# EARTHWATCH INSTITUTE FIELD REPORT

**Project Title:** Bringing Back the Bilbies

**Principal Investigators:** Katherine Moseby and John Read

**Position/Affiliations:** Research Coordinator Arid Recovery, BHPBilliton Land Management Supervisor

**Research Site:**

The Arid Recovery Reserve is an 86km$^2$ rabbit, cat and fox proof fence protected area of land. It is located 20km north of Roxby Downs in central South Australia

**Local Management Status of the Research Site:**

The reserve contains land from the BHPBilliton special mining lease and four pastoral leases. The reserve is protected by a memorandum of understