (and pigs, camels, horses, donkeys etc) in response to the various climate change scenarios (increasing temp+greater aridity v. increasing temp+greater rainfall).

ISSUE: LACK OF INCORPORATION OF THE KNOWLEDGE AND CAPACITY OF TRADITIONAL OWNERS

Traditional Owners (TOs) have knowledge of bilbies and capacity for research and management. We need to know how to incorporate and promote the use of Traditional Owner knowledge and capacity.

We know	We assume	We need to know
Fire patterns close to some Aboriginal communities are more diverse, mosaic-like and beneficial for bilby habitat suitability.	There will be ongoing willingness amongst TOs to support activities in bilby conservation and management.	How to promote/encourage the Spiritual/Cultural aspects of bilbies for TOs.
The bilby has a high spiritual and cultural value to TOs.	There will be an increase in the area which is either reserved as Indigenous Protected Area or managed under joint management arrangements with TOs.	What is an effective engagement process for working with TO rangers?
Many TOs once had exceptional knowledge about bilbies, their threats, their foods and their behaviour.	Involvement in bilby recovery actions will have positive benefits for TOs and Indigenous communities.	How best to engage at least a core group of people in many communities to remain interested in monitoring and managing wildlife, including bilbies.
Some TOs still have very good knowledge of where bilbies are and where they used to occur, and bilby ecology.	That the fire management advice being provided by TOs is beneficial and promotes habitat suitability for the bilby.	How to increase capacity of TO rangers to accurately and systematically monitor bilbies.
Those who have the knowledge will also likely have the capacity to undertake survey and monitoring as well as management (fire/predators/ weeds etc).	Anecdotally, there is evidence that the timing of burning suggested by TOs has become influenced by pastoral managers in some regions.	The effect on bilby abundance/ persistence of the burning/ fire management conducted on Aboriginal lands i.e. burning is being conducted but there has been no systematic, broad-scale assessment of its effect on bilbies.
Traditional knowledge can be lost over time as generations pass.		How to bring about regionally relevant threatened species/ communities action which uses bilbies as an “umbrella species”.
Some remote communities are scheduled to be closed down.		

Group 2: Wild Population - Southern Range including Queensland

ISSUE: PREDATION

Excessive predation leads to reduced bilby abundance, reduced range and fragmentation, leading to local extinctions. Several factors impact on predation pressure, including declines in habitat quality, lack of predator evasion techniques (lack of co-evolution of predators and prey) and potentially reserve size (high intensity land use may limit the ability of a population to bounce back from predation effects). In summary, predation is a complex issue within which five effects or trends can be identified:

1. Range expansion by foxes continues to contract the range of the bilby.
2. Baseline predation by predators keeps downward pressure on bilby abundance.
3. Baseline predation is exacerbated by (sustained) high alternative prey numbers.
4. Predation is increased by 'pulse' predator/prey relations e.g. rats.
5. Predation events are intensified by habitat degradation

Observations indicate that bilbies cannot co-exist with foxes but may co-exist with dingoes and cats in some areas and under particular conditions. Observations also indicate that dingoes eat cats and also keep fox densities at low levels, possibly through competitive exclusion. Poison baiting can control dingoes and foxes, but does not control cats, thereby allowing their densities, and impacts to increase. There is currently no effective landscape level approach to cat control and may not be one for several decades. **Therefore, the group took the approach that for the foreseeable future, sustaining the bilby in the landscape will require a combination of predator control and fire and habitat management, to promote conditions that will allow bilbies to co-exist with predators.**

SUB-ISSUE: RANGE EXTENSION BY FOXES CONTRACTS THE RANGE OF BILBIES

We know	We assume	We need to know	Regional Specificity	References
The range of the bilby is contracting from the south in NT. **Foxes are expanding north and west (NT, WA).** **Negative correlations between foxes and bilbies.**	There is a causal relationship between these observed patterns in the ranges of bilbies and foxes.	Lack of monitoring data on fox, cat and bilby distribution/ abundance. Lack of experimental data showing positive benefits of fox control on bilby abundance. Lack of knowledge of extent and dynamics of fox distribution near/in Qld bilby sub-populations. Whether presence of dingoes influences or slows fox distribution/expansion.	NT, WA	NT Paltridge (unpublished) surveys conducted in 2000, 2010.

SUB-ISSUE: BASELINE PREDATION KEEPS DOWNWARD PRESSURE ON BILBY NUMBERS

We know	We assume	We need to know
Predators are always present, but don't always cause local extinctions. **Even low levels of predators have caused extinctions of reintroduced populations.** **Positive correlations between dingo presence and bilby presence; the two species co-existed across most of the continent for thousands of years.**	Low habitat quality increases the impact of low level predation. High habitat quality reduces impacts of low predation levels.	Under what conditions is baseline predation causing local extinctions? Under what habitat conditions are bilbies resilient to baseline predation pressure? Is there a minimum size for a resilient population? How do dingoes, foxes and cats interact?

SUB-ISSUE: BASELINE PREDATION IS EXACERBATED BY HIGH ALTERNATIVE PREY DENSITIES (E.G. RABBITS)

We know	We assume	We need to know
Presence of rabbits elevates predator densities.	Sustained predator levels lead to increased predation on bilbies.	What rabbit abundance thresholds or accompanying circumstances elevate predators to the levels that threaten bilby populations?

SUB-ISSUE: PREDATION BY CATS IS INCREASED AFTER PULSES OF PREY (I.E. LONG-HAIRED RATS)

We know	We assume	We need to know
Episodic increases in cat abundance in western Queensland linked to plague rat dynamics. **Prey switching from rats to bilbies occurs immediately after rat numbers crash.** **A small number of cats can have a significant effect when bilby numbers are critically low.** **We do not have an effective landscape-scale cat control technique.**	The timing, frequency and size of rats plagues and the associated response in cat numbers is a response to a range of local environmental conditions If we could conduct effective cat control as soon as the rats crash we could reduce extent of predation on bilbies	Predicting the timing of prey switching is difficult due to unknown population dynamics of prey. Long-term effects of these prey switching events on bilby abundance, relative to seasonal fluctuations. Whether the importance of predators other than cats increases as bilby numbers decline and, therefore, whether strategies may be more effective if they involve protecting bilbies against the full range of potential predators rather than just targeting cats.

SUB-ISSUE: PREDATION EFFECTS ARE INTENSIFIED WHEN HABITAT DEGRADATION OCCURS

We know	We assume	We need to know
Evidence from other mammal species in Top End is showing increased resilience or descreased predation in areas with more cover or greater habitat structure.	Bilbies are more vulnerable to predations when cover has been reduced by fire/grazing.	Size and quality of habitat required to support sustainable bilby numbers in the presence of predators.

ISSUE: HABITAT DEGRADATION

Habitat degradation accentuates the problem of predation. Lack of cover increases vulnerability to predation and potentially reduces the chance of successful colonisation of patches after local extinctions. It can also reduce bilby food resources, which lowers breeding potential and juvenile and adult survival.

Additional notes:

- Habitat degradation may not necessarily mean dry periods (though the potential for habitat degradation is often heightened in dry periods in conjunction with retention of stock on land that is not capable of supporting them during those periods).
- Excessive grazing tramples burrows, causes soil compaction (which physically impacts on burrows), reduces food abundance, and may cause erosion.
- Locust spraying could potentially reduce food abundance for bilbies in SW Queensland.
- Weeds like buffel are not a current problem in Queensland but are a potential issue.
- Grazing by cattle can change food composition (reducing preferred seeds).
- Watering points increase cattle and land use, degrading landscapes.

We know	We assume	We need to know	Regional Specificity
Excessive grazing reduces plant cover. **The earliest declines in the Queensland sub-population occurred in the more intensively-grazed landscapes.** **Cattle and goat trampling affects bilby burrows.** **Grazing intensification has increased in recent decades with more watering points and different cattle breeds.**	Total grazing pressure reduces food availability for bilbies and increases vulnerability to predation. Burrow trampling causes bilbies to abandon burrows and that this has contributed to further range contraction of bilbies.	Impact of watering points on predator composition. Stocking levels and environmental conditions which lead to habitat degradation.	This is mainly an issue for the Queensland sub-population but could become an increasing problem in the rest of the wild population.

ISSUE: FIRE

Fire regimes in the spinifex deserts dramatically changed following a reduction in Aboriginal burning practices as people moved into settlements. Fire patterns changed from a regime of frequent small fires to occasional very large fires. Fire can promote growth of bilby food plants in spinifex sand plain habitats that are otherwise relatively unproductive for bilbies. Lack of vegetation cover across vast areas following large hot wildfires leaves bilbies vulnerable to predation.

We know	We assume	We need to know
Bilbies have persisted in areas around Aboriginal communities with a fine-scale fire mosaic. **Fire regimes have drastically changed since depopulation of deserts.**	That the mosaic burning benefits bilbies due to reduced wildfires and increased food resources. Increased size of wildfires has negatively impacted bilbies with increased vulnerability to predation and lack of food.	Impact of climate change on fire regimes and other things.

ISSUE: INFRASTRUCTURE DEVELOPMENT

The extent of mining development in bilby habitat is ever increasing. Mining developments may threaten bilbies through vegetation clearance, increased risk of road kill and elevated predator densities resulting from food and water resource subsidies (e.g. introduced watering points and rubbish dumps). However, mining developments can also provide an opportunity for habitat management in areas that are otherwise too remote for sustained management.

We know	We assume	We need to know
Introducing watering points and food resource subsidies (rubbish dumps) can elevate predator densities. **Bilbies can persist in close proximity to mining developments.**	Increased predator densities lead to increased predation on resident bilbies. Infrastructure development increases bilby mortality due to road kills. Infrastructure development can improve fire regimes for bilbies by introducing barriers to the passage of wildfire and providing opportunities for active fire management.	Whether certain densities of dingoes can benefit bilbies through mesopredator suppression, and at what density do dingoes have a negative impact on bilby numbers due to increased predation. Impacts of infrastructure in relation to impeding bilby movements and increasing predator movement is unclear.

ISSUE: POPULATION ISOLATION AND SIZE

Across the former range of the Greater Bilby, human-mediated threats have combined to eliminate the species from some areas and to create isolated population fragments of declining size in others. Smaller population fragments are more vulnerable to loss than larger ones from chance-driven environmental, demographic and genetic effects.

We know	We assume	We need to know
Small populations are more exposed to extinction risk than large ones due to chance-driven effects. **Numerous interacting factors can contribute to reductions in numbers including availability of suitable habitat, reduced abundance of food and shelter, increased predation pressure and reduced reproductive output due to reduced fitness.**	Some of the factors driving populations down can be managed to reduce the risk of local extinction.	Minimum viable population size for bilbies. Key factors affecting individual populations. Assessment of the robustness/ resilience of current populations including identification of those most susceptible to local extinction. Cost effective methods for estimating and monitoring population abundance.

Group 3: Captive and Fenced Populations

ISSUE: ABSENCE OF DIRECTION FROM THE WIDER RECOVERY PROGRAM

SUB-ISSUE: BREED, HOLD & SUPPLY OF BILBIES FOR RELEASE

There are no unifying, widely agreed goals for the captive and fenced populations to guide their contribution to establishing/supporting wild populations.

We know	We assume	We need to know	Regional Specificity
In the past, captive/fenced bilbies have been used successfully for wild release. **We can successfully breed bilbies.** **There is capacity for captive/ fenced populations.**	Bilbies will be required for release-to-wild projects.	How many animals are needed? When? Where? And how often? Any special requirements identified in specific translocation proposals. What defines “fit for purpose?” (eg predator savvy?). The location and nature of potential new release sites.	ZAA Annual Reports.

SUB-ISSUE: CLARIFICATION OF ADVOCACY ROLE, INSURANCE ROLE, RELEASE STRATEGY

We know	We assume	We need to know	Regional Specificity
There are animals in captive/ fenced areas for advocacy, insurance, release.	These roles will be required ongoing.	What is the relative importance/investment of these roles? What might be the timing of any changes to these roles?	

ISSUE: GOVERNANCE AND COORDINATION

SUB-ISSUE: LACK OF COLLABORATION AND COMMUNICATION BETWEEN RECOVERY TEAM AND MANAGERS OF WILD, FENCED, AND CAPTIVE POPULATIONS.

There is a lack of appropriate governance/coordination of the captive/fenced component of the recovery program. This issue was also identified and examined by the Community, engagement and governance working group.

We know	We assume	We need to know	Regional Specificity
There is no regular, focused communication between managers of wild, captive and fenced populations.	Better communication is necessary for better outcomes and decision making.	Who are the key people and organisations? What are their institutional roles and responsibilities? What formal lines of communication are needed? The details of translocation proposals (to improve communication/ expectations/understanding of needs).	ZAA Annual Reports.

ISSUE: RELEASE ANIMALS

There is uncertainty about what constitutes a "fit for purpose" release animal (this will be case-specific depending on the proposed translocation conditions/environment) and there is a need to ensure adequate risk management with respect to supply of these.

Specifically, "fit for purpose" with respect to:

- genetically suitable;
- demographically stable;
- behaviourally suitable;
- physically healthy.

Specifically, risk management with respect to:

- redundancy (ability to absorb fluctuations in numbers);
- security (financial and enclosure);
- natural disaster (eg fire);
- multi-species sites (eg competition between species);
- ecosystem conditions.

SUB-ISSUE: RISK MANAGEMENT

We know	We assume	We need to know
There is risk management of animal supply.	We have identified risks. Risks can be managed.	Current risks. Future risk. Consequence and likelihood of risk.

SUB-ISSUE: FIT FOR PURPOSE

We know	We assume	We need to know
Genetics, demography, behaviour, physical health etc. can influence the viability of translocated populations.	Fitness can be influenced by breeding, training etc.	Translocation conditions and requirements.
Translocation success is influenced by the fitness of individuals.	Larger initial release cohorts reduce the negative impacts of chance-driven events.	History of sites and individuals.
Population modelling reveals the potential effects of low numbers on successful establishment during the initial stages of releases.		Results of previous translocations (or attempts).
		Traits/characteristics which improved the survival and successful establishment of release animals in the past.

Group 4: Community, Engagement and Governance

ISSUE: COORDINATION

Inadequate and inconsistent reporting due to a lack of national and jurisdictional coordination makes it impossible to demonstrate effective on ground responses to actions to reduce threats and promote recovery of the wild bilby population.

We know	We assume	We need to know
There is not one plan and everyone is not reporting against one plan (multiple plans). **Activities are not being implemented uniformly/ consistently.** **The existing recovery/ action plan is not current.** **No national coordination leadership or accountability.** **Actions have been taken but improvements in knowledge and outcomes are not communicated to others.**	Coordination would be improved by a revised national plan. Recovery teams provide a level of effective coordination. Appropriate levels of coordination will lead to appropriate levels of ownership & accountability. Improvements in knowledge influence management decisions and improve the effectiveness of programs.	An effective governance model for the Greater Bilby recovery program and national recovery team.

ISSUE: MONITORING

Lack of agreed and compatible survey and monitoring protocols and parameters makes it impossible to demonstrate either national trends in the wild population or effective on ground responses to actions in reducing threats.

We know	We assume	We need to know
Monitoring and survey work is occurring across the range of the Bilby using multiple techniques. **Survey & monitoring protocols have been developed and are being applied.**	Methods are not compatible with each other. An agreed national approach would support a more effective program (tell us what we need to know). The ability to demonstrate both national trends in the wild bilby population and the effectiveness of on-ground actions in reducing threats would support/justify resource allocation/ funding decisions.	Agreed national monitoring and survey protocols.

ISSUE: RESEARCH

The lack of a clear national research agenda/program limits ability to implement appropriate measures to support and inform the bilby conservation and recovery program.

We know	We assume	We need to know
There are gaps in knowledge that would be informed by targeted research. **Priority for research to support bilby conservation is in relation to threats (inc. predation, fire herbivores).** **NESP hub of threatened species funded to $30mill.**	Research could be better directed with better communication and coordination between funded researchers and managers. National recovery team is best placed to define priority research questions to support recovery program.	How do we effectively influence research funding decisions to address priorities. What are our agreed research priorities?

ISSUE: REPORTING

The lack of a national framework that supports comprehensive and consistent reporting of trends of the wild population and effectiveness of threat management actions limits the programs ability to demonstrate effective on ground responses to actions to reduce threats and promote conservation of the wild population.

We know	We assume	We need to know
No national reporting framework. **No policy/strategy requiring reporting/accountability for recovery plans at national or state level.** **No national requirement for reporting.** **Current reporting is linked to specific funding programs, of specific actions in specific locations.** **There is no central repository or arrangements for the storage and sharing of data relevant to bilby conservation and recovery.**	National reporting framework would benefit recovery program.	What are the key things we need to be reporting on? An effective mechanism and process for the central storage and sharing of data relevant to bilby conservation and recovery.

ISSUE: ENGAGEMENT

Ineffective engagement of all potential relevant parties (public sector, resource sector, agricultural sector, traditional owners, NGOs and the general community) prevents a comprehensive approach to bilby conservation, reduces opportunities for shared ownership and limits access to potential funding, human resources, land, expertise and public support.

We know	We assume	We need to know
Current programs don't fully/ effectively harness/encourage partnerships to deliver outcomes. **Opportunities exist which we can't effectively grasp.** **There is no formal acknowledgement of the cultural and spiritual significance of the bilby to Traditional Owners and they have not been fully engaged as partners in the recovery program.** **Mobilising the support and knowledge of traditional owners in remote communities offers significant opportunities for sustained on-ground conservation action for the Greater Bilby across its range.** **Public opinion drives/influences support including $$$$$.**	Improved engagement will lead to more money and more people, which equals more bilbies. If people know more about the status of the bilby and recovery efforts they will be supportive and value the program. There are additional, as yet untapped, resources and capacity to support the Bilby recovery program.	Who should we be partnering with? How do we leverage support? What are the key messages we need to communicate? How do we more effectively harness the knowledge and capacity of Traditional Owners to support bilby recovery particularly in relation to existing Indigenous Protected Area and Working on Country programs?

ISSUE: ACCOUNTABILITY/RESPONSIBILITY

The absence of formal governance and accountability frameworks reduces the coordination and effectiveness of the national conservation and recovery program for the Greater Bilby.

We know	We assume	We need to know
Legislation requirements only relate to preparation of a plan, not to its implementation. **Inequity in accountabilities across parties involved in recovery.** **No requirements for implementation of recovery plans.**	Defining specific accountabilities will ensure ownership of actions and improved delivery.	Need to identify who is going to be responsible/accountable for both individual actions and overall coordination.

Challenges and Obstacles

to achieving desired outcomes for the Greater Bilby in Australia, including some of their their underlying causes and inter-relationships

Figure 16. Challenges and obstacles to achieving desired outcomes for the Greater Bilby in Australia, including some of their their underlying causes and inter-relationships.


More deaths &/or fewer births
Reduced pulse of food & toxicity
Aerial spraying for locusts
Disease (potential)
Cats & foxes (rise in numbers or efficiency)
Increased opening up of habitat
Inappropriate fire management
Land clearing
Artificial water
Agriculture expansion
Rat (& other prey) plagues
Abundant food
Absence of dingoes (can reduce cats)
Rainfall events
Over-abundance of dingoes (can sometimes control cats)
Road kill
More road and rail corridors
Mining
Rainfall events
Fire
CLIMATE CHANGE
More population fragmentation
Road & rail corridors
Mining
Infrastructure development
Mining
Tourism
Inappropriate fire regime
Expanding agriculture
Reduced population size or more constraints on growth
Infrastructure development
Habitat degradation
Aerial spraying for locusts
Infrastructure development
Aerial spraying for locusts
Infrastructure development
Rabbits, goats, cattle, roos
Weeds (buffel & couch)

Goals

Goals were developed against each of the issues identified. Goals were framed as a desired shift in a state or condition and were written in the form "Our goal is to…." Where groups felt able to do so, each goal was linked to a time-frame and to a specific measure, to allow achievement of the goal to be evaluated. Working groups brought their goals to plenary. Goals dealing with similar issues were grouped into "themes" and these themes were prioritised by participants (using sticky dots) according to:

1) expected impact on achieving the VISION and 2) urgency. The ranking of "goal themes" is shown in Figure 17. The complete list of goals is shown in Figure 18. Note that some of these priority goals are inter-reliant, which complicates prioritisation, and that assessment of feasibility is not included here but is deferred for later consideration by the recovery team.

Rank	Impact on VISION	Urgency	Combined score
1	Manage predators effectively	Manage predators effectively	Manage predators effectively
2	Achieve unified national coordination & Manage risk through a metapopulation plan	Achieve unified national coordination	Achieve unified national coordination
3	Enlarge and reconnect small sub-population fragments (especially in the Qld sub-population)	Agree monitoring and survey methods	Enlarge and reconnect small sub-population fragments (especially in the Qld sub-population)
4	Mitigate grazing and land-use issues	Enlarge and reconnect small sub-population fragments (especially in the Qld sub-population) & Share, collate and report information effectively	Agree & implement monitoring and survey methods
5	Agree & implement monitoring and survey methods	Manage risk through a metapopulation plan	Manage risk through a metapopulation plan & Share, collate and report information effectively
6	Manage appropriate fire regimes	Manage appropriate fire regimes	Manage appropriate fire regimes
7	Share, collate and report information effectively	Mitigate grazing and land-use issues	Mitigate grazing and land-use issues
8	Engage communities effectively	Fix legislation issues	Engage communities effectively & Fix legislation issues
9	Fix legislation issues	Implement a program of priority research	Implement a program of priority research
10	Implement a program of priority research	Engage communities effectively	Improve quality of release animals
11	Improve quality of release animals	Improve quality of release animals	

Figure 17. Ranking of goal themes according to 1) expected impact on the vision and 2) urgency.

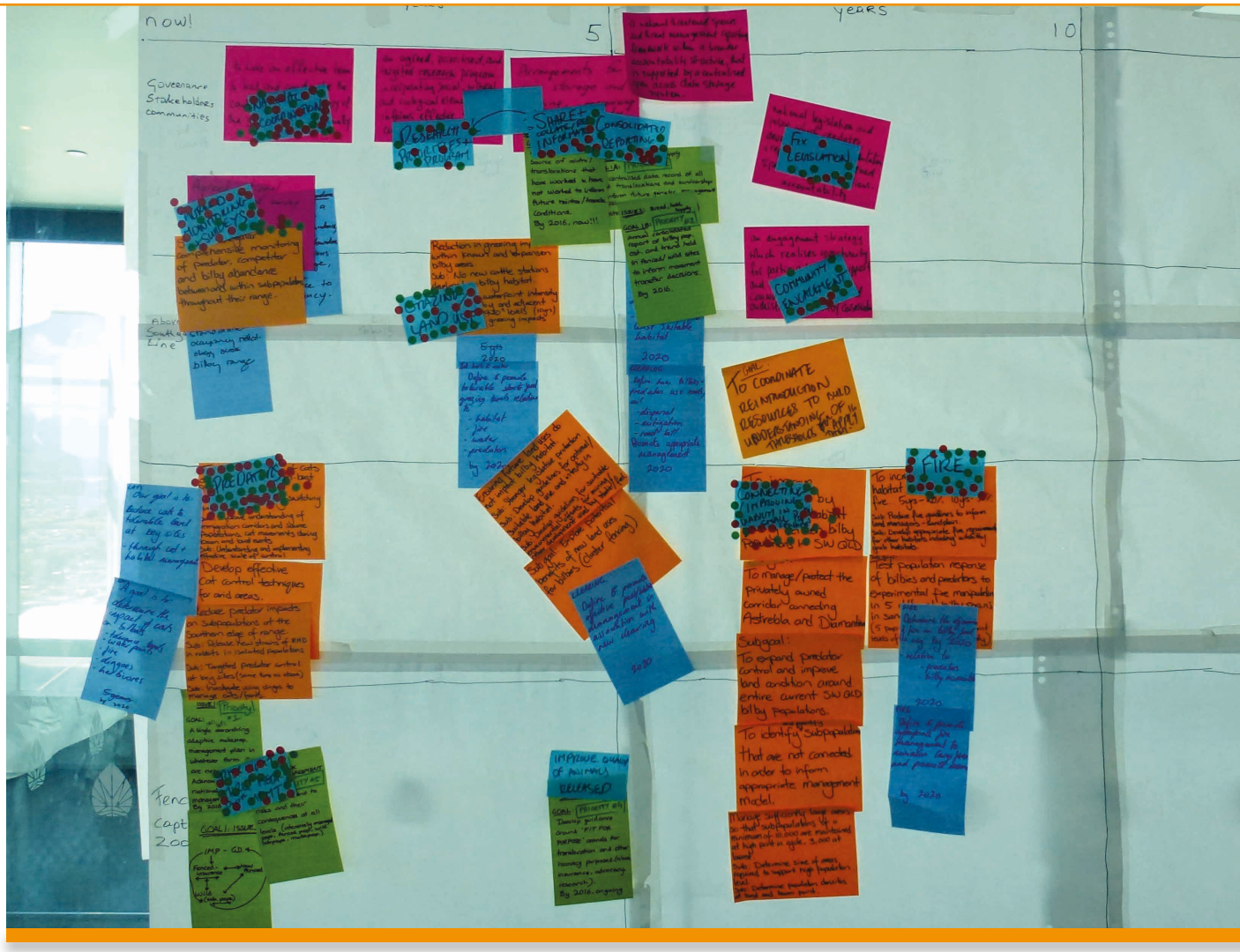


Figure 18. A full list of the goals developed, clustered under goal themes in ranked order of priority (using combined scores for importance and urgency). Each goal is attributed to the relevant working group as follows: Wild Population – Southern Range (W-SR); Wild Population – Northern Range (W-NR); Captive & Fenced (C&F); Engagement, Communities & Governance (ECG)

Goals	Working Group
Managing predators effectively	
1) Develop effective cat control techniques for arid areas by 2025.	W-SR
2) Reduce predator impacts on sub-populations at the southern edge of range.	W-SR
3) Reduce impacts of cats on bilbies during boom-bust prey events.	W-SR
4) Determine the impact of cats on bilbies in a system with few foxes and rabbits.	
5) Determine levels of occupancy and detectability of cats within and outside the range of the bilby.	W-NR
6) Test efficacy of manipulative management measures aimed at reducing cat abundance and determine the effort required to reduce cats to tolerable levels to enable bilby persistence.	W-NR
7) Reduce cats to tolerable level at key sites through cat and habitat management.	W-SR
8) Determine if foxes are extending their range northward	W-NR
9) Determine the climatic conditions, weather conditions and key habitat and prey resources that affect fox extent of occurrence and levels of occupancy.	W-NR
10) Determine levels of occupancy and detectability of dingoes within and outside the range of the bilby	W-NR

Goals	Working Group
Achieving unified national coordination	
11) Have an effective team to lead and coordinate the conservation and recovery of the Greater Bilby nationally, by June 2015.	ECG
Enlarge and reconnect small wild sub-population fragments (especially in the Qld sub-population)	
12) Improve connectivity by managing habitat quality between bilby sub-population fragments in SW Qld.	W-SR
13) To manage sufficiently large areas so that sub-population fragments of a minimum of 10,000 are maintained at high point in cycle, 3,000 at lowest.	W-SR
Agreeing and implementing monitoring and survey methods	
14) Agree national monitoring and survey protocols.	ECG
15) Standardise and implement occupancy/habitat survey method of bilbies, predators and herbivores across bilby range.	W-NR
16) Standardise method of abundance measurement, determine abundance, calibrate abundance to occupancy, determine genetic diversity, geneflow and sources/sinks.	W-NR
Managing risk through a coordinated metapopulation plan	
17) Develop a single overarching adaptive metapopulation management plan, in whatever form necessary, acknowledging one national genetic management unit, by 2016.	C&F
Managing appropriate fire regimes	
18) Determine the dynamics of fire on bilby food resources and vegetation density relative to predator/bilby accessibility, by 2020.	W-NR
19) Define and promote appropriate region specific fire management to minimise large scale fires and promote mosaics, e.g. through patch burning, traditional burning, linear fire breaks etc, by 2020.	W-NR
20) Increase the area of bilby habitat managed through fire.	W-SR
Sharing, collating and reporting information effectively	
21) Have a national threatened species and threat management reporting framework within a broader accountability structure, which is supported by a centralised open access data storage system.	ECG
22) Have in place arrangements for data storage and sharing, recognising intellectual property rights – scientific and traditional.	ECG
23) Create a shared information source of reintroductions/translocations that have worked/not worked to inform future reintroduction/translocation conditions, by 2016.	C&F
24) Create a centralised data record of all past translocations and survivorship to inform future genetic management decisions by 2016.	C&F
25) Create an annual consolidated report of bilby population estimates and trends for fenced and wild sites to inform movement and transfer decisions, by 2016.	C&F

Goals	Working Group
Mitigating grazing and land-use issues	
26) To define and promote tolerable stock grazing levels relative to: habitat, fire, predators, water points by 2020	W-NR
27) To define and promote tolerable feral grazing levels relative to: habitat, fire, water, predators, by 2020	W-NR
28) Determine whether the provision of artificial water increases or decreases overall predation pressure on bilbies.	W-NR
29) Define how bilbies/predators use roads/rail relative to dispersal, road kill, and mitigation, and promote appropriate management, by 2020.	W-NR
30) To understand and identify key bilby habitat in different bioregions and to limit clearing to least suitable habitat, by 2020.	W-NR
31) To define and promote effective pest/habitat management in association with new clearing by 2020.	W-NR
32) Reduce grazing impacts within known bilby sites and adjacent expansion areas.	W-SR
33) Reduce water point intensity in known bilby habitat and that adjacent to it, to 1970s levels, by 2025	W-SR
Engaging communities effectively	
34) To develop an engagement strategy which realises opportunities for participation and support and which engenders community awareness and understanding of bilby conservation.	ECG
35) Recognise and properly engage with Traditional Owner communities in recognition that rangers will be a major part of data collection and management.	**W-NR**
36) Capture which threatened species/ecosystem threat abatement actions are relevant to which geographical areas to aid land managers and Traditional Owners.	**W-NR**
37) Validate and promote the Greater Bilby as an umbrella species/habitat engineer.	**W-NR**
Fixing legislation issues	
38) Have in place national legislation and policy which regulates the development, implementation and reporting of threatened species programs.	ECG
39) Have consistent State legislation and policing of environmental impact projects regarding land clearing.	W-NR
Implementing a program of priority research	
40) Develop an agreed, prioritised and targeted research program incorporating social, cultural and ecological elements which informs effective bilby conservation.	ECG
41) To use reintroduction resources to place animals in the landscape so that understanding of thresholds can be built (e.g. predators, livestock, disturbance etc).	W-NR
42) Determine whether predicted climatic change conditions will alter the distribution of threatening herbivore and predator species.	W-NR
Improving the quality of release animals	
43) Develop guidance around “FIT FOR PURPOSE” animals for translocation and other recovery purposes (release, insurance, advocacy, research) by 2016.	C&F

Actions

Actions and goals developed by working groups are re-organised here under the twelve goal themes listed in the previous section. Issue statements relevant to these themes have been combined. To help maintain context, the working group responsible for each goal/action is indicated on the right using the following colour scheme:

W-SR Wild Population - Southern Range

W-NR Wild Population – Northern Range

C&F Captive & Fenced

ECG Engagement, Communities & Governance

GOAL THEME:	**MANAGING PREDATORS EFFECTIVELY** Excessive predation leads to reduced bilby abundance, reduced range and fragmentation, leading to local extinctions. Several factors impact on predation pressure, including declines in habitat quality, lack of predator evasion techniques (lack of co-evolution of predators and prey) and potentially reserve size (high intensity land use may limit the ability of a population to bounce back from predation effects). In summary, predation is a complex issue within which five effects or trends can be identified: 1.Range expansion by foxes continues to contract the range of the bilby. 2.Baseline predation by predators keeps downward pressure on bilby numbers. 3. Baseline predation is exacerbated by (sustained) high alternative prey numbers (or by water availability reducing stress on predator populations i.e. allowing them to persist more easily). 4.Predation is increased by 'pulse' predator/prey relations e.g. rats. 5. Predation events are intensified by habitat degradation Observations indicate that bilbies cannot co-exist with foxes but may co-exist with dingoes and cats in some areas and under particular conditions. Observations also indicate that dingoes eat cats and also keep fox densities at low levels, possibly through competitive exclusion. Poison baiting can control dingoes and foxes, but does not control cats, thereby allowing their densities, and impacts to increase. There is currently no effective landscape level approach to cat control and may not be one for several decades. Therefore, the group took the approach that for the foreseeable future, sustaining the bilby in the landscape will require a combination of predator control and fire and habitat management, to promote conditions that will allow bilbies to co-exist with predators.					**WG**
GOAL 1:	**Develop effective cat control techniques for arid areas by 2025** *(General note: biological agents are likely to be the only method of broadscale control. If this is not feasible then the focus should be on habitat management and on maintaining dingoes at appropriate levels, to better support billbies where cats are present*).					**W-SR**
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
Action 1.	Prioritise research into biological control of feral cats as the only realistic method of broadscale control	TBC	By 2025	Availability of a biological control agent for feral cats	Invasive Animals CRC?	

Action 2.	Continue refining and trialling new baits and attractants for cats in arid areas	TBC	2015-2020	Best practice baiting techniques developed for different landscapes	TBC	
Action 3.	Conduct field trials to refine effectiveness of Cat Grooming Trap	John Read	2015-2017	Grooming traps available for deployment	TBC	
Action 4.	Ensure landowners and managers are resourced and trained to conduct localised cat management around priority sites using the most appropriate methods. Integrate cat control into ranger/land management work programs	TBC	2015	Number of trained groups conducting effective cat control	TBC	
GOAL 2:	**Reduce predator impacts on bilbies at the southern edge of bilby range.**					**W-SR**
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
Action 5a.	Identify key sites on southern edge of range (Sangsters Bore (NT), Wiluna (WA), Warburton (WA), Kiwirrkurra (WA), Birdsville (Qld), Astrebla (Qld), Palparara (Qld).	Qld NPWS/ EPA, Traditional Owners, neighbouring pastoralists.	2015	Sites selected	Indigenous Land Management Organisations	
Action 5b.	Establish baseline monitoring of bilbies and predators using agreed monitoring techniques that are consistent across the region.	TBC	2016	Bilby and predator indices calculated.	TBC	
Action 5c.	Test and implement control techniques (primarily baiting, grooming trap, shooting, training rangers and neighbouring pastoralists to trap (Qld) traditional hunting, fox and cat-specific baiting, trapping, grooming trap, shooting, (NT and WA)).	Qld NPWS, Indigenous Ranger Groups,	2016- 2020	Number of sites with regular predator management.	Biosecurity Qld	
Action 5d.	Tap into existing shooting programs (e.g. for kangaroos) to include cats. This may require incentives for shooters.	SW NRM	By 2018	Number of cats shot.	TBC	
Action 5e.	Use results from above to develop regional predator management strategies (e.g. Tanami, southern WA, northern WA, SW Qld)	State agencies in WA, NT, Qld				

GOAL 3:	**To reduce impacts of cats during boom-bust prey events.**					**W-SR**
Sub-goal 3a:	Improve understanding of immigration corridors, source populations and cat movement during boom and bust events in SW Qld to enable implementation of effective scale of control					**W-SR**
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
Action 6.	Identify immigration/cat movements through 1) GPS tracking of individual cats, 2) population source through DNA analysis/comparisons (e.g. gene flow), for Astrebla (Qld) and surrounding potential source areas. 3) conduct wider monitoring of cats within a 100km radius of Astrebla using camera traps	DAFF, Griffith Uni, NPWS	By 2020	Cat sources and sinks identified.	AWC	
Sub-goal 3b:	To implement a rapid response strategy after boom events.					**W-SR**
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
Action 7.	Develop indicators of prey-switch timing to enable actions to be implemented before prey-switching escalates. a) Measure cat diets at low and high prey densities. b) Increased monitoring of rat abundance during prey boom cycles c) Develop a rapid response predator control model and test after crash periods Astrebla (Qld)	DAFF, NPWS, Griffith Uni.	RTC	Rapid Response strategy developed and tested after boom-bust event	RTC	
Sub-goal 3c:	To suppress the impacts of rabbit population fluctuations on predator densities and diets in bilby areas					**W-SR**
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	

Action 8.	Test isolated rabbit populations in bilby areas for RHDV and release new strains if appropriate: 1) Consult Traditional Owners (Sangsters Bore, Punmu, Jupiter Well, Lake Mackay) 2) Collect blood samples and test for RHDV 3) Release new strains of RHDV at sites if appropriate 4) Conduct predator management following release of RHDV to counter prey-switching to bilbies	TO communities, biosecurity contractors in WA?	Conduct consultations and testing in 2016 Release in 2017	Number of rabbit populations sampled, Number of sites where RHDV is released	Indigenous Land Management Organisations	
GOAL 4:	**Determine the impact of cats on bilbies in a system with few foxes and rabbits.**					**W-NR**
GOAL 5:	**Determine levels of occupancy and detectability of cats within and outside the range of the bilby.**					**W-NR**
GOAL 6:	**Test efficacy of manipulative management measures aimed at reducing cat abundance and determine the effort required to reduce cats to tolerable levels to enable bilby persistence.**					**W-NR**
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
Action 9.	Apply a single methodology or integrated set of methods across bilby range to benchmark cat detectability and occupancy. Reassess at 10 yr intervals or sooner to capture response to exceptional rainfall or drought events.	Rick Southgate, Martin Dziminski	TBC	Snap-shot of cat extent of occurrence, area of occupancy and detectability estimates and relationship with other predators, key introduced and native prey and climatic parameters	State and Federal conservation authorities, Indigenous organisations.	
Action 10.	Determine tolerable levels of cat occupancy by monitoring locations where bilby colonies persist compared to localities (with similar conditions) where bilbies are absent.	Rick Southgate, Martin Dziminski	2018-2020	Multiple sites each with multiple temporal estimates of cat occupancy from each treatment.	State and Federal conservation authorities. Indigenous organisations.	

Action 11.	Apply a reputably effective form of cat management at several sites where bilbies can be translocated or re- introduced.	Rick Southgate, Martin Dziminski	TBC	Survival of known individuals and persistence of bilby colonies where management was instigated. Real costings for sustained implementation of effective management.	State and Federal conservation authorities Indigenous organisations.	
GOAL 7:	**Reduce cats to a tolerable level for bilbies at key sites, through appropriate cat and habitat management.**					**W-SR**
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
	Contingent on key questions being resolved through the research program.	TBC	TBC	TBC	TBC	
GOAL 8:	**Determine if foxes are extending their range northward.**					**W-NR**
GOAL 9:	**Determine the climatic conditions, weather conditions and key habitat and prey resources that affect fox extent of occurrence and levels of occupancy.**					**W-NR**
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
Action 12.	Apply a single methodology or integrated set of methods across bilby range to benchmark fox detectability and occupancy. Reassess at 10 yr intervals or sooner to capture response to exceptional rainfall or drought events.	Rick Southgate, Martin Dziminski	2018-20	Snap-shot of fox extent of occurrence, area of occupancy and detectability estimates and relationship with other predators, key introduced and native prey and climatic parameters.	State and Federal conservation authorities, Kimberley Land Council (KLC), Central Land Council (CLC) and other TOs.	
GOAL 10:	**Determine levels of occupancy and detectability of dingoes within and outside the range of the bilby.**					**W-NR**
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
Action 13.	Apply a single methodology or integrated set of methods across bilby range to benchmark dingo detectability and occupancy. Reassess at 10 yr intervals or sooner to capture response to exceptional rainfall or drought events.	Rick Southgate, Martin Dziminski	2018-20	Snap-shot of dingo extent of occurrence, area of occupancy and detectability estimates and relationship with other predators, key introduced and native prey and climatic parameters	State and Federal conservation authorities Kimberley Land Council (KLC), Central Land Council (CLC) and other TOs.	

GOAL THEME:	ACHIEVING UNIFIED NATIONAL COORDINATION Inadequate and inconsistent reporting due to lack of national and jurisdictional coordination makes it impossible to demonstrate effective on ground responses to actions to reduce threats and promote recovery of the wild bilby population.					WG
GOAL 11:	**Have an effective team to lead and coordinate the conservation and recovery of the Greater Bilby nationally, by June 2015**					**ECG**
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
Action 14.	Appoint national recovery team coodinator	Workshop	Friday 13 March	Agreement & appointment	Save the Bilby Fund	
Action 15.	Establish Recovery Team according to terms of reference (TOR) relating to reporting frequency, roles, responsibilities etc., and convene a meeting.	Draft TOR (Geoff Lundie-Jenkins); Recovery Team Meeting (Kev Bradley, STBF).	Before July 2015.	Terms of Reference (TOR) agreed. Recovery Team membership confirmed. Initial recovery team meeting convened.	Workshop participants.	
Action 16.	Develop a "deliverables plan" to direct the recovery team program for 2015/16	RTC - Draft RTC – endorse	End June 2015 (Scan fro time critical elements).	"Deliverables plan" prepared.	Recovery Team with others as required.	
Action 17.	Review 2006 recovery plan	RT	End Dec 2015	Review completed	Recovery Team with others as required.	
Action 18.	Develop new 5-year recovery plan integrating review of 2006 plan and outcomes from Summit workshop.	RT	May 2016	New 5 year recovery plan developed	Recovery Team with others as required.	

GOAL THEME:	ENLARGING AND RECONNECTING SMALL WILD SUB-POPULATION FRAGMENTS (ESPECIALLY QUEENSLAND) Across the former range of the Greater Bilby, human-mediated threats have combined to cause local extinctions, thus fragmenting the wild population. These threats have since acted to reduce the size and increase the degree of isolation of these fragments. Small, isolated sub-population fragments are more vulnerable to loss than larger ones due to their greater susceptibility to environmental, demographic and genetic uncertainty. Not only bilby numbers but reserve size is implicated; high environmental variability, exacerbated by predation events, is likely to require an ability for numbers to increase during good years in order to weather the inevitable crashes during poorer ones.					WG
GOAL 12:	**Improve connectivity by managing habitat quality between bilby sub-population fragments in South-west Queensland.**					**W-SR**
Sub-goal 12a:	Manage/protect the existing privately owned corridor connecting Astrebla Downs and Diamantina NP					
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
Action 19.	Work with landholder to maintain good land condition and manage predators in the strip of land between Astrebla and Diamantina NP.	NPWS	By 2018	Agreement with landholder in place.	Private landholder and Indigenous Land and Sea Ranger Program.	
Sub-goal 12b:	Improve predator control and improve land condition around SW Qld sub-population fragments					**W-SR**
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
Action 20.	To enable bilby numbers to expand in good seasons and facilitate dispersal between sites, work with neighbouring pastoralists to maintain good land condition and manage predators in buffer zones around known bilby sites.	NPWS, DAFF	By 2020	Agreements with landholders,	Private landholder and Indigenous Land and Sea Ranger Program.	

GOAL 13:	**Manage sufficiently large areas to support sub-populations of up to 10,000 individuals (target a lower limit of 3,000)**					**W-SR**
Sub-goal 13a:	Determine bilby densities at low and high points in cycle, in different habitats.					**W-SR**
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
Action 21.	Conduct burrow counts/estimation of no. individuals using burrows, at different points in the bilby boom-bust cycle in SW Qld, Kiwirrkurra IPA, Ngaanyatjarra IPA, Punmu area and western Tanami Desert.	QDEH, DPAW?, DLRM	TBC	Trends in bilby numbers inferred from occupancy data at selected sites	AWC, NPWS, Indigenous land management organisations	
Action 22.	Use DNA sampling to calibrate burrow data to bilby abundance at selected sites.	DPAW?	TBC	Estimate of abundance at selected sites.	Indigenous land management organisations.	
Sub-goal 13b:	Determine sizes of areas required to support high bilby numbers.					**W-SR**
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
Action 23.	Spatial assessment of suitable habitat extent.	Tania Laity, AG DoE (ERIN)	TBC	Improved habitat extent mapping produced	State Agencies	
Sub-goal 13c:	Regular comprehensive monitoring of predator, competitor and bilby abundance within and between sub-population fragments throughout their range.					**W-SR**
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
	Contingent on other actions being completed.	TBC	TBC	TBC	TBC	

GOAL THEME:	**AGREEING AND IMPLEMENTING MONITORING AND SURVEY METHODS** Lack of agreed and compatible survey and monitoring protocols and parameters makes it impossible to demonstrate either national trends in the wild population or effective on ground responses to actions in reducing threats. Bilbies are found in very different habitats across their range in Australia. For example: Tanami, Great Sandy Desert, drainage lines and granite areas in the Pilbara and "forested" areas in the Kimberley. We know some information about the ecology of bilbies from particular habitats. We don't know, however, if this information is consistent across bilbies in very different habitats. We need to know more about: • abundance, occupancy and presence/absence comparable across range • key foods (plant and invertebrate) and the conditions that promote these foods • sources, sinks and geneflows across range *(Note: key timeline to meet is October 2015 when NESP funding may become "active")*	**WG**
GOAL 14:	**Agree national monitoring and survey protocols.**	**ECG**

	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
Action 24.	Establish working group of appropriate technical experts and relevant industry/stakeholder groups involved in survey and monitoring.	Facilitated by RTC	ASAP	Group established including W-SR and W-NR scientists	TBC	
Action 25.	Prepare draft discussion papers on survey and monitoring protocols and parameters to support bilby recovery.	Technical experts	TBC	Paper draft	NESP	
Action 26.	Circulate discussion papers for review and endorsement.	RTC	TBC	Draft circulated	TBC	
Action 27.	Convene work group meetings to seek agreement on survey and monitoring protocols, parameters, sites etc.	Facilitated by RTC and working groups	TBC	Meeting convened & agreement rectified	TBC	
Action 28.	Get survey and monitoring protocol endorsed by recovery team and published.	Recovery Team	June 2015	Protocol endorsed and published.	TBC	

GOAL 15:	**Standardise and implement occupancy/habitat survey methods for bilbies, predators and herbivores across the range of the Greater Bilby**					**W-NR**
GOAL 16:	**Standardise a method for abundance measurements, determine abundance, calibrate abundance to occupancy; and determine genetic diversity, geneflow and sources/sinks.**					**W-NR**
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
Action 29.	Collate and review success of past method implementation	Rick Southgate	2016	Data amount and quality	Organisations currently using methods, statisticians and DOE/ALA	
Action 30.	Compile a document of methods for presence/ absence, broad scale habitat, occupancy and abundance, which is appropriate for different regions.	Rick Southgate, Martin Dziminski, Jean-Marc Hero, Katherine Moseby and Rachael Paltridge	2016	An accepted monitoring and survey protocol for the extant area of bilbies	As for responsibility	
Action 31.	Get protocol accepted for EPBC and relevant state/territory conservation legislation/ processes	Recovery Team and government reps	2017	Monitoring accepted and implemented in national and state/territory legislation/ processes	Federal and State/territory government	
Action 32.	Make protocol accessible to different communities and promoting it to relevant organisations	Recovery Team and government reps	2018	Information products, cybertracker routine, uptake of methods by relevant organisations, reporting data back from methods	Land councils, TO groups, consultants, state/territory conservation departments, Academic ecologists, E NGO, other relevant organisations	
Action 33.	Periodically review methodology	Recovery Team and government reps	every 5 years	Data quality and amount, uptake of methods by relevant organisations	Land councils, TO groups, consultants, state/territory conservation departments, Academic ecologists, E NGO, other relevant organisations	

Action 34.	Survey occupancy with a priority in Kimberley, northern Tanami and Pilbara. Then at selected sub-population fragments (Pilbara, Kimberley, QLD and Tanami) across the bilby range monitor abundance, then calibrate abundance to occupancy using approved methods.	Rick Southgate, Martin Dziminski	2020	Occupancy surveys completed in Kimberley, Northern Tanami and Pilbara; selected sub-population fragments monitored for abundance; report on how occupancy relates to abundance	DPaW Pilbara; KLC / EK Kimberley; QP&W QLD; CLC/NT P&W Tanami. AWC and Arid Zone?	
Action 35.	Develop protocol for genetic sampling. Determine genetic diversity, geneflow and source/sinks through scat/tissue collection. Collect from wild sub-population fragments across the current range, and from captive and fenced populations.	Martin Dziminki & Vere Nicolson to coordinate.	5 years	Sources and sinks identified, population genetics and source/sink mechanisms understood. Publication produced and circulated.	DPaW, SA Museum, QLD Museum, NT Museum, WA Museum, AWC (Mt. Gibson animals), Arid Recovery, Zoo's, Dreamworld, Kanyana.	

GOAL THEME:	**MANAGING RISK THROUGH A COORDINATED METAPOPULATION** There are no agreed, unifying goals for the captive and fenced populations to guide their contribution to the recovery and conservation of the wild population. Specifically more direction is needed in the areas of breeding, holding & supplying bilbies for release, and in clarifying the most appropriate role or roles (advocacy? Insurance? Release?). Further, there is a lack of appropriate governance/coordination of the captive/fenced component of the recovery program. In particular, lack of collaboration and communication between recovery team/ wild pop managers, fenced population managers, and captive population managers, and a lack of national coordination.					**WG**
GOAL 17:	**To develop a single overarching adaptive metapopulation management plan, in whatever form necessary, acknowledging one national genetic management unit by 2016.**					**C&F**
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
Action 36.	Seek formal agreement from recovery representatives for a single management unit that meets recovery objectives.	ZAA	April 2015	Single management unit adopted by recovery team and by all bilby holders.	All holders/managers.	

Action 37.	Develop a metapopulation management plan. **Purpose:** to map current metapopulation structure, the future desired metapopulation structure and how to get there. **Plan to consider:** number, size, location and genetic quality, demographic structure of sub-populations (current and needed); types of sub-populations (current and needed: intensive, fenced, less intensive etc); roles of subpopulations (current and needed; insurance, research, advocacy, release, wild); prioritise sub-populations; determine required interaction between them (movement of animals and information flow, including "fit for purpose"); **Identify:** research priorities; information gaps; resource implications; feasibility; constraints; risks.	National coordination team	Identify contributors (people), by end of March. Establish process for developing plan (3 months). Establish process for developing plan and develop map of current metapopulation structure (1 page) and desired metapopulation structure (1 page) within 6 months. Develop full metapopulation plan (and revised maps) within 2 years. Revise metapopulation plan based on progress within 5 years.	TBC	As per national coordination team.	
Action 38.	Develop a Captive Management Plan for the captive population to service the captive component of the recovery plan.	ZAA ASMP team (Claire Ford, Camille Goldstone-Henry, Jodi Buchecker and Vere Nicolson)	January 2016		ASMP team and ZAA members	

GOAL THEME:	**MANAGING APPROPRIATE FIRE REGIMES** A decision model linking fire, rainfall and the promotion of a key bilby plant food (*Yakirra*) has been developed. This indicates that hot fire followed by good rainfall produces abundant *Yakirra*. Cool season fires result in little production of *Yakirra* and fewer other key plant foods used by the bilby. There is uncertainty about whether this situation extends across the northern range of the bilby, particularly in the lancewood, pindan and woodland parts of Dampier Land. Some work in the Kimberley indicates that predation pressure from cats increases in recently burnt areas. There is uncertainty over how the scale, frequency and season of fires affects predation pressure. We assume that large- scale fires will decrease bilby numbers through decreased cover (causing an increase in predation efficiency), and through decreased habitat heterogeneity, which minimises long-term access to food as different food resources become available at different times. Also, as vegetation matures (i.e. ground cover approaches and exceeds 35%) these vast areas will become largely impenetrable to bilbies.					**WG**
GOAL 18:	**Determine the dynamics of fire on bilby food resources and vegetation density relative to predator/bilby accessibility, by 2020**					**W-NR**
GOAL 19:	**Define and promote appropriate region-specific fire management to minimise large-scale fires and promote mosaics, e.g. through patch burning, traditional burning, linear fire breaks etc, by 2020**					**W-NR**
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
Action 39.	Validate the sand-plain fire management model at a number of localities across sand-plain habitat.	Responsibility: Rick Southgate	2020	In fire managed areas increased occupancy, increased food resources, increased breeding.	CLC and KJ (Martu), DPaW @ Matawa	
Action 40.	Develop fire management protocols for other regions/habitats based on standardised survey methods and habitat modelling.	Rick Southgate	2020	In fire managed areas increased occupancy, increased food resources, increased breeding.	Partners: CLC and KJ (Martu), DPaW @ Matawa	
Action 41.	Validate fire management protocol for other regions/habitats eg QLD, Pilbara, Lancewood and Dampierland and Nth Sandy; spinifex and sandy plains, woodland based on standardised survey methods and habitat modelling.	Rick Southgate	2025	In fire managed areas increased occupancy, increased food resources, increased breeding.	KLC/EK M. Lindsay, Pilbara and KJ N. Burrows and M. Dziminski, CD NTS, QLD P&Ws, CLC and KJ (Martu), DPaW @ Matawa.	
Action 42.	Increase area of bilby habitat with appropriate fire management.	Rick Southgate	5 years - 20% 10 years - 50%	Area managed by appropriate fire (monitor sampling plots).	KLC/EK M. Lindsay, Pilbara and KJ N. Burrows and M. Dziminski, CD NTS, QLD P&Ws, CLC and KJ (Martu), DPaW @ Matawa.	

GOAL 20:	Increase the area of bilby habitat managed through fire.					W-SR
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
Action 43.	Test response of bilbies (plus habitat quality, food availability, predators, dingoes) to experimental fire manipulation in 5 different bilby sub-population fragments in sand plain habitat (different levels of intensity:frequency). There are two scales that need to be reported on here: (i) at the very large landscape scale through satellite imagery interpretation annually and (ii) at a more localised management district scale that includes local on-ground assessments of intensity. Based on the results, produce fire guidelines for sand plain habitats to inform land managers.	TBC	By 2020	Fire management guidelines developed for sandplain habitats	TBC	
Action 44.	Develop appropriate fire management prescriptions for other habitats including those where witchetty grubs are a key food resource.	TBC	By 2020	Fire management guidelines developed for a range of habitats.	TBC	

GOAL THEME:	SHARE, COLLATE AND REPORT INFORMATION EFFECTIVELY The lack of a national framework that supports comprehensive and consistent reporting of trends of the wild bilby population and effectiveness of threat management actions limits the programs ability to demonstrate effective on ground responses to actions to reduce threats and promote conservation of the bilby.					WG
GOAL 21:	**Have a national threatened species and threat management reporting framework within a broader accountability structure, which is supported by a centralised open access data storage system.**					ECG
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
Action 45.	Get consideration of national reporting framework on the agenda at the National Threatened Species Summit in July 2015	Peter Copley	July 2015	(+ve) response from the TS Commissioner	Summit participants	
GOAL 22:	**Have in place arrangements for data storage and sharing, recognising intellectual property rights – scientific and traditional**					ECG
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
Action 46a.	Develop a discussion paper scoping arrangements and issues associated with the establishment of a centralised open access data storage system, including: • Intellectual property issues • Data types/formats • End users • Access • Acknowledgement • Housing and maintenance/ management	Tania Laity/ Commonwealth	ASAP	Scoping Document prepared	Workshop participants. ERIN	
Action 46b.	Discussion paper presented to Recovery Team.	RTC	June 2015	Scoping document endorsed by Recovery Team	TBC	
Action 46c.	Joint submission to Commonwealth DoE from state jurisdictions regarding establishment of a centralised open access data storage system	Facilitated by Recovery Team	2016	TBC	TBC	

GOAL 23:	**Create a shared information source of reintroductions/translocations that have worked/not worked to inform future reintroduction/translocation conditions, by 2016.**					**C&F**
GOAL 24:	**Create a centralised data record of all past translocations and survivorship to inform future genetic management decisions, by 2016.**					**C&F**
GOAL 25:	**Create an annual consolidated report of bilby population estimates and trends for fenced and wild sites to inform movement and transfer decisions, by 2016.**					**C&F**
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
	See above action (#46) and action relating to metapopulation plan development (#37).					

GOAL THEME:	**MITIGATING GRAZING AND LAND-USE ISSUES** Introduced herbivores will reduce bilby numbers through degradation of habitat via erosion, compaction and de-vegetation, which decreases bilby access to food resources and burrow sites. Artificial water points will increase abundances of predators and introduced herbivores, decreasing bilby abundance via increasing or enabling persistence of predation, competition and habitat degradation. Broad-scale land clearing decreases bilby numbers through direct loss of habitat, degraded habitat surrounding the clearing, increased predation and fragmentation of sub-populations. We are uncertain about the effects on bilbies of linear land clearing for tracks, road and rail. They could negatively affect bilbies through: habitat fragmentation leading to decreased dispersal and isolation, reducing the gene pool; increased mortality via increased access by predators and through road kill; and by affecting food resources through changed hydrology and fire patterns. Linear land-clearing could also positively affect bilbies through: increased dispersal opportunities allowing resource access and enhanced connection between sub-population fragments; and increased fire heterogeneity leading to increased access to resources.	**WG**
GOAL 26:	**Define and promote tolerable stock grazing levels for bilbies, relative to suitable habitat, fire, predators and water points, by 2020.**	**W-NR**
GOAL 27:	**Define and promote tolerable grazing levels of feral herbivores, relative to suitable habitat, fire, predators and water points, by 2020.**	
GOAL 28:	**Determine whether the provision of artificial waters increases or decreases overall predation pressure on bilbies.**	**W-NR**

	Action details	Proposed responsibility	Time line	Measures	Partners	
Action 47.	Determine the effect of turning on and off water points on predator composition and their relative abundance/occupancy	TBC	2020		Mining companies	
Action 48.	Determine tolerable stocking levels associated with persistent bilby colonies	TBC	2020	Guidelines for stocking levels	Mining companies	
Action 49.	Experimentally determine whether a reduction or removal of stock can restore habitat suitability and enable reintroduced bilbies to persist	TBC	2020	Survivourship of bilby individuals/ persistence time of reintroduced/ translocated groups.	Mining companies	
GOAL 29:	**Define how bilbies/predators use roads/rail relative to dispersal, road kill, and mitigation, and promote appropriate management, by 2020.**					**W-NR**
GOAL 30:	**Define key bilby habitat in different bioregions, and limit land clearing to least suitable bilby habitat, by 2020.**					**W-NR**
GOAL 31:	**Define and promote effective pest and bilby habitat management in association with land clearing, by 2020.**					**W-NR**
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
Action 50.	Consider for action	RT	TBC	TBC	TBC	
GOAL 32:	**Reduce grazing impacts within known bilby sites and adjacent expansion areas.**					**W-SR**
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
Action 51.	Quantify the grazing impacts on bilbies. Compare bilby abundance near and remote from grazing pressure under different grazing intensities (to determine thresholds of acceptable grazing)	TBC	By 2020	Grazing management guidelines developed for bilby habitats in SW Qld	?	
Action 52.	Work with Indigenous landholders to ensure no new cattle stations developed in bilby habitat in WA/NT	TBC	2016	No increase in area of current bilby range in NT/WA utilised for pastoralism	Indigenous land management organisations, ILC	

GOAL 33:	Reduce water point intensity in known bilby habitat and in adjacent habitat to 1970s level by 2025 (note: see also Goal 28)					WR-N
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
Action 53.	Investigate potential for stewardship payments in SW Qld to reduce grazing impacts	Save the bilby fund & Bush Heritage	TBC	TBC	South-west natural resources management.	
Action 54.	Legislate for minimum grazing intensity in high quality bilby habitat *[Note: there is currently a State Leasehold Land Review in progress in Queensland which provides the framework for influencing natural resource management and conservation outcomes across large areas which could be focus for these actions].*	Save the bilby fund & Bush Heritage	TBC	TBC	TBC	
Action 55.	Engage more corporate pastoral companies in bilby management	Save the bilby fund & Bush Heritage	TBC	TBC	TBC	

GOAL THEME:	ENGAGING COMMUNITIES EFFECTIVELY Ineffective engagement of all potential relevant parties (public sector, resource sector, agricultural sector, traditional owners, NGOs and the general community) prevents a comprehensive approach to bilby conservation, reduces opportunities for shared ownership and limits access potential funding, human resources, land, expertise and public support. In particular, there is a lack of appropriate recognition, and poor engagement and involvement, of Traditional Owner knowledge and capacity to support bilby recovery; Traditional Owners have knowledge of bilbies and capacity for research and management which is not currently mobilised.					WG
GOAL 34:	**To have an engagement strategy which realises opportunity for participation and support, and which engenders community awareness and understanding for bilby conservation**					ECG
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
Action 56.	Consult with relevant marketing, communication and engagement specialists to inform process for development of an engagement strategy	STBF/RTC	June R/T Meeting		Dreamworld QUT	

Action 57.	Seek nominations of relevant engagement practitioners from workshop participants including specific focus on indigenous engagement	GLJ	End April 2015	Email circulated to workshop participants seeking nominations	TBC	
Action 58.	Form working group of key engagement practitioners to contribute to bilby engagement plan. Establish lead practitioner to chair working group and coordinate/lead process	RT Working Group Chair	July 2015	Working group nominations and chair confirmed by recovery team	TBC	
Action 59.	Develop principles for engagement plan	Lead by Chair of Working Group	Aug 2015	Principles for engagement plan developed	TBC	
Action 60.	Draft framework for engagement plan including identification of focus areas for Bilby Conservation	Working Group	Dec 2015	Draft framework for engagement plan endorsed by working group and recovery team	TBC	
Action 61.	Convene workshop of practitioners to draft Engagement Strategy	Lead by Chair of Practitioner W/G	TBC	Workshop convened Draft engagement plan prepared	TBC	
Action 62.	Review Draft Engagement Plan by Recovery Team	RT	TBC	Draft engagement plan endorsed by recovery team and published	TBC	
Action 63.	Develop implementation plan to deliver key engagement outcomes	TBC	TBC	Implementation plan developed and initiated.	TBC	
GOAL 35:	**Recognise and properly engage with Traditional Owner communities in recognition that rangers will be a major part of data collection ad management.**					**W-NR**
GOAL 36:	**Capture which threatened species/ecosystem threat abatement actions are relevant to which geographical areas to aid land managers and Traditional Owners.**					**W-NR**
GOAL 37:	**Validate and promote how bilby ecology and conservation is important to broader arid zone conservation e.g. bilby as an umbrella species/habitat engineer.**					**W-NR**
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	

Action 64.	Develop a strategy for this goal	M. Lindsay., R. Southgate, R. Paltridge with input from KLC, CLC and other TOs	**TBC**	A strategy for this goal is developed.	Kimberley Land Council (KLC), Central Land Council (CLC) and other TOs	
Action 65.	Present proof of concept model to NESP Hub, Commissioner, other recovery teams, Threatened Species Summit etc.	TBC	TBC	TBC	Kimberley Land Council (KLC), Central Land Council (CLC) and other TOs	

GOAL THEME:	**FIXING LEGISLATION ISSUES** The absence of formal governance and accountability frameworks reduces the coordination and effectiveness of the national conservation and recovery program for the Greater Bilby. Inconsistent legislation and policing with regard to land clearing presents an obstacle to attempts to conserve the Greater Bilby.					**WG**
GOAL 38:	**Have in place national legislation and policy which regulates the development, implementation and reporting of threatened species programs.**					**ECG**
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
Action 66.	Develop briefing to T/S Commissioner re need for national policy on governance and accountability of recovery programs	P. Copley and others including STBF	ASAP	Letter sent, response from TS Commissioner & inclusion on program for July National TS Summit	State jurisdictions	
Action 67.	Raise national policy on governance and accountability of recovery programs for inclusion on Threatened Species Summit in July	P. Copley and others inclusind STBF	ASAP	Letter sent, response from TS Commissioner & inclusion on program for July National TS Summit	State jurisdictions	
GOAL 39:	**Have in place consistent state legislation and policing of environmental impact projects regarding land clearing.**					**WR-N**
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
Action 68.	For consideration by the Recovery Team.	TBC	TBC	TBC	TBC	

GOAL THEME:	IMPLEMENTING A PROGRAM OF PRIORITY RESEARCH The lack of a clear national research agenda/program limits the program's capacity to implement appropriate measures to support and inform the bilby conservation and recovery program. *[Note: key timeline to meet is October 2015 when NESP funding may become "active"]*					WG
GOAL 40:	**Have an agreed, prioritised, targeted research program incorporating social, cultural and ecological elements which informs effective bilby conservation.**					**ECG**
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
Action 69.	Establish working group including representatives from all relevant disciplines. A chair of the working group to be established to lead the process.	Facilitated by RTC. Chair of research WG.	June	Working group established WG Chair appointed	NESP	
Action 70.	Prepare a draft research project list.	WG Experts.	TBC	Draft Research List	TBC	
Action 71.	Circulate draft research project list for feedback and prioritisation of projects/ themes.	RTC facilitated.	TBC	Draft circulated and prioritised	TBC	
Action 72.	Convene meeting of working group to review preliminary research project list and prioritisation.	Facilitated RTC Working group Chair.	TBC	Endorsed List	TBC	
Action 73.	Preliminary research project list and prioritisation endorsed by Recovery team.	RT	September	Priority research program endorsed and published	TBC	
Action 74.	Promote prioritised research program to research organisations and engage with researchers.	Working Group Chair.	Ongoing	Priority research program distributed Meetings convened	TBC	
Action 75.	Establish framework to obtain feedback regarding implementation of research program and to ensure research outcomes are communicated to influence management.	Recovery Team.	Ongoing	Research reporting framework established Repository for research publications and outcomes established Forums convened toinform management	NESP et al	

GOAL 41:	Use reintroduction resources to place animals in the landscape so that understanding of thresholds can be built (e.g. predators, livestock, disturbance etc).					WR-N
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
Action 76.	For consideration by Recovery Team.	RT	TBC	TBC	TBC	
GOAL 42:	**Determine whether predicted climatic change conditions will alter the distribution of threatening herbivore and predator species**					
	Action details	**Proposed responsibility**	**Time line**	**Measures**	**Partners**	
Action 77.	Develop models for cat, fox and rabbit extent of occurrence and area of occupancy based on climate change scenarios.	Rick Southgate		Modeling to define acceptable climate envelopes for each targets sp. Output models for each spp. in relation t various climate change scenarios	CSIRO BOM	

GOAL THEME:	IMPROVING THE QUALITY OF RELEASE ANIMALS There is uncertainty about how to ensure "fit for purpose" release animals and adequate risk management with respect to supply of these.					
GOAL 43:	**Ensure "fit for purpose" release animals and adequate risk management with respect to supply of these.**					**C&F**
	Action details	**Responsibility**	**Time line**	**Measures**	**Partners**	
Action 78.	*Tied to metapopulation goals and actions.*	ZAA, AWC and Recovery Team.	TBC	TBC	TBC	

Summary of Outcomes

The Greater Bilby Summit has successfully reviewed and revised strategies for achieving conservation and recovery of the bilby and in doing so has developed detailed actions to address both the ecological and organisational challenges currently affecting recovery efforts.

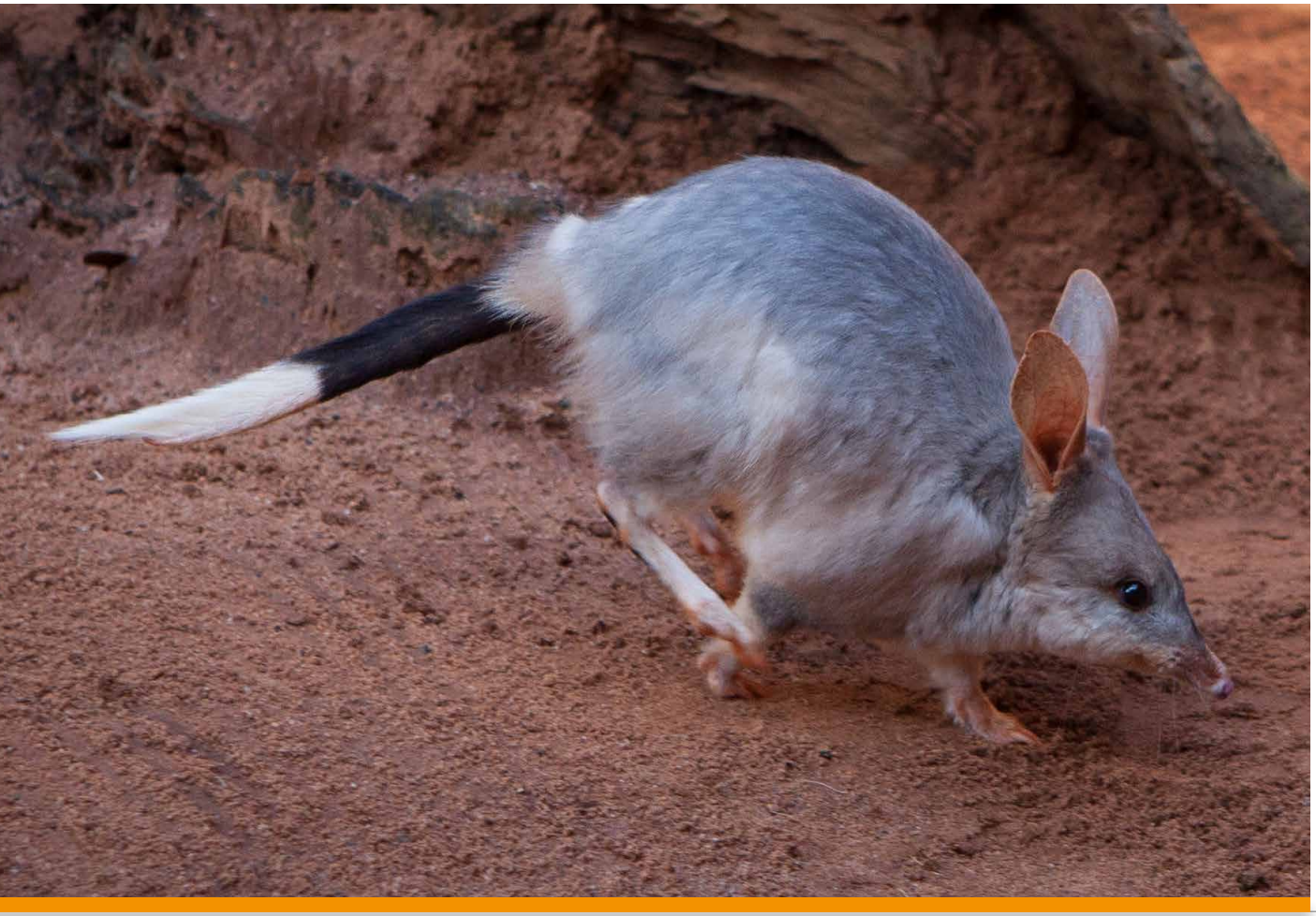
The Summit recognised as a primary concern that there is currently no effective landscape scale management control method for addressing the issue of feral cats. Introduced predators together with inappropriate fire regimes and grazing impacts remain key ecological threats to the continued survival of wild bilbies. The Summit also emphasised that these threats have complex ecological interactions that affect bilby sub-populations to different degrees in different environments.

It was noted that these key threats also affect many other declining species across Australia's arid landscapes and that these species would also benefit from the development of appropriate predator, herbivore and fire management regimes.

Considering Queensland's threatened mammals alone, species such as the Kowari, Brush-tailed Mulgara, Julia Creek Dunnart, Dusky Hopping-mouse, Plains Mouse and the Purple-necked Rock Wallaby all lack the public profile of the bilby, but would benefit from the same environmental management actions.

As a consequence the Summit has identified the need for structured adaptive research trials of different combinations of management protocols, applied at appropriate landscape scales, with uniformity of reporting, as an urgent priority.

In addition to the ecological challenges threatening the conservation and recovery of the bilby the workshop identified a number of past and present organisational arrangements which are limiting the effectiveness of recovery efforts for the bilby through their impacts on coordination, engagement and resourcing and monitoring of recovery actions.



Key recommendations

National Recovery Team

The Summit unanimously endorsed the re-establishment of a national recovery team and is seeking the support of the Save the Bilby Fund and the Australian Government to establish appropriate arrangements for the governance and oversight of this key national coordination entity. The lack of any formal policy that clearly articulates the governance and accountabilities for implementation of national scale recovery programs is a matter that the participants of the Greater Bilby Recovery Summit considered should be addressed as part of the proposed National Threatened Species Strategy.

Indigenous Protected Area Programs

The Summit participants agreed that one of the greatest opportunities for the sustained on-ground conservation of wild bilby populations across their range is the Commonwealth's Indigenous Protected Area Program and associated Indigenous Ranger Programs. The challenge in harnessing the potential of these programs lies in improving organisational engagement and coordination. Shaping this lies outside the current capacity of the proposed National Bilby Recovery Team and hence Summit participants agreed that the assistance of the Office of the Threatened Species Commissioner should be sought in identifying and engaging the appropriate representatives of these and any other appropriate Government programs to join / partner with the new National Bilby Recovery Team to progress implementation of priority actions.

National Threatened Species Summit and Strategy

As a consequence of the deliberations at the Greater Bilby Recovery Summit, participants noted that the bilby afforded an ideal case study to highlight common issues for declining arid zone wildlife at the scheduled National Threatened Species Summit. This proposal was also communicated to the Threatened Species Commissioner for consideration in planning the National Threatened Species Summit.

Summit discussions also identified the following key themes important for inclusion in the proposed National Threatened Species Strategy. It noted that:

1. There is an urgent need to develop a national coordinated adaptive management / research program to determine effective predator, herbivore and fire management regimes for the recovery of arid zone wildlife species – including the Greater Bilby.

2. Such a research programme – and Australia's threatened species programme more widely – would benefit significantly from the development of a coordinated national threatened species and threats management reporting framework.

3. Such a national reporting framework would, in turn, benefit from the establishment and ongoing management of a national data management system for threatened species populations *and conservation threats.*

Review of National Recovery Plan

The outputs of the Summit, as presented in this report, will provide a sound basis for a comprehensive review and revision of the National Recovery Plan for the Greater Bilby (Pavey, 2006) and will build on other recent work, notably that documented in *The Action Plan for Australian Mammals, 2012* (Woinarski et al., 2014). The first task of the new Recovery Team will be to shape these outputs into a five-year recovery plan confirming priorities, time-lines and responsibilities.

Community Engagement

Engaging people: mobilising the support and knowledge of Traditional Owners in remote communities was considered to offer one of the greatest opportunities for sustained on-ground conservation action for the Greater Bilby across its range. In addition to this, formally engaging and coordinating the support of NGOs, zoos and government agencies, including the NESP Hub, was considered essential.

On-ground Action at Key Sites

There is an urgent need to identify key sites across the species' range that require immediate on-ground management action to ensure the ongoing maintenance of bilby abundance and persistence. Summit participants recognised that sites within Queensland should be prioritised for immediate attention.

APPENDIX I:

Acronyms and Abbreviations

AG	Australian Government
AWC	Australian Wildlife Conservancy
BQ	Biosecurity Queensland
CBSG	Conservation Breeding Specialist Group (of the IUCN SSC)
CLC	Central Land Council
DAFF	Department of Agriculture Fisheries and Forestry
DLRM	Department of Land and Resource Management
DOE	Department of Environment
DPAW	Department of Parks and Wildlife W.A
EK	Environs Kimberley
ERIN	Environmental Resource Information Network
IUCN	International Union for the Conservation of Nature
KLC	Kimberley Land Council
QDEH	Queensland Department of Environment and Heritage Protection
Qld	Queensland
QP&W Qld	Queensland Parks and Wildlife
NESP	National Environmental Science Program
NGO	Non-governmental Organisation
NPWS	National Parks and Wildlife Service
NSW	New South Wales
NT	Northern Territory
RT	Recovery Team
RTC	Recovery Team Coordinator
SA	South Australia
SSC	Species Survival Commission (of the IUCN)
STBF	Save the Bilby Fund
SW NRM	South West Natural Resource Management
TCSA	Taronga Conservation Society Australia
TO	Traditional Owner
WA	Western Australia
ZAA	Zoo and Aquariun Association

APPENDIX II:
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APPENDIX III:

Conservation of the Greater Bilby: a broad overview of national conservation progress

Peter Copley, Senior Ecologist, Threatened Species & Ecological Communities, SA

Introduction

I have been asked to set the scene for the discussions at this summit by summarising what is known about the biology / ecology of the Greater Bilby, about its past and present distributions and about the threats to its survival. I have also been asked to summarise progress with implementing the national recovery plan.

Much of this information has fortunately been documented in the current national recovery plan (Pavey, 2006) and updated more recently in The Action Plan for Australian Mammals 2012 (Woinarski, Burbidge and Harrison, 2014). Here I will highlight the key points that I think will underpin the discussions we will have over the next two and a half days.

Key aspects of bilby biology/ecology

- The Greater Bilby is a solitary, nocturnal, omnivorous marsupial.
- It is a sexually dimorphic species with males (800 - 2500g) generally larger and heavier than females (600 -1100g).
- Bilby home ranges are highly variable and differ between sexes, habitat types and habitat conditions / seasons. Examples of home ranges recorded are:
  - 20-50 ha in SW Queensland
  - 110-300 ha in Northern Territory
- Home ranges shift with food availability.
- Bilbies are fossorial and may have many burrows within a currently-occupied home range.
- 'Burrow ranges' are considerably smaller than 'home ranges'.
- Remaining wild population occupies 3 major habitat types:
  - open tussock grasslands on uplands & hills
  - mulga woodland / shrubland on ridges & rises
  - hummock grasslands in plains & alluvial areas
- Litters number 1-3 offspring (usually 2).
- Longevity in wild & captivity is up to 11 years.
- Breeding: females can be reproductively active at 5 months, males at 8 months.
- Generation time is about 4 years.
- Key landscape-scale threats have been identified as:
  - predation (by foxes, cats, dingoes)
  - habitat (cover) loss through very large fires
    - grazing by rabbits / livestock??
- Dingo predation of feral cats has been recorded and is thought to be important in limiting cat densities where dingoes occur. This suggests that precautions are necessary when planning fox/cat control techniques.
- Survey / monitoring techniques have been developed and tested for bilbies in different land systems, but are these consistent and sufficiently standardized to compare trends between sites?

Bilby conservation research and management

The current efforts on bilby conservation date from the late 1970s when a research program was commenced by the Arid Zone Research Institute (AZRI) in Alice Springs, led by Ken Johnson. Rick Southgate was employed to work on bilby conservation, as part of AZRI's program, in the early 1980s and a wide range of projects has arisen from that work that provided the foundational ecological research on the wild bilby in the Northern Territory and parts of Western Australia. It also formed an integral part of a project recording indigenous knowledge of desert mammals (Burbidge, Johnson, Fuller & Southgate 1988) that was foundational in establishing and developing Aboriginal involvement in government-funded conservation programs, which today include indigenous ranger programs in many desert Aboriginal communities. Similar foundational work on the bilbies of south-western Queensland was also commenced in the 1980s by Peter MacRae and others, after the bilby's rediscovery there in 1988.

Conservation plans

There have been several conservation plans developed since the latter 1980s that provide useful points of reference for the current planning exercise. The main national documents include:

- Southgate, R. I. 1987. *Conservation of the Bilby Macrotis lagotis (Reid, 1937)*. Conservation Commission of the Northern Territory.
- Bellchambers, K. & Johnson, K. A. 1991. *Recovery plan for the Greater Bilby*. Prepared by the CCNT for ANPWS. (Revised Southgate 1995).
- Southgate, R. I. & Paltridge, R. 1998. *Recovery of the Greater Bilby Macrotis lagotis*. Endangered Species Program and Feral Pests Program.
- Pavey, C. 2006. Recovery plan for the Greater Bilby, *Macrotis lagotis*, 2006-2011. Northern Territory Department of Natural Resources, Environment and the Arts.
- Woinarski, J.C.Z., Burbidge, A.A. & Harrison, P.L. 2014. Action Plan for Australian Mammals. Greater Bilby pp. 203-207.
- Southgate, R. 2014. Concerns over management intensity: a framework for threatened species and predator management.

Bilby diet and habitat

Some important papers on diet and habitat management include:

- Gibson, L. A. 2001. Seasonal ***changes in diet, food availability and food preference*** of the Greater Bilby in far south-western Queensland.
- Paltridge, R. & Southgate, R. 2001. The effect of ***habitat type and seasonal conditions*** on fauna in two areas of the Tanami Desert
- Southgate and Carthew 2007. Post-fire ephemerals and spinifex-fuelled fires: a decision model for ***bilby habitat management*** in the Tanami

Predators

Two papers on different aspects of the predators of bilbies are:

- Paltridge, R. 2002. The ***diets of cats, foxes and dingoes*** in relation to prey availability in the Tanami Desert
- Moseby, K. E., et al. 2011. ***Predation*** determines the outcome of 10 ***reintroduction*** attempts in arid South Australia

Monitoring

Monitoring trends in the wild bilby population is confounded by a wide range of environmental variables. Some useful techniques have been developed for some environments, but there are still significant issues that need to be resolved around standardising methodologies. Two of the key papers on this are:

- Southgate, R., Paltridge, R., Masters, P. & Nano, T. 2005. An ***evaluation of*** transect, plot and aerial ***survey techniques*** to monitor the spatial pattern and status of the bilby in the Tanami Desert.
- Southgate & Moseby 2008. Track-based monitoring for the deserts and rangelands of Australia

Captive & fenced populations, and reintroduced bilbies

National Captive Breeding Program

A national captive breeding program for the Greater Bilby began in 1995/96 and continues as a ZAA conservation program today.

South Australian Re-introductions / Releases	**Began**
• Yookamurra Sanctuary	1996
• Thistle Island	1997
• Arid Recovery	2001
• Venus Bay Pen.	2001
New South Wales	
• Scotia	2001
Western Australia	
• Project Eden	2000
• Return to Dryandra →	
– 2 x 10ha pens	1998
– Woodland	2000
• Matawa	2007
Queensland	
• Currawinya	2005

Publications about the captive breeding program and re-introductions include:

- Southgate, R. I. 1994**.** Why reintroduce the bilby? ***Reintroduction Biology of Australian and New Zealand Fauna*****.**
- Southgate, R. I. & Possingham, H. **1995**. ***Modelling*** the ***reintroduction*** of the Greater Bilby *Macrotis lagotis* using the meta-population model analysis of the likelihood of extinction (ALEX).
- Southgate, R. I., Christie, P. & Bellchambers, K. 2000. ***Breeding biology*** of captive, reintroduced and wild greater bilbies
- Moseby, K. E. & O'Donnell, E. 2003. ***Reintroduction*** of the Greater Bilby to northern South Australia: ***survival, ecology*** and notes on reintroduction ***protocols***.

Conservation objectives

Conservation objectives for the Greater Bilby have been documented in both the current recovery plan (Pavey (2006) and *The Action Plan for Australian Mammals 2012* (Woinarski, Burbidge and Harrison, 2014).

The five main conservation objectives identified in the action plan are to:

- Maintain sustainable subpopulations at key sites throughout current range
- Maintain sustainable sub-populations on Thistle Island and within mainland islands
- Monitor Bilby numbers and numbers of introduced predators at key sites throughout current range
- Continue to develop effective Red Fox and feral Cat control technologies and apply at key sites
- Maintain captive colonies

1. Maintain sustainable sub-populations at key sites throughout current range

This objective focuses on both naturally-occurring and translocated bilbies. However, this summit will need to agree on definitions (verbally and spatially) for:

- 'sub-population'
- 'key sites'
- thresholds for 'sustainable'.

The summit will also need to test 'assumptions' made in "*The Action Plan for Australian Mammals 2012*", that

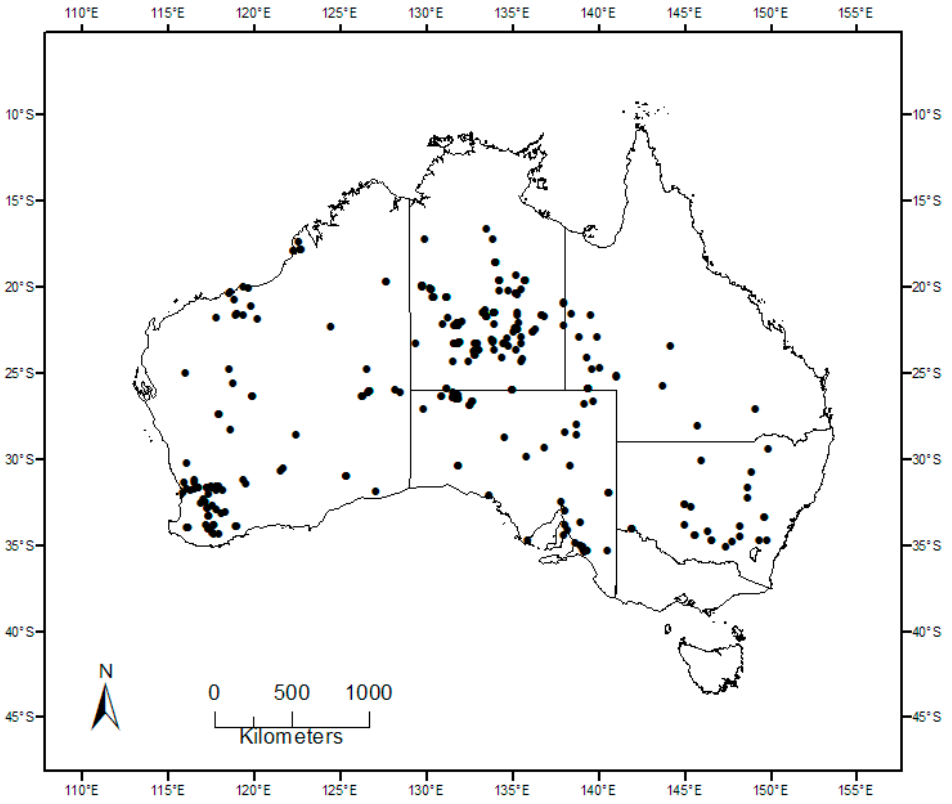
1. there are > 10 sub-populations
2. the largest sub-population is c. 1,900 (mature individuals?)
3. the number of mature individuals > 10,000 and is decreasing
4. the Area of Occupancy is ca 2,150 km2 and is decreasing
5. the Extent of Occurrence 3,100,000km2 and is decreasing

These assumptions beg questions about what the actual baseline measures were for the year 2012? Where is the largest sub-population; that estimated to be about 1,900 individuals was Scotia Sanctuary? Is there a wild sub-population that is larger? If so, what are the spatial boundaries for that sub-population? What are the spatial boundaries for the definition of Area of Occupancy?

These points also reinforce questions that will need to be addressed about how to improve and standardise our methods for measuring population parameters so that it is possible to obtain repeatable monitoring measures and report on trends.

The coarsest measures of population trends are provided by changes in mapped locations of bilby occurrence during sequential periods. The three distribution maps provided in the recovery plan (Pavey, 2006) are included below. Unfortunately, these maps do not identify areas searched but with negative results. There is therefore no indication of overall search effort, or of areas not searched.

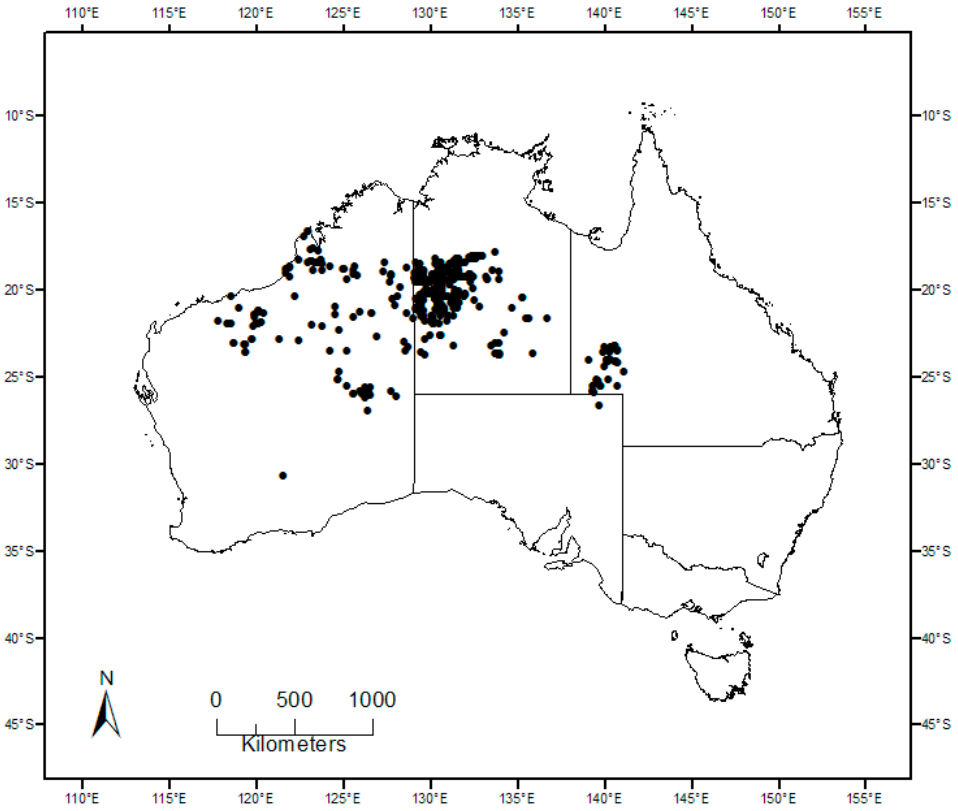
A. Records of the occurrence of the Greater Bilby up to and including 1970



This map highlights the widespread distribution of the Greater Bilby (*sensu lato*) at the time of European arrivals. At this scale, there are indications that the (sub-)populations in south-west Queensland were historically connected with those to the SW (into SA) and to the NW (into the NT) - refer to the paper by Craig Moritz (et al. 1997).

Figure 19. Map A

B. Records of the occurrence of the Greater Bilby for the period 1971 to 1990



Comparison of this map with Map A shows that contractions in the bilby's range before 1970 occurred mainly from the southern 'half' of the bilby's range. This map (Map B) highlights the peak fieldwork period for AZRI (especially Rick Southgate; Geoff Lundie-Jenkins & others) in the Tanami Desert and CALM WA (Burbidge, Fuller, Pearson, Friend, etc.) in northern Western Australia, plus survey and research activities in SW Queensland (especially Peter McRae's work).

Figure 20. Map B

C. Records of the occurrence of the Greater Bilby from 1991 to 2004

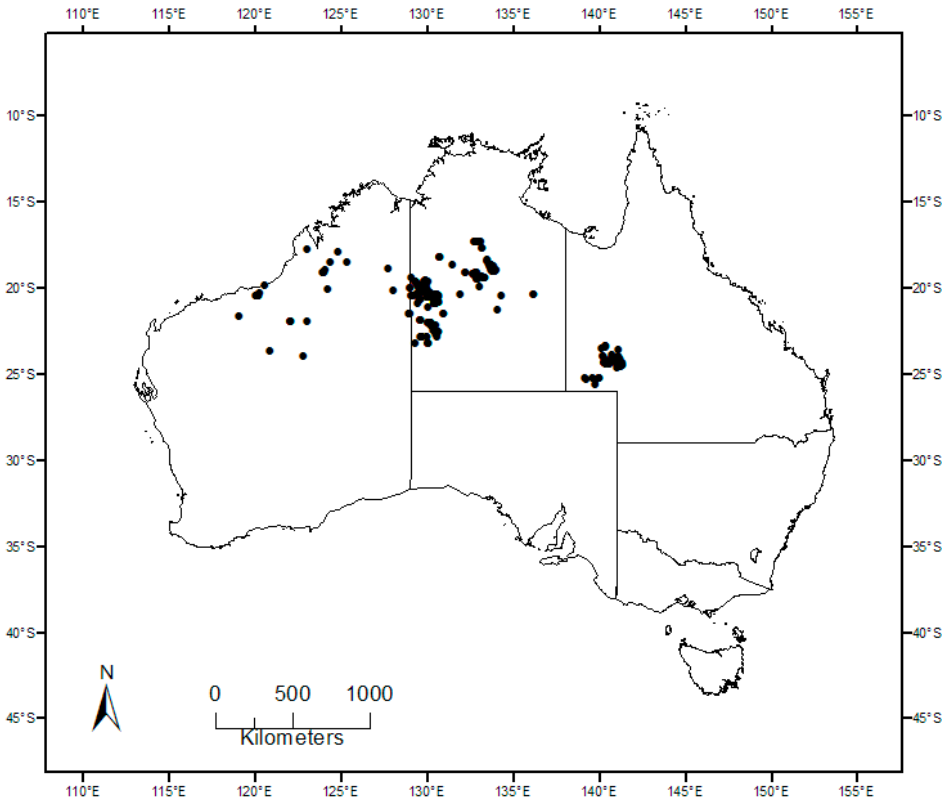


Figure 21. Map C

This map (Map C) suggests further range contractions northwards after 1990.

The distribution clusters also highlight research, monitoring and management efforts in SW Queensland and mostly EIS-related surveys for mining proposals in WA and NT.

It is important to update this map and identify known but "missing" records and to identify the losses from this distribution since 2004. It is also important to include locations searched, but with negative results (apparent absences)

In future it would also be useful to identify regular monitoring sites versus random records.

Re-introduced (free-ranging, fenced and island) sub-populations also need to be added to indicate the current Extent of Occurrence, as these sites add considerable environmental diversity (in terms of latitudinal breadth and habitat types).

Also, as points for further discussion, we need to note that *The Action Plan for Australian Mammals 2012* (2014) cites bilby sub-population estimates:

- for WA as 5-10,000
- for the NT as <1,000 and
- for SW Qld as 200-500.

Extent of Occurrence

We still seem to have difficulty in agreeing upon boundaries (or defined extremities of distribution) to use as baseline measures for both 'area of occupancy' and 'extent of occurrence'.

The closest we have been to having such limits defined are some of Rachel Paltridge's established southern monitoring 'sites'.

The Action Plan for Australian Mammals 2012 states that the Extent of Occurrence is > 20,000 km^2 on the basis of a calculated (estimated) EoO of 3.1 million km^2, that is presumed to be decreasing. The mapping upon which these estimates are based should be obtained by the bilby recovery team for future reference.

Area of Occupancy

The Action Plan for Australian Mammals 2012 (2014) suggests that the Area of Occupancy AoO for the bilby is "unlikely to be < 2,000 km^2" on the basis of a calculated (estimated) AoO of 2,150 km^2 that is also presumed to be decreasing. This estimate also includes an assumption that the "number of sub-populations is > 10".

This suggests that the authors of the action plan have maps that could potentially be used as baselines for future reporting on trends in distribution. But, how should we monitor area of occupancy? Where are such measures feasible? These questions reflect back onto earlier questions about how we define "sub-population" and "areas occupied".

2. Maintain sustainable sub-populations on Thistle Island and within mainland islands

As part of the baseline mapping and calculations of EoO and AoO, it is important that the re-introduced (free-ranging, fenced and island) sub-populations of bilbies are included. It is also important that monitoring of trends is standardised as much as possible across all sites.

3. Monitor Bilby numbers and numbers of introduced predators at key sites throughout current range

A significant issue for the summit and any ongoing recovery team to address is that of developing agreed monitoring and analysis methods and protocols (frequencies; intensities) across key sites. This still requires considerable investment in adaptive management research to firstly test, and then establish, agreed techniques, bearing in mind that a significant opportunity for implementing management and monitoring protocols for remnant wild sub-populations will be through Indigenous Ranger teams. This will require either expanding existing, or establishing new research partnerships.

4. Continue to develop effective Red Fox and feral Cat control technologies and apply at key sites

This will require adaptive management trials of both control technologies and monitoring techniques to define thresholds of what constitutes 'effective' control of either foxes, cats, or both. This may also involve experimenting with habitat management through the use of prescribed fire.

5. Maintain captive colonies

To date, as well as providing animals for releases into fenced mainland islands and onto Thistle Island, the conservation breeding program for the bilby has provided excellent background and guiding data on bilby reproductive behaviours and population genetics.

As an ongoing, integral part of the recovery effort, there is now a need to update and re-establish a clear statement of purpose that differentiates between:

- Insurance populations
- Source for reintroductions
- Research
- Education

Implementation / Coordination of Conservation Action

A critical objective of the bilby recovery plan (2006) that was not highlighted in *The Action Plan for Australian Mammals 2012* (2014) was the need to establish and maintain national coordination of the recovery effort for the bilby. Such coordination existed through part-time facilitation by the National Threatened Species Network's (TSN) arid zone coordinator during the late 1990s and early 2000s. Through that coordination there were annual recovery team meetings and the implementation of the recovery plan's actions were reviewed and priority actions were revised. Since the disbanding of the TSN, there has been little coordinated effort at the national scale; the clear exception being the excellent work of ARAZPA (now ZAA) in managing and updating the captive population and its associated databases. As a consequence of the lack of national coordination, the recovery team has faltered and communication between (former) partners has only occurred informally and very rarely. There has been little alignment of priorities and funding has been limited.

If the recovery of the bilby is to be taken seriously, then a crucial first step is the reconstitution of a national recovery team and the appointment of an appropriately-resourced national recovery team coordinator / facilitator.

There is also a need for the business of such a recovery team to focus on progressing the implementation, and ongoing review, of the national recovery plan. Recovery team meetings should therefore have agendas based around the objectives and actions identified in the recovery plan, with minutes of the meetings acting as ongoing progress reports on the plan's implementation.

Ongoing challenges to implementation of the recovery plan include:

- Logistical issues around
    a. The vast areas of desert where remnant sub-population fragments occur
    b. The remoteness of most remnant bilby sub-population fragments with limited track access
    c. The costs associated with working in such areas
- Knowledge gaps around
    a. The current distribution of bilbies (EoO and AoO)
    b. The relative importance of different habitat types, especially with respect to bilby susceptibility to predation
        i. Vegetation cover / density
        ii. Fire extent, severity and frequency
    c. Effective techniques for controlling feral cats and foxes
    d. Effective monitoring and analysis techniques for determining trends in the wild bilby population with respect to habitat and predator management regimes
- Establishing and maintaining effective partnership
    a. With Indigenous Ranger teams
    b. With research institutions and relevant academics

Conclusions

There has been an ongoing national conservation effort for the bilby for more than 30 years. This has resulted in:

- Peer-reviewed publications that cover all aspects of bilby biology and ecology
- Indigenous Ranger projects that are contributing to remote area actions
- A conservation breeding program that has supplied genetically diverse bilbies for establishing additional sub-populations and maintained very good baseline records
- Additional sub-populations at 6(+) locations, increasing geographic spread (EoO)

However, there are still numerous issues that need to be addressed, not the least of which is to determine what management prescriptions need to be implemented to turn around the ongoing decline of the remaining wild bilby population.

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APPENDIX IV:
The Greater Bilby in Queensland

Liana Joseph

Overview

Description

- Bilbies exist in the wild in the following blocks of western Queensland (north to south): Springvale block, Diamantina National Park, Coorabulka block, Astrebla Downs National Park, Cluny Block, Palparara block, and Birdsville Block (Figure 22).
- Bilbies have been reintroduced into predator-free enclosure in Currawinya National Park.

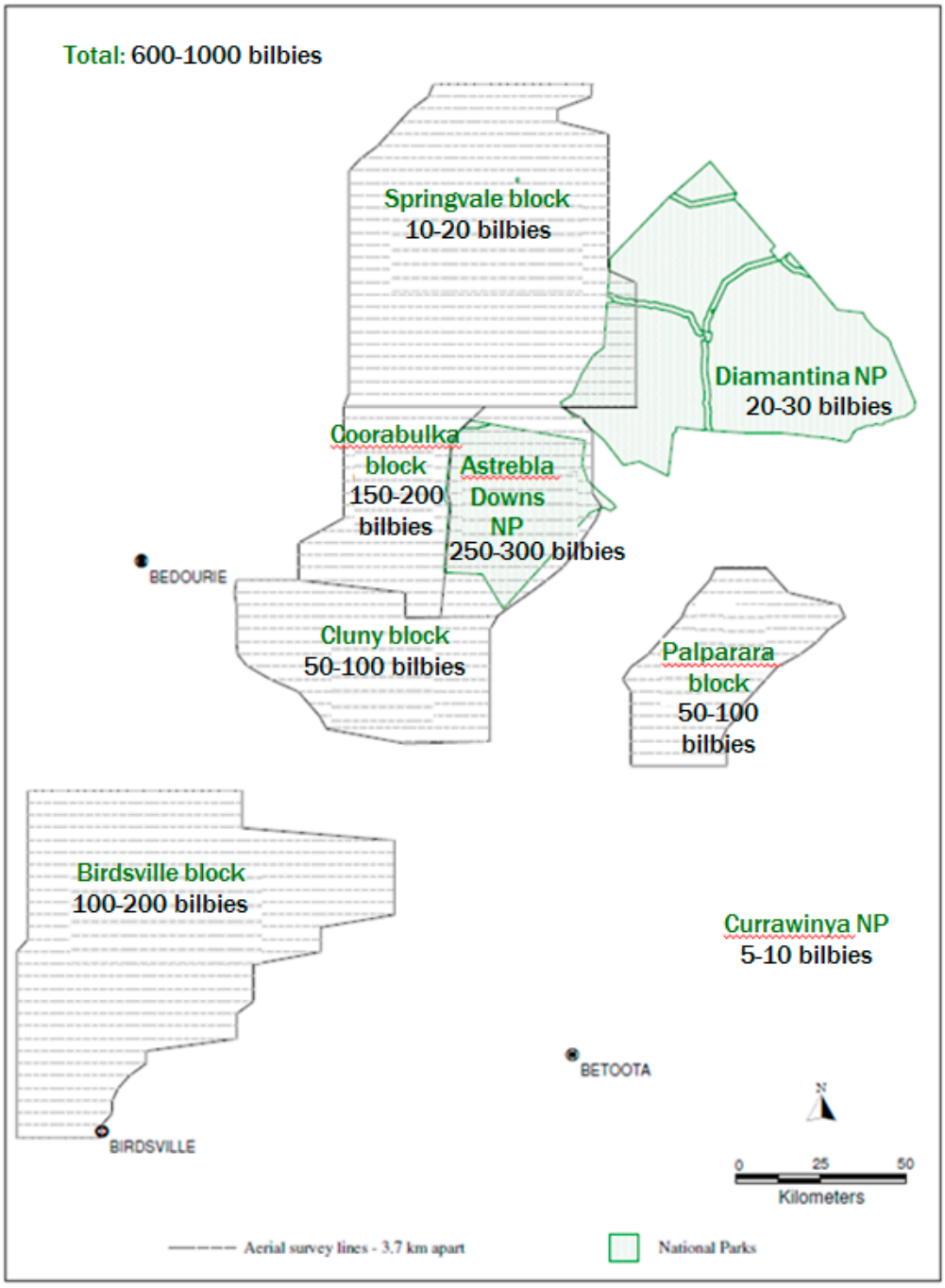

Figure 22. Current location and approximate sizes of Greater Bilby sub-population fragments in south-western Queensland.

Description of the threats

- The biggest threat to greater bilbies in Queensland is cats, especially during plague times.
- Cattle and Sheep pose a moderate threat to bilbies caused by overgrazing during harsh times resulting in changes in insect fauna and through overstocking and compaction of soils leading to poor vegetation.
- Artesian bores and tanks are bringing water to areas that have never had permanent free water before. The open water results in increases in cats and dingos putting pressure on the bilbies.

Status of the sub-population in 2006

- In 2006, the number of bilbies in Queensland as relatively high as it had been 10 years since the last cat plague (i.e. 1996) and the bilby sub-population had stabilised.
- The number of bilbies in 2006 is estimated as being between **1000-2500**.
- This estimate is based on the sum of estimated numbers for each of the eight sub-population fragments: Springvale block (10-20 bilbies), Diamantina National Park (20-30 bilbies), Coorabulka block (200-300 bilbies), Astrebla Downs National Park (500-1500 bilbies), Cluny Block (100 bilbies), Palparara block (100-200 bilbies), Birdsville Block (100-200 bilbies), and Currawinya National Park (30-50 bilbies).

Status of the sub-population in 2015

- The number of bilbies in south-western Queensland are currently recovering after a severe cat plague in 2012.
- The number of bilbies in 2015 is estimated as being between **600-1000**.
- This estimate is based on the sum of estimated numbers for each of the eight sub-population fragments: Springvale block (10-20 bilbies), Diamantina National Park (20-30 bilbies), Coorabulka block (150-200 bilbies), Astrebla Downs National Park (250-300 bilbies), Cluny Block (50-100 bilbies), Palparara block (50-100 bilbies), Birdsville Block (100-200 bilbies), and Currawinya National Park (5-10 bilbies).

Priorities

- The highest priority for bilby conservation in Queensland is to continue to be aware of cat numbers and respond appropriately including maintaining shooting programs and trailing baiting programs.
- In 2015, a priority is to remove all cats from the predator-free enclosure in Currawinya National Park and supplement bilby numbers with captive bred animals.
- Identifying and establishing colonies at new sites is an upcoming priority.
- Maintaining and increasing captive bred colony for supplementing new and existing reintroductions.
- Gaining a better understanding of distribution and sub-population size within Queensland.

Opportunities and impediments

- As with most conservation challenges, lack of resources is an impediment to effective and timely conservation of bilbies in Queensland.
- Maintaining and establishing new partnerships (e.g. AWC, zoos, Save the Bilby Fund) is a priority for future bilby conservation.

Springvale block (Springvale, Lorna Downs and Canary)

Description of the area

- Mix of stony country and cracking clay. Bilbies tend to be mainly in the cracking clay.
- Cattle on Springvale and sheep on Lorna Downs and Canary: 3 property owners
- Very large block: 82 km x 96 km
- Adjacent to Currabulka and <20 km north of Astrebla Downs NP
- Small, fragmented colonies of bilbies. Highest density of bilbies is found in the southern parts of Springvale.

Description of the threats

- Cat plagues is the main issue.

Status of the sub-population fragment in 2006

- Situation was probably much the same as now: 10-20 bilbies (see below).

Status of the sub-population fragment in 2015

- The top end of Springvale block didn't have any active sites in 2000 and is likely to be the same now (there were five sites that were active in 1994). The southern part of the block is fragmented further.
- There is approximately 10-20 bilbies in the very southern part of Springvale block (which is <20 km north of Astrebla Downs NP).

Management

- No bilby management

Research activities

- No bilby research

Emerging issues

- This small and highly fragmented sub-population fragment is highly likely to become locally extinct in the near future.

Current priorities

- None

Diamantina National Park

Description of the area

- Mixture of sand dunes and cracking clay. On the southern boundary is a calcrete mound (limestone outcrop).
- National Park

Description of the threats

- Cats.
- Cattle (fences are good, maintaining fencing) – probably ~200 head, talk with the station owners, will round them up and move them back.

Status of the sub-population fragment in 2006

- Probably would have looked much the same as now: 20-30 bilbies (see below).

Status of the sub-population fragment in 2015

- The sub-population fragment is likely to have been affected by the 2012 cat plague.
- Small group on the southern boundary with Davonport Downs with about 20 bilbies. Tulka waterhole and Mungeroo Knobs is about 20-30 bilbies.

Management

- Cat Shooting
- Park rangers are monitoring bilby sites.

Research activities

- No research.

Emerging issues

- None.

Current priorities

- Keeping cat numbers down.

Coorabulka block (CB)

Description of the area

- Cracking clay and Mitchell grass, barren landscapes ("bad lands"), 209 ml annual rainfall.
- Leasehold, NAPCO, 8000 head of cattle depending on season.
- 40 km from Astrebla Downs NP
- 637,000 ha
- A well-managed cattle property that is managing the land in a way that is suitable for bilby.

Description of the threats

- Cat plagues is the main issue. Unlikely to be many cats during harsh environment conditions.
- Cattle not an issue as they are managed well.

Status of the sub-population fragment in 2006

- In 2006, the sub-population fragment was relatively stable and varied due to environmental variation.
- In 2006, there were approximately 200-300 bilbies.

Status of the sub-population fragment in 2015

- The sub-population fragment is likely to have been affected by the 2012 cat plague.
- Guessing that bilby numbers have dramatically declined, it is likely that the number of bilbies is <200.

Management

- No bilby management

Research activities

- No bilby research

Emerging issues

- No major emerging issues of concern.

Current priorities

- Continue to do surveys every 5 years.
- Provide assistance during cat plagues to reduce cat numbers.

Astrebla Downs National Park (SP)

Description of the area

- Cracking clay, Mitchell grass
- Land tenure – National Park
- 170,000 ha

Description of the threats

- Cat plagues.
- Cattle (fences are good, maintaining fencing) – probably 30 head, talk with the station owners, will round them up and move them back.

Status of the sub-population fragment in 2006

- In 2006, the sub-population fragment was stable and wasn't under any major threat, it was just oscillating according to environmental conditions.
- In 2006, there were approximately 500-1500 depending on the conditions (best time for bilbies is the harsher times as there is very little predation).

Status of the sub-population fragment estimate in 2015

- The sub-population fragment underwent a considerable decrease over recent years because of the cat plague of 2012. In 2012, >100 bilbies (majority would be juvenile) were found in the stomach contents of cats.
- A rough estimate of the number of bilbies is 300 in Astrebla Downs National Park (intensive aerial surveys in May).

Management

- Cat shooting. Do trips out intermittently to assess and shoot cats.
- Cattle removal. Work with cattle owners to remove last few cows.

Research activities

- Peter McRae, 2004, "Aspects of the Ecology of the Greater Bilby in Queensland".
- Lesley Gibson, PhD student in Astrebla NP (1999), Ian Hume supervisor, "Nutritional Ecology of the Greater Bilby in far-western Queensland".
- PhD student (incomplete), Russel Palmer, Diamantina and Astrebla, 1993/1995.
- Cat research – a guy from DNR , 1993/1995.
-

Emerging issues

- No emerging issues.

Current priorities

- Cat management unit to be ready to go as soon as increase in cat numbers are detected.
- New facilities to make it comfortable for people to work out there.

Cluny block (CLY)

Description of the area

- Mix of land types: stone country, cracking clay, dunes
- Small area that is suitable for bilby on the cracking clay.
- One leasehold property.
- 2842 km^2

Description of the threats

- Cat plagues is the main issue.
- Cattle not an issue as the property managed well.
- Free standing water sources is potential a major threat on Cluny.

Status of the sub-population fragment in 2006

- The sub-population fragment at this time was probably pretty stable and changing with natural environmental variation.
- In 2006, the number of bilbies was likely to be around 100 bilbies.

Status of the sub-population fragment estimate in 2015

- At the moment, the sub-population fragment is likely to be recovering from cat plague in 2012. The bilbies are quite close to drainage lines which makes them quite susceptible to cat predation.
- The area for bilby is about 1000 km^2 with probably <100 bilbies.
- Very fragmented.

Management

- No bilby management.

Research activities

- No bilby research.

Emerging issues

- Increase free water sources.

Current priorities

- Establish extent of free water sources.

Palparara block (Palparara and Davonport Downs)

Description of the area

- Treeless, cracking clay
- narrow area; 70km x 31km
- gas pipeline through it
- Owned by Macquarie Bank.
- Approximately 12km east of the Diamantina River system
- An important sub-population fragmentbecause it is isolated from the main block of bilbies around Astrebla by the Diamantina River system to the west and a series of major waterways to the north.
- Is likely to be the most easterly sub-population fragment of bilbies in Queensland.

Description of the threats

- Cat plagues.
- Cattle
- Open water sources: two new bores.

Status of the sub-population fragment estimate in 2006

- In 2006, the sub-population fragment was probably relatively stable but varying according to environmental conditions.
- In 2006, there was likely to be 100-200 bilbies.

Status of the sub-population fragment estimate in 2015

- At the moment, the sub-population fragment is likely to be recovering from cat plague in 2012.
- Currently, there is likely to be <100 bilbies.

Management

- No bilby management.

Research activities

- No research activities.

Emerging issues

- Increase in free water.

Current priorities

- Establish extent of free water sources.

Birdsville block (BVL)

Description of the area

- Stony, gibber country
- 8 leasehold properties in 250 x 350 km2 area.
- Well-managed cattle properties that is managing the land in a way that is suitable for bilby.
- An important sub-population fragment because it is isolated from the main block of bilbies around Astrebla. These bilbies are separated from other sub-population fragments because of a large area of Lake Machattie, clay pans and extensive dune fields.

Description of the threats

- The Birdsville block doesn't suffer from the rat/cat plagues due to the local conditions that are not suitable for rats or cats. Stony country in Birdsville block is too stony for grassy vegetation, so not enough feed for rats which results in less fluctuation in bilby numbers or rats and cats.
- Properties owned by big-businesses (e.g. Macquarie Bank, the Kidmans, NAPCO) that can afford to move their cattle or sheep off during harsh conditions. Compared with Canary and Lorna Downs, which has lots of smaller property owners that have to keep their cattle on the land during the harder times.
- Artesian bores and tanks are bringing water to areas that have never had permanent free water before. The open water results in increases in cats and dingos and a decline in bilbies.

Status of the sub-population fragment in 2006

- A rough estimate of the number of bilbies found in in 2006 was is 100-200 bilbies (20-300). Average density of burrows was ~ two burrows/km^2.
- In 2006, the sub-population fragment was stable and not under changing threat.

Status of the sub-population fragment in 2015

- Currently, the sub-population fragment is stable. Birdsville sub-population fragment was affected to a much lesser extent by cats because it is unsuitable stony country.
- A rough estimate of the number of bilbies found in is 100-200 bilbies (20-300).

Management

- Generally not much need for on-ground management in the Birdsville block. No current management of bilbies in the Birdsville block.
- Peter McRae doing ground surveys (Palpara, Cluny, Springvale, Birdsville, Coorabulka)
    - Revisiting all the way-points that were visited in 1993/1994 and 1999/2000.
    - Count bilby pellets, recent and old burrows, recording whether they're still there or not there.

Research activities

- No research activities in Birdsville block.

Emerging issues

- Increasing free water: Increasing bores and tanks, increasing road dams along new road works (roadworks – digging up gravel and soil to put on roads – end up with road dams).
- Poisoning dingos. At the moment, there is probably a good natural (low) level of dingos but there is concern that the dingos are being persecuted too much and may result in meso-predator release.

Current priorities

- Designing something to keep cats and dogs out of water tanks while allowing cattle to use them.
- Designing "road-dams" in such a way to reduce permanence of the water.

Currawinya National Park

Description of the area

- Currawinya National Park is the only site in Queensland where greater bilbies have been re-introduced into the wild
- The park is 1,513 km^2
- Dunes and mulga scrub

Description of the threats

- The biggest threat to bilbies at Currawinya National Park is cats, especially during plague times.

Status of the sub-population in 2006

- In 2006, the predator free fence was operational; the number of bilbies was increasing from 6 in 2005 to ~300 in 2012.

Status of the sub-population in 2015

- In 2012, the predator free fence was damaged a breached.
- There are currently fewer than 10 bilbies in the fenced area at Curawinya. At least 3 people have seen bilby tracks on the ground but no one has observed a bilby.

Management

- In 2001, a predator free fence was competed on Currawinya.
- After removal of predators and drought on Currawinya, bilbies were released in 2005.
- This fence is of a special design, with tight mesh to prevent any predator from squeezing through, an outward-hanging top section to prevent cats from climbing over, and a buried skirt that prevents predators from burrowing in (and greater bilbies from burrowing out).
- Over subsequent years, the bilby sub-population within the fenced areas grew to approximately 300 individuals.
- In 2012, the fence was damaged and cats got into the enclosure. The bilby sub-population was reduced from approximately 300 to fewer than 10 bilbies.
- The fence has been repaired? QPWS now maintains the fence on Currawinya NP.
- There are currently approximately 6 cats within the fenced area.
- The next action is to remove the remaining cats from the enclosure. Steve Austin, a dog trainer with experience of eradicating cats from Macquarie Island, will be working with EHP to eradicate cats in March 2015.
- A captive breeding, led by Vere Nicolson at Dreamworld, is breeding up bilbies for release into Currawinya to improve and maintain the genetics of the sub-population.

Research activities

- Jean-Marc Hero is conducting research at Currawinya.
- UQ researcher is beginning a research project on using drones to remotely detect cats.

Emerging issues

- None

Current priorities

- Maintain fence and maintain captive breeding program.

APPENDIX V:

The Greater Bilby in South Australia

Peter Copley

SA Department of Environment, Water and Natural Resources

Former South Australian Distribution

At the time of European settlement the Greater Bilby had a widespread distribution in South Australia that is thought to have excluded the area south and east of the River Murray and all offshore islands, including Kangaroo Island.

Last records of wild Bilbies in South Australia

The last extant records of this species for South Australia appear to have been in the north-west of the State where 49 specimens were collected by three museum collectors (RM Williams, HH Finlayson and NB Tindale) between 1928 and 1934. By 1961, Finlayson (1961) observed that the bilby that was "formerly one of the most plentiful and universally distributed of central Australian mammals … was rapidly being reduced to the status of a rare form [that had been] completely eliminated from much of the [southern part of their arid range] in the [previous] 25 years, by the fox".

Interviews undertaken with local Aboriginal elders suggest that the species became extinct from the south and east of that region (now known as the Anangu Pitjantjatjara Yangkunytjatjara (APY) Lands) during the droughts of the 1930s and early 1940s, but that a few survived in the north-west corner of the State (near Kalka) until at least the 1960s (see Copley, et al. 2003).

Re-introductions of Bilbies to South Australia

A national captive breeding program was established for the bilby in the mid-1990s (managed through Zoos SA at Monarto Zoological Park) and this provided animals for releases to protected sites within parts of their former range. Three of these release sites are areas that have been fenced to allow eradication and ongoing exclusion, of rabbits, foxes and cats – two as totally-fenced mainland 'islands' (Yookamurra Sanctuary and Arid Recovery Reserve); the other, a coastal peninsula (Venus Bay Conservation Park). The fourth site, Thistle Island, was chosen for the higher levels of biosecurity it presented in terms of exclusion of rabbits, foxes and cats.

Figure 23. South Australian Bilby Release Sites and current estimates of numbers present at each site ([1] More information provided in separate papers at summit)

Site	Area (Ha)	First Releases	Est. Numbers March 2014-15*
Yookamurra[1]	1100	1996	125
Thistle Island	3900	1997	500
Arid Recovery[1]	6000	2001	500
Venus Bay	1400	2001	<10

See also *The Action Plan for Australian Mammals 2012* pp. 203-207.

Monitoring

The bilbies at Yookamurra Sanctuary are monitored twice-yearly using spotlighting-distance-sampling. Those at Arid Recovery are monitored approximately quarterly using relative frequency of tracks counted on established sandy drag-lines. The few remaining bilbies at Venus Bay Conservation Park are currently being monitored incidentally by camera-traps that have been established to determine feral cat numbers within the fenced peninsula as a precursor to a cat control trial. The Thistle Island bilbies are not currently monitored. However, there are holiday houses on the island and regular reports on the bilbies' continued presence are provided through people visiting these houses.

Trends

The bilby sub-populations at Thistle Island, Yookamurra Sanctuary and Arid Recovery Reserve are all relatively stable, with their relative abundances fluctuating primarily in response to seasonal conditions that drive local productivity. The sub-population at Venus Bay peninsula however, has declined substantially in recent years due to the presence of a significant number of feral cats within the fenced area. There has been no recent evidence of recruitment of juvenile / sub-adult bilbies, but the camera-traps have recorded a bilby at different extremities of the peninsula on 2 December 2014, 14 February and 19 February 2015.

Acknowledgements

Kylie Piper provided information on bilby numbers and trends at Arid Recovery, Leah Kemp provided general information for Yookamurra Sanctuary and Liz McTaggart supplied updates for both Venus Bay and Thistle Island.

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APPENDIX VI:

The Greater Bilby in New South Wales

Mike Fleming & Sarah Pizzey

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The Wild Population in NSW

Bilbies are extinct in the wild in NSW. They were previously distributed throughout NSW west of the Great Dividing Range with an outlying sub-population fragment near Goulburn. They had largely disappeared by 1912 with the last record from Wagga Wagga.

The Captive Population in NSW

There is one sub-population in NSW that is part of the captive population. This is at “Scotia” Sanctuary within predator proof enclosures and number about 1200 animals. They are managed by Australian Wildlife Conservancy.

The Fenced Population in NSW

There is one sub-population in NSW that is part of the fenced population. Four animals are held by Taronga Zoo at their Western Plains facility. All of these animals are derived from translocated Bilbies from central and western Australian.

Future Introductions / Translocations

The NSW Government intends to partner with experienced conservation organizations to reintroduce locally extinct mammals into predator-free fenced enclosures of several thousand hectares. The overarching objective for this new project is the restoration of ecosystem health through the establishment of viable numbers of reintroduced mammals including the Bilby. The long-term aim is to create conditions outside the fenced enclosures to allow the establishment of bilbies (and other mammals) beyond the fences.

APPENDIX VII:
The Greater Bilby in Western Australia

Dr Manda Page

Principal Zoologist

Western Australian Department of Parks and Wildlife

Species Status, Distribution and Abundance

Bilbies were listed as rare or likely to become extinct under the Western Australian *Wildlife Conservation Act 1950* in 1973. They are classified as Vulnerable using IUCN criteria.

Bilbies were formerly recorded over most of the State but are currently restricted to the Pilbara, Southern Kimberley and Goldfields Regions (deserts) (Figure 24). The abundance of bilbies across the distribution is unknown but they are generally considered to be in low abundance.

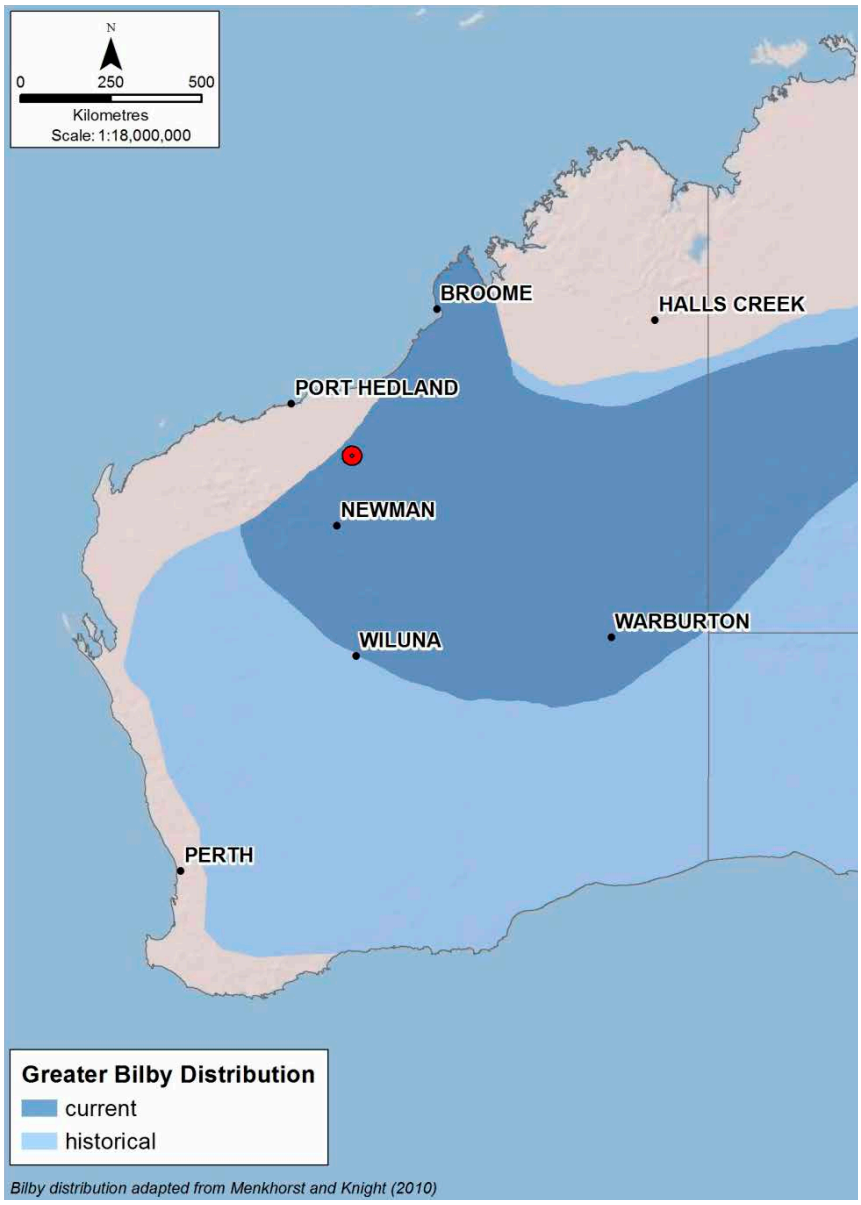


Figure 24. Current and historic distribution of bilbies in Western Australia.

Bilby records across a Western Australia are provided in Figure 24 including pre and post 2006 records, and fossils and subfossil records. The source of these records include:

- Threatened and Priority Fauna Database; includes observations and anecdotal records, the records of the WA Museum, and Parks and Wildlife survey records.
- Fauna Survey Returns; presence data from scientific license returns which are required as a license condition.
- Pilbara Threatened Fauna Database; database set up by Martin Dziminski as part of the Pilbara bilby research project funded by offsets.

Note there are a number of limitations associated with the Western Australian records (Figure 24) including that they only represent species occurrence, they rely on sources that have varying degrees of accuracy, quality and completeness, are biased by survey effort and include no information on methods. There are no null or negative records captured so where there is no record does not necessarily mean that bilbies are not present, it may simply indicate that there has been no survey effort at that location. In addition, scientific license returns do not always report observation, sign or photographs from remote cameras so not all records may be captured. The Pilbara Threatened Fauna Database is an attempt to capture such records.

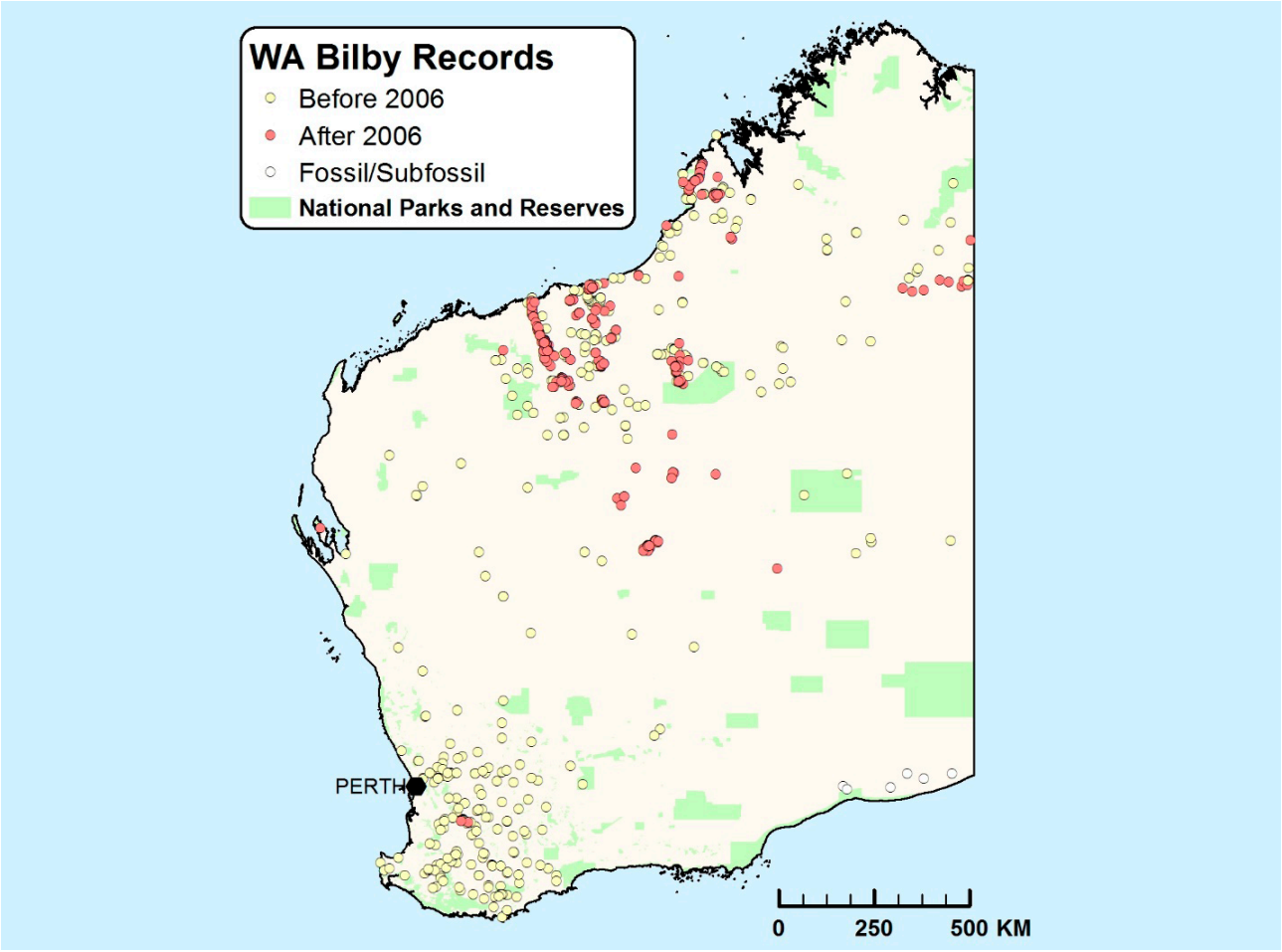


Figure 25: Western Australian bilby records including before and after 2006, and fossil/subfossil records.

Recovery plan actions

Below is a list of the relevant actions from the current Bilby Recovery Plan (Pavey 2006) and the progress made in Western Australia to date.

Reduce impact of predation by introduced carnivores

Fox control is undertaken at some sites in Western Australia under the Western Shield program however there are limited records of bilbies on the conservation estate where Western Shield is primarily focused. A bigger issue is likely to be predation by feral cats. The Department of Parks and Wildlife have recent registered Eradicat ©, a bait targeted atferal cat control. The specific sites for early operational use and continued experimental use of this cat bait is being developed and may have some implications for bilbies.

Maintain genetic diversity through number and size of remnant sub-population fragments

The size and number of sub-population fragments in Western Australia is generally unknown as is genetic diversity with and between 'remnant' sub-population fragments.

Maintain genetic diversity through managed captive breeding program

The Department of Parks and Wildlife are not actively involved in any captive breeding programs at present as it is not considered a priority recovery action for the species in Western Australia to undertake reintroductions of captive bred animals. There are some non-government organisations that are involved or can potentially be involved in a managed captive breeding program however the State Government currently has no capacity to dedicate resources to such programs.

Establish self-sustaining sub-population fragments

There have been four attempts in Western Australia to establish self-sustaining bilbies since the inception of this Recovery Plan. Two are considered to have been successful (Matawa and Shark Bay) and two are considered to have failed (Dryandra Woodland and Upper Warren). The failed attempts were mostly attributed to predation and possible fitness of captive bred animals.

Monitor trends in occurrence and abundance

In Western Australia monitoring has been initiated at a small number of sites in Pilbara in association with offset conditions. The development of new survey and monitoring techniques are also being undertaken in the Pilbara. In addition it is recognized that a number of Traditional Owners and/or Indigenous Ranger Groups are undertaking monitoring. However, there is an issue relating to the provision of data from these surveys and monitoring.

Assess impact of threatening processes

The Department is not aware of any specific projects/programs assessing the impact of threatening processes specifically impacting bilbies in Western Australia.

Inform and involve community

There is little opportunity to involve the broader community in bilby related recovery programs in Western Australia mostly due to the remoteness of the species. Increased involvement of specific groups such as Traditional Owners and Indigenous Ranger Groups is observed but linking this into the recovery program for the species needs attention. Some non-government organisations undertake excellent school education programs that include the bilby.

Western Australia's Priority Bilby Recovery Actions

- develop survey and effective monitoring methods.
- survey and better understand the distribution of the species, including relationships to habitat, threatening processes etc.
- monitor wild populations for trends and responses to the manipulation of threatening processes (such as introduced predator control efforts, fire regimes etc.)
- improve coordination to capture data and coordinate recovery efforts.

However, it is recognised that there are several impediments to undertaking and achieving these actions, including:

- Lack of importance placed on threatened species recovery at both State and Commonwealth level. This is reflected in a lack of funding opportunities for threatened species programs at present.
- Limited funding and/or reliance on mining related resources only for survey efforts.
- Small isolated population over a very large areas means that survey and recovery efforts are challenging.
- Land tenure and access is an issue as there are few if any records of bilbies on the conservation estate.
- Lack of coordination including no active recovery team and an out-dated Recovery Plan.

On a more positive note there is a range of current or proposed projects currently being undertaken in Western Australia including:

- Conservation and management of the bilby in the Pilbara.
- Matawa reintroduction continuation.
- Mt Gibson (Australian Wildlife Conservancy Sanctuary) proposed reintroduction.
- Site specific management/monitoring project associated with offsets or conditions.
- Traditional Owner management and monitoring programs.
- Indigenous ranger programs including survey and monitoring.
- PhD research project on habitat use in Kimberley.

Note there are likely other works being undertaken that Parks and Wildlife are not currently aware of.

APPENDIX VIII:

The Greater Bilby in the Northern Territory

Simon Ward

Director Species Conservation

Flora & Fauna Division, Department of Land Resource Management, Northern Territory Government

Distribution in the Northern Territory

- Range of the bilby is continuing to contract
- Most records now west of Stuart Hwy, north of Yuendumu
- Stronghold in the palaeo-drainage lines in the Tanami Desert (Sangsters's bore area)
- Mostly on Indigenous-owned lands

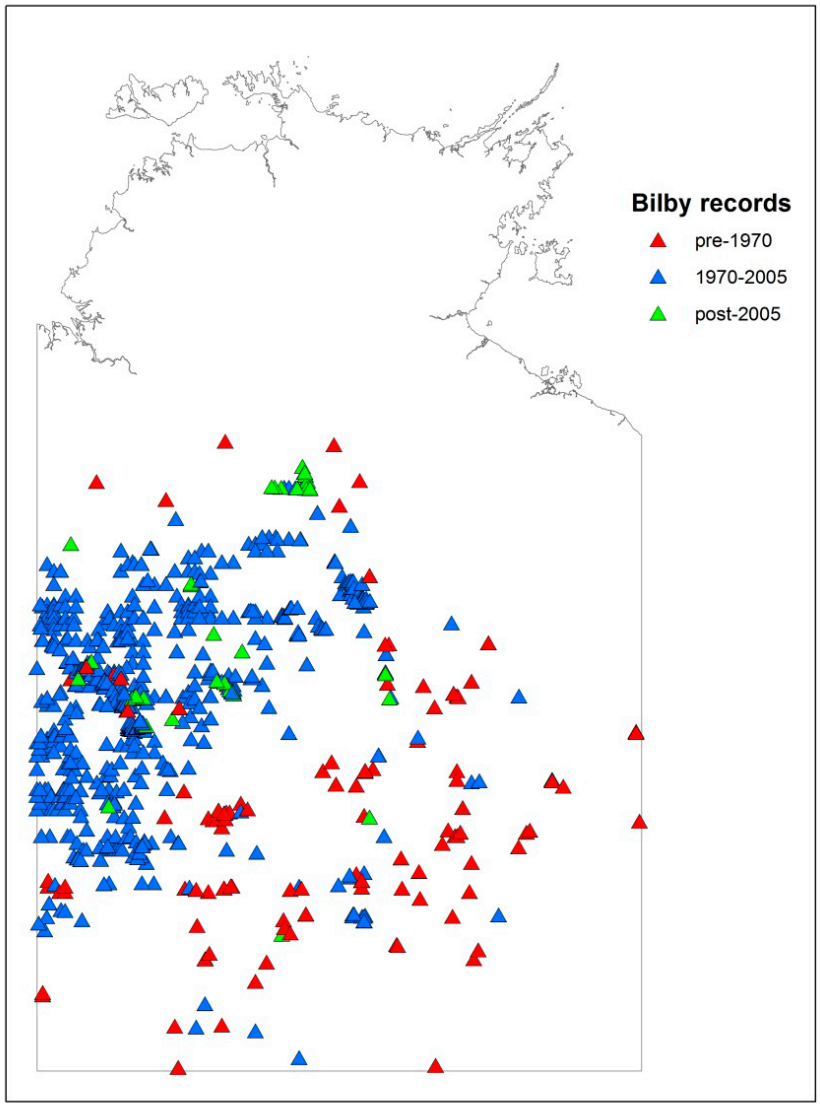


Figure 26: Bilby Records from the N.T. Government's Fauna Atlas database.
Note this may not include all recent records from the Tanami Desert.

- The southern edge of bilby distribution has contracted north by 200km in the past 20 years:
  - In the 1990s bilbies occurred as far south as Kintore
  - By 2004 Nyirripi was the southern edge of bilby distribution in the N.T.
  - There have been no records of bilbies south of Sangsters Bore since 2009
- In contrast, there has been little change to the northern edge of bilby distribution in the N.T.

Previous Work in the N.T. (1980s-90s)

- Foundation studies on distribution, diet, behaviour, ecology in the 1980s & 90s (Rick Southgate)
- Captive breeding
- Reintroductions to Watarrka and Simpson's Gap – both unfenced; both unsuccessful

Central Land Council projects in the NT (2000-2013)

- Central Land Council & Desert Wildlife Service– studies of bilby and predator activity and persistence
  - Trialling of fox-specific bait delivery at Sangster's Bore
  - Fire management in the Tanami Desert
  - 2008-10 surveys around the edges of range in the NT
- AWC and Desert Wildlife Services continuing trials of fox-specific bait delivery systems at Newhaven Sanctuary (2014-2015)

Recent work by Department of Land Resource Management

- DLRM – correlating patterns of decline with potential threatening processes using data in NT Fauna Atlas (Peter McDonald et al.; *Ecography* doi: 10.1111/ecog.01212)
  - Decline since 1975 correlated with grazing pressure and rabbit numbers (i.e. competition)
  - Data on foxes & cats not strong enough for modelling
- Produced a Fact Sheet http://www.lrm.nt.gov.au/__data/assets/pdf_file/0019/10828/greater_bilby_vu.pdf

Northern Territory Government's Action Plan for the Northern Territory

- Species ranked as a high priority for action in the NT
- Key Objectives to achieve by 2019
  1. Complete another monitoring survey
  2. Management of foxes & rabbits across 20% of the area of overlap of foxes and bilbies
  3. Local control of cats around at least two major sub-populations of bilbies

APPENDIX IX:
The Greater Bilby Management Unit Recommendations

Paul Andrew

CBSG Australasia & Taronga Conservation Society, Australia

Greater Bilby: a single management unit for the purposes of conservation

The species occurs in two separate geographic areas; one extending from the western deserts region (Tanami, Great Sandy, Gibson) of NT and WA north to the Pilbara and Kimberley regions, the second in south-western QLD. (Pavey et al. 2006:16).

The proposition tabled here is that any action should first be weighed against its impact on Bilby conservation, specifically keeping Bilby in the Australian landscape, rather than any perceived historical process that might or might not be of philosophical value.

However, in the past this disjunct distribution has led to the precautionary management of two populations in the Australian Species Management Program [ASMP], a Western Australia/Northern Territory population and a Queensland population. Likewise, the Recovery Plan (Pavey et al. 2006) recommended the recognition of two management units:

Detailed molecular analysis (mitochondrial DNA and microsatellite loci) indicates that the species should be considered as a single Evolutionary Significant Unit (i.e. no evidence of strong genetic structure across populations) (Moritz et al. 1997). However, Moritz et al. (1997) recommended that populations in each State/Territory should be considered as separate management units. The recovery plan follows this recommendation. This approach may not be entirely accurate because it is very likely that bilbies in the western deserts of NT and WA are a distinct meta-population with movement of individuals across State/Territory boundaries. However, a State/Territory-based approach seems a useful interim measure until core populations are better defined.' (Pavey et al. 2006:16)

The Action Plan for Australian Mammals noted that the captive population is managed as two distinct units, but recognised no subspecies which is consistent with Moritz et al. (1997) finding no ESUs.

However, genetic research suggests that currently extant populations (including the isolated subpopulation in south-western Queensland) show very little genetic variation (Moritz et al. 1997) and the subspecies are unlikely to be valid. As the former distribution was more or less continuous, extinct subspecies are equally unlikely to be valid. No subspecies are recognised in this Action Plan.' (Woinarski et al. 2014:205).

Further, Frankam et al. (2012), Frankham (in press), and Weeks et al. (in review) caution against isolating subpopulations by recognising too many fragments for independent management, particularly when conservation is the goal.

"As increasingly fragmented and isolated populations of threatened species become subjected to climate change, invasive species and other stressors, there is an urgent need to consider adaptive potential when making conservation decisions rather than focussing on past processes. In many cases, populations identified as unique and currently managed separately suffer increased risk of extinction through demographic and genetic processes." (Weeks et al. in review).

Weeks et al. (in review) further points out that the subpopulation distinctiveness is often not of adaptive origin but a consequence, not a cause, of isolation and that we must be wary of compromising conservation in pursuit of a 'naturalness' that is not real:

"Using datasets from natural Australian mammal populations, we show that drift processes are driving uniqueness in populations of many threatened species, and that conserving and managing such remnant populations separately will therefore often decrease their adaptive potential and increase species extinction

risk. We develop new guidelines to show where diversity should be preserved at the expense of uniqueness, and where uniqueness becomes paramount in conservation decisions. These results highlight the need for a paradigm shift in conservation biology practise; strategies need to focus on the preservation of genetic diversity at the species level, rather than population, subspecies or evolutionary significant unit, and in situ translocation needs to be considered as a way of decreasing extinction risk." (Weeks et al. in review).

The issue of management units within Bilby stems from a genetic analysis of Moritz *et al*. (1997). Note that Moritz *et al*. (1997) refers to Moritz (1994) for definitions of ESUs and MUs:

Moritz (1994; see also Avise 1994) suggested a binary approach to defining conservation units that seeks to identify populations that have been isolated historically (Evolutionarily Significant Units, ESUs) vs. those that are currently isolated, or effectively so, but were connected to others historically (= Management Units, MUs).

"ESUs can be recognized as having reciprocal monophyly of mtDNA lineages among areas, together with supporting divergence in nuclear allele frequencies, whereas MUs differ in allele frequency but are not phylogeographically distinct." (Moritz *et al*. 1997:933).

This conclusion bears on strategies for translocation to re-establish populations of the bilby (Southgate 1994), in particular whether bilbies should be moved between states or mixed for re-introductions. Elsewhere, it has been suggested that translocations could include mixtures of individuals from different historically connected populations (i.e. MUs), but, where possible, should not be conducted between historically isolated population units (Vrijenhoek *et al*. 1985; Moritz 1995). If the **goal of management is to maintain historical population processes (Moritz 1995)**, it would be appropriate to encourage connectivity between the historically connected NT and WA populations. The situation for QLD populations is less clear. Although it seems unlikely that the QLD population has been historically isolated, there also does not appear to have been *extensive* exchange across the geographical distance now separating the NT and QLD populations.' (Moritz et al. 1997:933).

Moritz found patterns which may or may not have been historical and recommended management of at least two populations. There may well have been some logic to such a position if the goal were to 'maintain historical population processes'. Given that the goal is explicitly the conservation of the Bilby and it's far too late to worry about historical patterns as species go extinct (unless the historical pattern is consistent with conservation), this PHVA is predicated on conservation outcomes determining the movement of Bilby genes because:

1. Subpopulation uniqueness is not necessarily a consequence of adaptation: it may be a consequence of drift.
2. Micro-adaptation is not necessarily a good thing: in a changing environment adaptive potential is the goal, not management according to historical processes.
3. It is well established that out-breeding improves fitness in small populations. The objection to out-breeding is a philosophical fundamentalism not conservation.

References:

Frankham, R. (in press) Genetic rescue of small inbred populations: meta-analysis reveals large and consistent benefits of gene flow.

Frankham, R., Ballou, J.D., Dudash, M.R., Eldridge, M.D.B., Fenster, C.B., Lacy, R.C., Mendelson, J.R. Porton, I.J., Ralls, K. and O.A. Ryder. 2012. Implications of different species concepts for conserving biodiversity. *Biological Conservation* 153:25–31.

Moritz, C. (1994) Defining evolutionary significant units for conservation. *Trends in Ecology and Evolution* 9:373-375.

Moritz, C., Heideman, A., Geffen, E. and P. McRae (1997) Genetic population structure of the Greater Bilby Macrotis lagotis, a marsupial in decline. *Molecuar Ecology* 6:925-936.

Weeks, A.R., Stoklosa, J. and A.A. Hoffmann (in press) Conservation of genetic uniqueness of populations may increase extinction likelihood of endangered species.

APPENDIX X:
Bilby Distribution Mapping

Greater Bilby – National Mapping Scoping document

Tania Laity

Project Background

The Greater Bilby Recovery Summit was held between 10th and 13th March 2015. The goals of this summit included bringing together managers and other stakeholders to form a common understanding of priorities and threats to the species, and to develop a shared vision and plan for action for its conservation.

In line with these goals it was agreed that a national map of the Greater Bilby would be of use to facilitate national coordination and prioritisation of recovery actions for the species.

Project Scope

Objectives

Provide a national map for the Greater Bilby that will be a useful tool for recovery planning coordination across the country.

Out of scope

Inclusion of time series Landsat imagery. This could be a project in its own right to develop a methodology using GA's datacube (http://nci.org.au/virtual-laboratories/earth-observation/australian-geoscience-data-cube/) to identify area of land cover change. This would be a valuable product for several areas within the Department.

Addition of other arid zone threatened species to the mapping exercise.

Benefits

Coordinated approach to recovery planning for the Greater Bilby nationally that could prove a useful model for other species or groups of species.

Project Approach

Weather

Data sets available – Weather monitoring station locality data layers available, however, station number is not able to be directly linked to BOM page for each station as URLs don't reflect station number.

Further work - Request has been placed to determine if a lookup table exists that could be used to link station numbers to URLs for current and recent weather data for each station.

Vegetation / Habitat

Data sets available:

- NVIS data - Identification of NVIS vegetation types preferred by Greater Bilby – initial quick query has been undertaken to select potentially relevant major vegetation subgroups (see table below).

MVS Number	Name
20	Mulga (*Acacia aneura*) woodlands and shrublands +/- tussock grass +/- forbs
33	Hummock grasslands
34	Mitchell grass (*Astrebla*) tussock grasslands
35	Blue grass (*Dichanthium*) and tall bunch grass (*Chrysopogon*) tussock grasslands
36	Temperate tussock grasslands
37	Other tussock grasslands
45	Mulga (*Acacia aneura*) open woodlands and sparse shrublands +/- tussock grass
51	Mulga (*Acacia aneura*) woodlands and shrublands with hummock grass
52	Mulga (*Acacia aneura*) open woodlands and sparse shrublands with hummock grass

- 1:1 million national geology mapping via GA – categories mapped where possible to the geology classes mapped by Southgate *et al* (2006) and then intersected with the Bilby distribution polygon. The classes and where they were mapped are listed in the table below.

Southgate et al 2006 Category	1:250,000 query (NT data layer)	1:1 million map symbols
calcrete	map symbol = 'Tt*' or 'Czt' or '–Cmm'	Cztg Cztmc
drainage	drain=1 or map symbol = 'Qa*' or 'Qb*' or 'Ql*'and not Tt*	Qa Qb Qbal Qban Qbha Qbto
laterite	map symbol ='Qr' or 'Tl*' or 'Qg*'	Qrc Qrcp Qrlb
rock feature	not 'calcrete' and not 'drainage' and not 'laterite' and not 'sand & dune' and not 'salt lakes & black soil'	Not mapped (null values)
sand plain & dune	map symbol ='Qs' or 'Qz' or 'Czs' and drain=0	Czs Czsar Czsp Qsm Qspe
salt lakes & black soil	map symbol = 'Czb*' or 'Qe*'	Czb Czbch Czbf Czbnu Czbst Qe

Further work

Vegetation

These could be refined based on other factors and in consultation with the recovery planning group.

Geology

Investigating availability of finer scale geology mapping from States and Territory (over 250 1:250,000 map sheets would be required, high workload to combine and standardise across the Bilby Distribution. (Out of scope for this project).

Fire

Fire frequency mapping – investigating methodology for producing surrogate fire intensity data to complement this. – 13 year composite available – 1997-2009 - Fire Frequency - AVHRR, Charles Darwin University algorithm, Australia coverage

Monthly burn cover – Aug 2000-July 2014 http://remote-sensing.nci.org.au/cgi-bin/lpdaac_view.pl

Site Monitoring / Survey data

- Inclusion of site monitoring data where available?
- Inclusion of survey data from other sources eg indigenous groups, survey data from individual researchers and NGOs where not available through state wildlife databases.
- Incorporation of validated records from state and territory agencies.

Recovery Planning Boundaries

- IPAs and other areas where Indigenous Rangers or communities have potential for undertaking Bilby monitoring or recovery planning actions (areas identified by bilby researchers).
- Australian Wildlife Conservancy boundaries
- Arid Recovery boundary
- State and Territory managed lands with potential for undertaking recovery actions
- Collaborative Area Management Boundaries – cluster fencing boundaries provided by South West Qld NRM group.

References

Southgate, R.I., Allan, G.E.and Ostendorf, B. (2006). An examination of the Stafford Smith/ Morton ecological model: a case study in the Tanami Desert, Australia. *The Rangeland Journal* **28**, 197-210.

APPENDIX XI:

James Price Point Bilby Surveys and Data Capture

A non-invasive survey of bilbies, bilby habitat and wildlife interactions with bilbies has been conducted over 4 yrs (start 2011) and is continuous. Bilby habitat and activity is identified by botanical structure, tracks, scats, and burrowing activity. Key habitats are monitored using 6 Bushnell trophy-cam trail cams, photo libraries of habitat are recorded using Nikkon D3000 23megapixel camera interfaced with Garmin 62s gps device (WGS84) then inputted into Garmin global satellite mapping system (Base Camp, Homeport and Garmin Satellite Birds Eye Imagery). All devices are time stamped and continuously record data in real time. Data collected includes all tracks, data points and transects recorded every 10 seconds for complete duration of survey, also extensive photo and video libraries of bilby behaviour, habitat, activity, food resources and interactions with other wildlife. See example images and information from the library below:

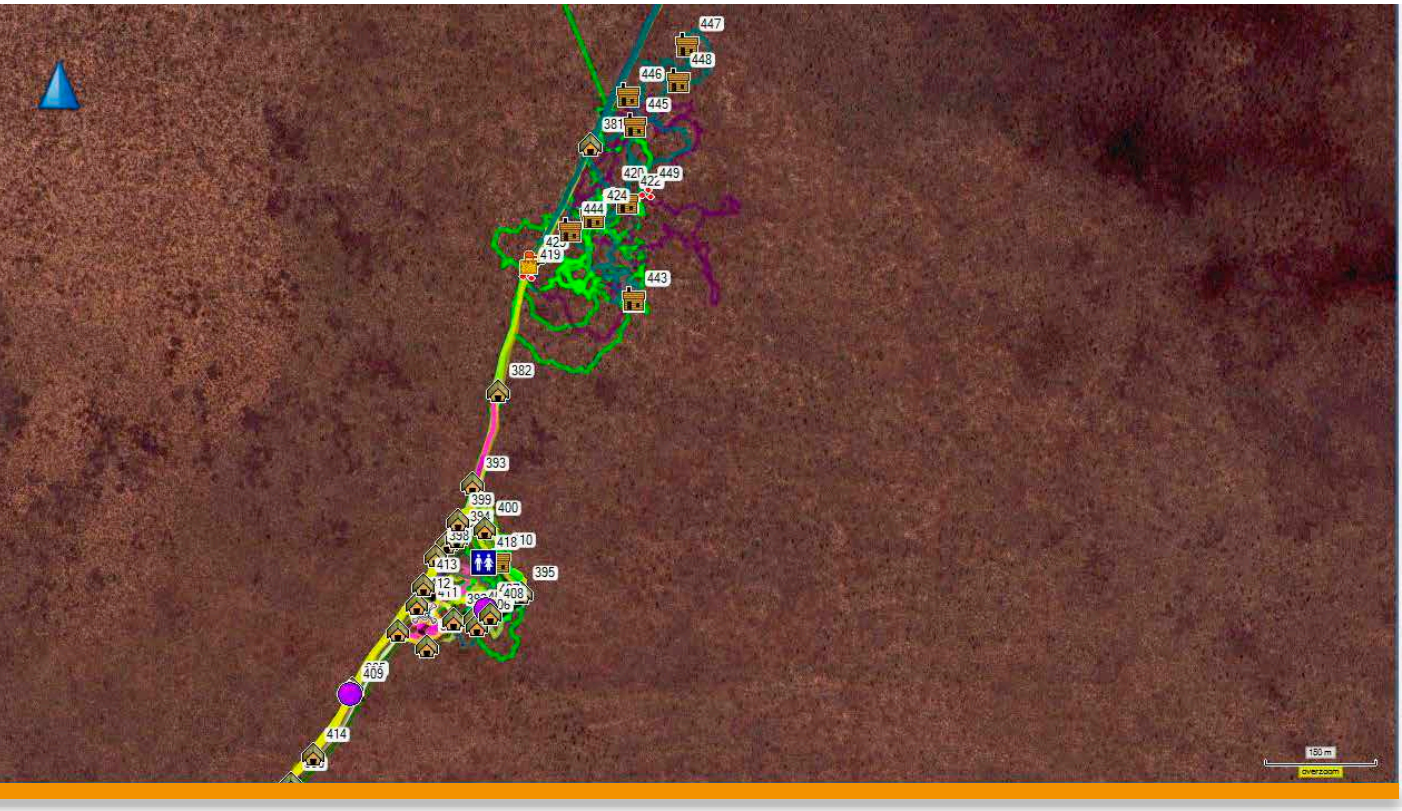


Figure 27: shows routes taken with numbered references to photographic files captured at each location along the trail.

With the support of the Native Title Claimants and true owners of the Dampier Peninsula who have great concerns for the welfare of the James Price Point Bilby we have been successful in locating, monitoring and predicting bilby movement, activity, habitat and food resources. Recording bilby behaviour at burrow sites has revealed many unseen and previously unknown interactions between the bilby, its environment and other interacting species. Over the coming years other areas will be assessed, recorded and documented using the same methods and techniques. All previous bilby locations are revisited at regular intervals to check for new activity and to record decay of abandoned, complete bilby systems. Surveys are conducted during the dry season and one survey has been completed during a wet season. Bilby behaviour, activity, habitat and food resources had changed and further surveys should be conducted over this period.

Figure 28: Sample of photographic records taken.

The surveys clearly indicate there are bilbies present in the Dampier Peninsula but their numbers are very low and under constant threat of predation by feral cats, which were recorded accessing active bilby burrows containing bilbies. Also, destruction of fragile habitat by legal and illegal land-clearing (for mining and associated industrial projects) has reduced usable bilby habitat.

In addition to the photographic record, scat samples and any DNA-containing material is collected and stored. We have no results from testing at this stage.

I would like to acknowledge the help and input in this survey by Dampier Peninsula Native Title Claimants and true owners in particular Uncle Phillip Roe Senior Law Boss and the Goolarabooloo Tribe & Family. Special thanks to Yawuru, Jabbir Jabbir communities, Lurujarri Heritage Trail and Broome community for their input and support. For more information contact Craig Doudle: cdoudle@y7mail.com

APPENDIX XII:

Overview of the Bilby Captive Programs

Claire Ford, Zoo and Aquarium Association, Camille Goldstone-Henry, Zoo and Aquarium Association, Jodi Buchecker, Monarto Zoo and Vere Nicolson, Dreamworld.

The Zoo and Aquarium Association (ZAA) is the peak body representing the zoo and aquarium community throughout Australasia. The Association has 95 member zoos, aquariums and wildlife parks. The Association manages the coordination of breeding programs through the Australasian Species Management Program (ASMP).

ZAA coordinates 3 types of managed breeding programs, the most important being ASMP Conservation Programs which involve species that have a documented role in a formal recovery effort. Under the ASMP portfolio there are currently ASMP Conservation Programs for both Queensland-origin bilbies and NT/WA-origin bilbies.

The species coordinator the NT/WA bilby is **Jodi Buchecker, Monarto Zoo**. This one of our longest running ASMP programs. The species coordinator for Qld bilby is **Dr Vere NIcolson, Dreamworld**, and this program came formally under the ASMP just last year (2014), previously the captive program was overseen institutionally by Dreamworld. These two management units are in line with the current recovery plan.

NT/WA program in more detail

The program goals under which we've been operating are:

- To provide animals for release
- To return 90% of wild source genetic diversity (GD) to each release site
- To preserve the captive source population by maximising GD, minimising inbreeding, maintaining the population at carry capacity and optimising contribution of new founders.

The NT/WA captive program has a population of 65 across 14 institutions. Kanyana, Alice Springs Desert Park and Monarto Zoo are the major holders. The population has been reduced in recent years with releases winding up. This is a long running program that consists of predominately captive bred bilbies; there are few living wild origin animals. Around 20 births a year are needed to maintain the population at current levels.

NT/WA Bilby Studbook Genetic Statistics	
Pedigree known	99%
Founders:	27
Genetic diversity	92%
Pop Mean Kinship	0.081
Mean inbreeding	0.039

Genetically the program is meeting program benchmarks. There is a good number of founders, and reasonable gene diversity.

Since this has been such a long running programs we have some good demographic data. There are 1344 bilbies recorded in the studbook. For example:

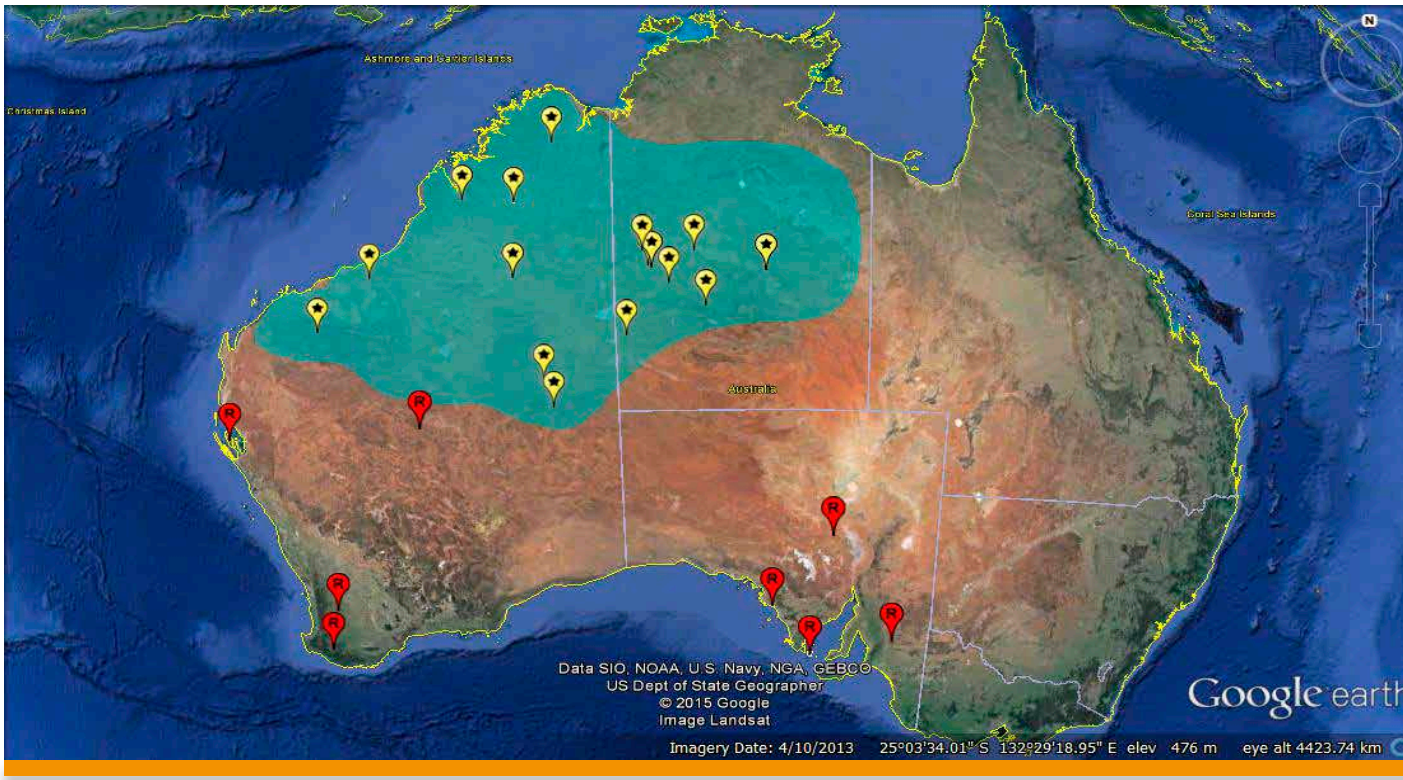
- The mean litter size recorded is 1.4.
- Peak age of breeding is 14-54 months for males and 7-44 mths for females. Although there are records of breeding up to 7 yrs for males and 6 years for females.
- There are records of both males and females living up to 10 years but generally males are gone by 6 years and females by 7 years.
- Generation length is 2.08 years
- Life table lambda or annual growth rate is 1.27 with a maximum growth rate of 1.5.

Camille Bilby Review

Camille Goldstone-Henry conducted a review of the NT/WA bilby program as her honours project and is now an ASMP staff member. Some of the things she looked at included founder origin, how well we have bred and what we released.

We aim to acquire unrelated individuals across the full range of the species' distribution. The review of founder origins indicates we have indeed sampled really quite well across the wild distribution. The Figure below shows founder acquisitions with yellow pins and reintroduction sites with red pins.

Breeding success was analysed and we are sitting on about 75% of attempted breedings resulting in offspring. This is really quite high. There was no discernible difference between bilbies that were captive born or wild born in terms of breeding success.

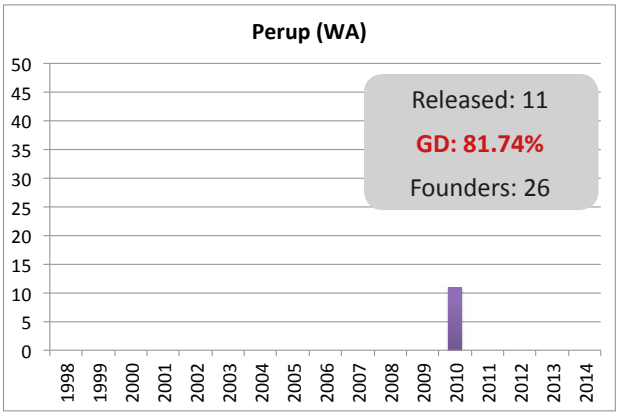


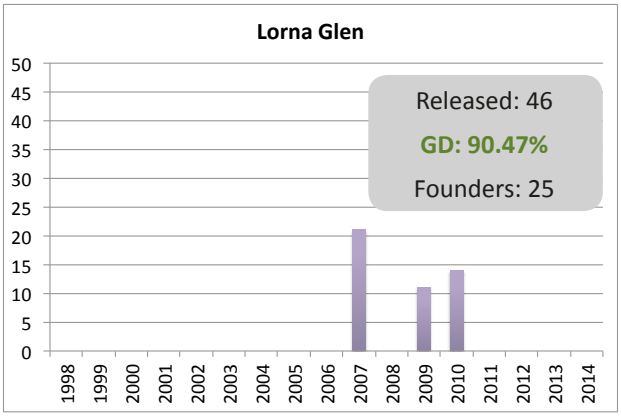
Breeding success was also analysed at an institutional level. An institution's success can be impacted by a number of factors: husbandry expertise, facility design, capacity, whether animals need to be transferred in or out amongst other things. It is important to identify institutions that consistently have good breeding success so that the program can utilise this expertise and work towards replicating their model. Not surprisingly, Peron, Kanyana and Monarto all demonstrate high efficiency in breeding.

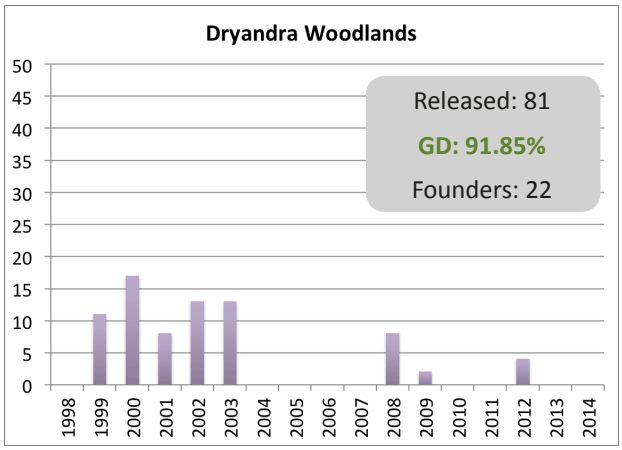
404 bilbies have been released to 8 reintroduction sites since 1995. There have also been a number of translocations between reintroduction sites however, this is one area where the studbook data are deficient and it would be great to have these recorded so more accurate representations can be made.

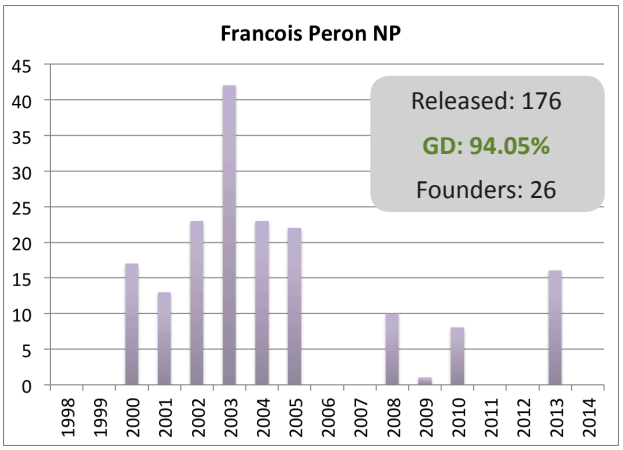
Release events in Western Australia

Based on which animals were released the gene diversity was modelled. Of course we don't really know what animals survived and went on to breed, however this is a guide of what was put out there. Three of the four sites had >90% wild source gene diversity released. The captive population has 27 founders represented, so there is the possibility of providing some additional diversity by targeting non-represented founder lines.





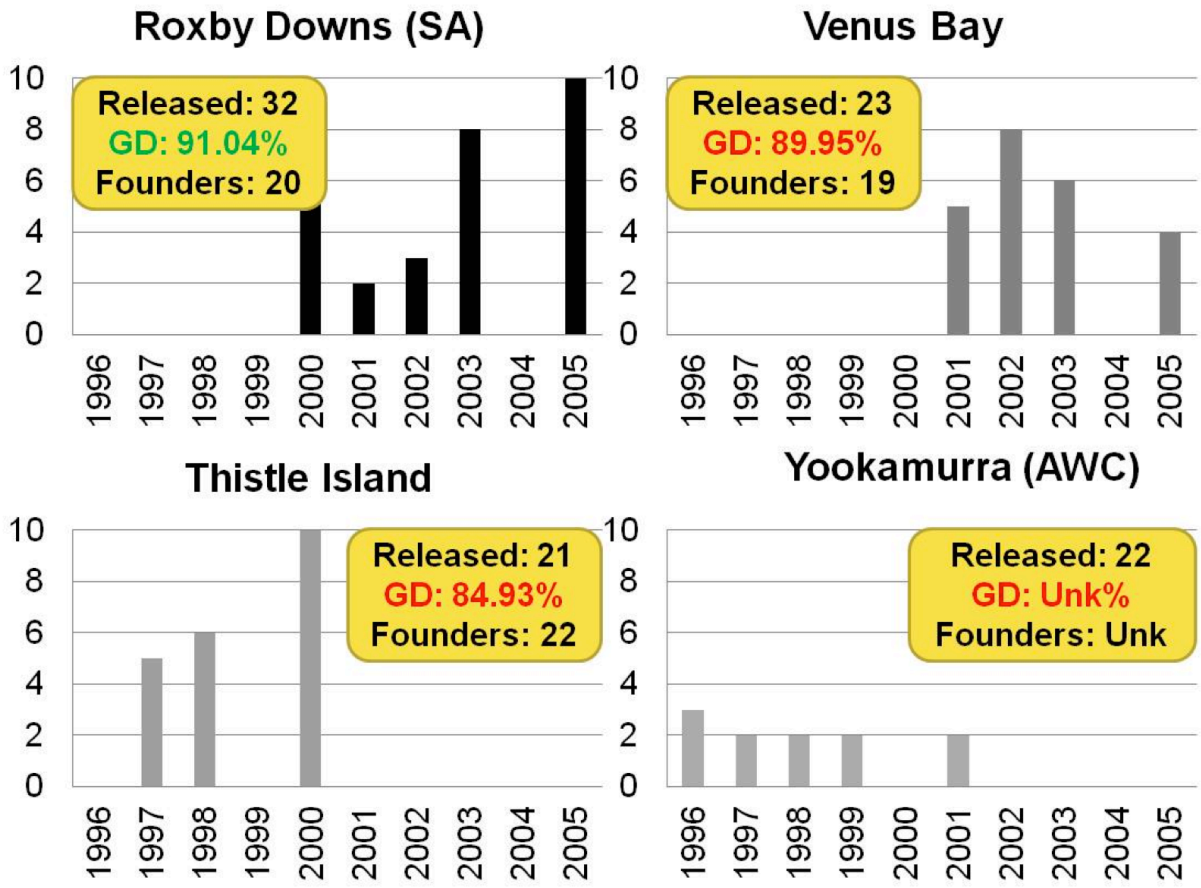




[Data : NT/WA studbook]

South Australian release events

Roxby Downs reached the 90% goal, and Venus Bay is very close. GD was modelled on what animals were released, we do not have data on what animals survived and bred. We also do not have any data on translocations between release sites subsequent to releases, and this could affect actual GD. No releases since 2005 and small releases <10 individuals put out at each release.



[Data: NT/WA studbook]

Queensland Program

The Qld bilby Conservation programs has a population of 41 bilbies. These are located across 6 institutions shown with the most held by Charleville and Dreamworld. The program is growing and there have been recent acquisitions from the wild. About 20% if the living population is wild origin. At this point around 10 births a year are needed to sustain the population at its current size. Obviously more births will be required to accommodate releases if needed.

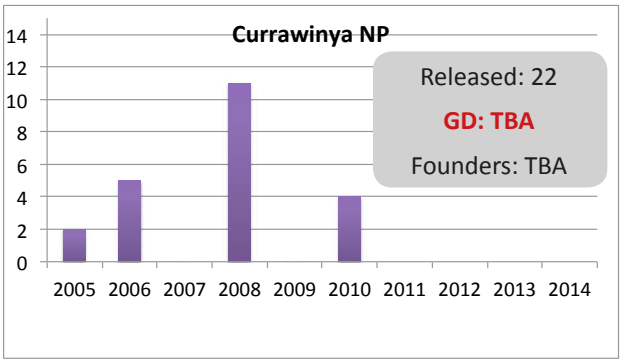
Genetically the Qld bilby is meeting standard benchmarks. A few more founders would certainly help to capture wild source GD especially from unrepresented Qld wild sites (ie sites other than Astrebla Downs).

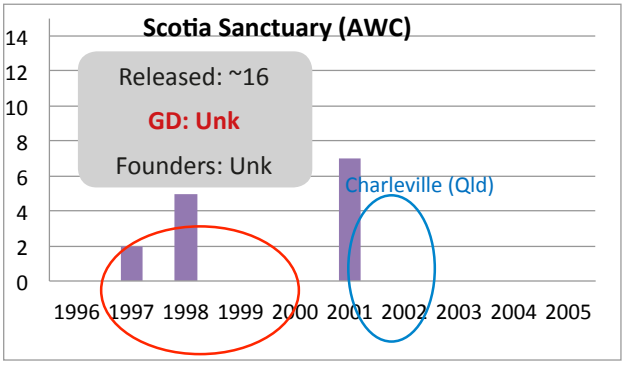
Qld Bilby Studbook Genetic Statistics	
Pedigree known	70%
Founders:	19
Genetic diversity	92%
Pop Mean Kinship	0.0791
Mean inbreeding	0

The captive program has founder representation from mostly Astrebla Downs national park and 2 bilbies have been acquired from unspecified Qld locations.

There have been few **releases using the Qld biby** captive population, according to the studbook ~22 were released to the fenced Currawinya site. This site now has very few individuals remaining if any. (Translocations direct from wild or from other reintroduction sites are presently not recorded in studbook, but this information would be very useful). Additionally there have been exchanges with Scotia Sanctuary, a predator free mainland island in NSW. Scotia was founded with a mix of animals from Yookamurra and Charleville, so it is possible that animals at Scotia represent a mix of QLD/NT/WA genetic lines.

This is significant as the current captive bilby population acquired 12 animals from Scotia and we are nominally managing a Qld only population. 18 out of 41 individuals have Scotia ancestry, so if maintenance of a “pure” Qld bilby captive population is deemed necessary then this should be taken into consideration when developing breeding plans.





[Data: Qld Bilby studbook and Leah Kemp per comm]

Molecular Genetics

Jenny Seddon, UQ has run genetic analyses on a significant proportion of the Qld bilby captive program. This work has been useful for "trothing" parental assumptions, particularly where sire and dam cannot be confirmed for joeys. There is also the potential to utilise genetic testing at the point of founder acquisition. Especially in terms of allelic frequencies to determine whether we are acquiring new material or new alleles with our founder acquisitions. Molecular genetics can also provide an indication of relatedness (useful for founders of unpedigreed pops). Note there is a considerable area for misassignment ie it is difficult to differentiate half and full sibs and first cousins when you look at relatedness. Jenny supports us in saying that this genetic work needs to be treated with a degree of caution (J Seddon pers comm). 7 microsatellite markers are not many markers to be drawing conclusions from. That said, we have 70% known pedigree, so the genetic work certainly allows us to be making some very sensible parental assumptions. It has also shown allelic diversity at the 7 markers is pretty good (av 6 alleles/locus). And heterozygosity is also higher than other conservation programs for which we have data. Ideally if more genetic work is to be employed we would be using SNPS but there is considerable cost associated.

A number of SA reintroduction sites have also had samples taken by Karleah Trengrove (University of Adelaide). These are yet to be analysed but we are working towards putting UQ and University of Adelaide in contact as clearly it would be useful if the same markers were used to allow comparison between the populations, or initiate SNPs which would benefit future genetic work on bilby.

Challenges

Currently we are managing two bilby programs which as well as being resource intensive, means we have 2 small populations rather than one big one. And small populations are of course vulnerable to stochastic events. Further, the programs can start to compete with each other for "zoo space".

There are significant strategy documents that have now expired including the Bilby Captive Management Plans and the National Recovery Plan. Both documents ideally would be prepared side-by-side and reference each other.

There would be benefit to be gained from expanding the information flow between captive and wild programs including:

- status of wild populations (population size, progress with threat abatement, what's working and what's not)
- post-release monitoring feedback, including surviorship of released individuals.
- Most importantly information related to wild-to-wild (or between fenced sites) translocations. As this may impact on bilby selection for release.

References

Buchecker, J. 2014. *Greater Bilby studbook [NT/WA captive population*], Zoos SA on behalf of the Zoo and Aquarium Association, Mosman NSW 2088 Australia

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Goldstone-Henry C et al 2014 *The NT/WA Greater Bilby Conservation Program: achievements and difficulties in captive breeding*. Zoo and Aquarium Association, Mosman NSW 2088 Australia

Seddon J 2014 *Final Report: 2014 Genetic Analyses on captive bilbies*, School of Veterinary Science, The University of Queensland, Qld Australia

Software used:		***Version***	***Author, date***
	SPARKS	1.6	ISIS, 16/05/2011
	PMx	1.0.2	J.D. Ballou (National Zoological Park) R.C. Lacy (Chicago Zoological Society, J.P Pollak (Cornell University). 2011.

APPENDIX XIII:

Minimum Viable Population Size Tool

Caroline Lees, CBSG

As wild populations decline they become increasingly at risk to chance factors. These can be categorised as: demographic stochasticity (chance fluctuations in birth and death rates, and sex-ratio); genetic risks (inbreeding depression and chance loss of diversity through drift); and environmental stochasticity (unpredictable and extreme changes in weather, flood supply, predators and other environmental influences) (e.g. Schaffer, 1981).

CBSG typically uses computer simulation models able to incorporate estimates of these multiple and interacting influences, to help practitioners estimate the level of abundance at which these forces of uncertainty could begin to exert undue influence on population-level fitness and extinction risk, within the time-frame of interest.

Models were not built for the Greater Bilby Summit. The species' biology shows "boom-bust" characteristics and the environment it inhabits is similarly volatile, varying both temporally and spatially across the range. Eliciting adequate estimates of this variability was considered too difficult and time-consuming, and was not a priority for this stage of planning.

Instead, as an alternative, the following guidance on likely minimum viable population sizes for the bilby was compiled from published multi-species analyses of minimum viable population sizes, science-based rules of thumb provided in the literature and advice from experts.

The values given below are a rough indication of the level of abundance of bilbies likely to be required to deliver the viability gains described. For more targeted guidance relating to specific circumstances, locations or projects, and particularly for situations involving hundreds rather than thousands of bilbies, the use of customised population simulation models is recommended.

Risk	Estimated MVP required for resilience	Rationale
Chance not natural selection drives gene pool composition	N ≈ 185	• Impact of drift can overwhelm natural selection in small populations (Grueber, 2013). • Population size required to ensure that natural selection is the dominant force shaping genetic composition will vary with species biology and circumstance. • If mean selection coefficients are around 0.025, overcoming drift will require effective sizes of at least N=25. • Assuming Ne/N = 0.135 (estimated ratio for Eastern-barred Bandicoots (EBBs) in Frankham, 1995), actual size required is at least N= 185.

Risk	Estimated MVP required for resilience	Rationale
Inbreeding depression	N ≈ 370-740	• Based on 50/500 rule (Franklin 1980) and recent proposed revision of this to 100/1000 (Frankham et al., 2014) • Assumes effective to actual size ratio (Ne/N) = 0.0135 (based on EBBs: Frankham, 1995). • MVPs in this case are expected to confer 5 generations of resilience to inbreeding depression (approximately 10 - 15 years for bilbies). • Assumes constant size.
Gene diversity loss	N ≈ 3,700 – 7,400	• Based on 50/500 rule (Franklin 1980) and recent proposed revision of this to 100/1000 (Frankham et al., 2014) • Expected to confer mutation-drift balance – that is, population will be generating new gene diversity through mutation at approximately the same rate it is losing it through drift.
Environmental uncertainty	N ≈ 5,000 – 7,000	• Traill et al, (2007) and Reed et al., (2003) considered 99% p(survival for 40 generations (≈ 100 years for bilbies) • Analysis of 102-212 published MVP estimates. • Conclude MVPs are context-specific – no simple short-cuts. • Traill (2007) results: for mammals (n=95) median = 3876 95% confidence interval = 2261–5095; recommends using the upper limit of the 95% C.I. • Reed et al., (2003) median = 5816 reported for vertebrates; recommends habitat provides for N=7,000.

References

Frankham, R., 1995. Effective population-size adult-population size ratios in wildlife – a review. Genetical Research 66, 95–107.

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Reed, D.H., O'Grady, J.J., Brook, B.W., Ballou, J.D., Frankham, R., (2003) Estimates of minimum viable population sizes for vertebrates and factors influencing those estimates. Biological Conservation 113, 23–34.

Traill, L.W., Bradshaw, C.J.A., and Brook, B.W. (2007) Minimum viable population size: a meta-analysis of 30 years of published estimates. Biological Conservation 13 (9): 159-166.

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Schaffer, M. (1987) Minimum viable populations: coping with uncertainty. In: Soulé, M. (Ed) Viable Populations for Conservation. Cambridge University Press.

APPENDIX XIV:

Workshop Program
Greater Bilby Recovery Summit

10-13 March 2015

Q1 SkyPoint Observation Deck Level 78, Gold Coast

SUMMIT GOALS:

- To assemble a community of stakeholders across Australia who are ready and able to take action for Greater Bilby conservation.
- To bring this community to a common understanding of the threats to and prognosis for the Greater Bilby across Australia.
- To develop a shared vision for the future of the Greater Bilby across Australia and a plan to guide its realisation.
- To agree, within this context, a plan of priority actions for the Greater Bilby in Queensland.
- To build a commitment to immediate action for this species and an enabling framework through which this can be sustained.

Background

The Greater Bilby is a widely known and loved Australian icon which has suffered an ongoing decline in range and abundance since the introduction of exotic mammals to Australia. The species is now listed as vulnerable at a national level and as endangered in Queensland where as few as 300 individuals remain.

This workshop will explore the plight of the Greater Bilby and the requirements for its recovery using a well-tested process designed and facilitated by the IUCN SSC Conservation Breeding Specialist Group (CBSG). This process brings together stakeholders to discuss openly the challenges to Greater Bilby recovery and to forge consensus on future needs and activities. The Summit will form the basis for a review and revision of the national Greater Bilby recovery plan and will build on past work, notably that documented in *The Action Plan for Australian Mammals, 2012* (Woinarski *et al*., 2014) and the *National Recovery Plan for the Greater Bilby* (Pavey, 2006).

The Greater Bilby currently exists as isolated fragments and under a variety of conditions including free-living wild populations, fenced and protected populations, and intensively managed captive populations. In keeping with CBSG's *One Plan Approach* to conservation planning, the Summit will bring together managers from across this spectrum to ensure that all relevant resources are mobilised effectively towards a brighter future for this species.

The draft program for the workshop is provided below. This will be updated regularly in the lead-up to the workshop.

Workshop Program

	Item	Process Notes
DAY 1	**Registration**	Starting 8.15am
9.00am	**Opening**	Welcome to Country – Rory O'Connor – Yugambeh Museum Welcome address - Dr Steven Miles, Queensland Minister for Environment Heritage and Protection
9.15am	**Introduction**	Introduction to the workshop, its goals and intended products – Frank Manthey OAM and Kevin Bradley CEO, Save the Bilby Fund.
9.30am	**Participant Introductions**	Participants introduce themselves, their affiliation and interest in the species, and provide answers to pre-set questions
10.00am	**Scene setting Presentations**	National status review – biology/ecology, past & present distribution, threats, broad overview of national conservation progress – Peter Copley (20) Wild/free-living populations (State or region-based presentations on priority issues and current or planned programs) – state reps (40)
11.00am	**TEA/COFFEE**	
11.15am	**Scene setting Presentations**	Fenced populations – summary of stocks (current number, founder number & source), management successes and challenge – Leah Kemp/ Katherine Moseby (20) Captive program – history, goals, current status and challenges - Claire Ford (15) Whole system Arid zone approach - Rick Southgate (15) Threatening processes- novel approaches to invasive species – Rachel Paltridge (15) Bilby species distribution mapping – Tania Laity (20) Management units - Paul Andrew (10)
1.00pm	**LUNCH** **Presentation**	 Gregory Andrews- Threatened Species Commissioner, Department of the Environment
2.00pm	**Process Introduction**	CBSG process and small population management tools - Caroline Lees
2.30pm	**Task 1. Visioning**	Participants work to develop a VISION (a desired future state) for the Greater Bilby in Australia
3.15pm	**TEA/COFFEE**	
3.30pm	**Task 2. Issue Generation**	Participants work to identify the full suite of obstacles to achieving the VISION
4.30pm	**Task 3. Issue Statements**	Working groups are formed around the issues identified. Groups are self-managed but with support from the facilitation team
6.00pm	**Close**	
6.30pm	**DINNER**	Summit dinner SkyPoint Observation Deck - cost included in registration fee

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6.00pm	**Close**	
6.30pm	**DINNER**	Summit dinner SkyPoint Observation Deck - cost included in registration fee

	Item	Process Notes
DAY 2		
8.30am	**Introduction**	Introduction to the day
9.00am	**Task 3. Issue Statements**	Groups continue to develop clarity around the key issues and formalise them as statements. These are prioritised
11.00am	**TEA/COFFEE**	
11.15am	**Presentations**	Issue statements and feedback (15 minute presentations from each group)
1.00pm	**LUNCH**	
2.00pm	**Task 4. Data Assembly and Analysis**	Working groups reform to consider: What do we know about this issue? What are we assuming? What are our major information gaps?
4.00pm	**Presentations**	Groups present their data assembly findings
5.00pm	**Task 5. Goals**	Groups develop goals for each issue
6.00pm	**Close**	
6.30pm	**DINNER**	Group dinner - Waves Restaurant Watermark Hotel-included in registration fee
DAY 3		
8.30am	**Introduction**	Introduction to the day
9.00am	**Task 5. Goals**	Groups continue to work on goals.
10.30am	**Presentations**	Goals are brought to plenary and prioritised by the wider group.
11.00am	**TEA/COFFEE**	
11.15am	**Task 6. Actions**	Actions are developed by working groups
1.00pm	**LUNCH**	
2.00pm	**Task 6. Actions**	Work on actions continues
3.15pm	**TEA/COFFEE**	
3.30pm	**Presentations**	Actions are presented and discussed in plenary
5.30pm	**Presentations**	VISIONING Group presents work
6.00pm	**Close**	
DAY 4		
9.00am	**Final Presentations**	Working Groups summarise their work: Mapping data; Implementation Framework; VISION
11.00am	**Final Discussion**	Next steps and workshop report
12.15pm	**Close**	End of workshop

Save the Bilby Fund was established in 1999 by Frank Manthey OAM and scientist Peter McRae ("The Bilby Brothers"), to raise funds to construct a predator-proof fence on Currawinya National Park to support the recovery plan for the Queensland bilby.

Save The Bilby Fund actively supports programs of education, research and direct action to secure the long term conservation of bilbies, and of other endangered or threatened Australian native species.

www.savethebilbyfund.org

Queensland Government

TARONGA CONSERVATION SOCIETY AUSTRALIA For the Wild

DWF Dreamworld Wildlife Foundation

Australian Government Department of the Environment

IUCN

Species Survival Commission

CONSERVATION BREEDING SPECIALIST GROUP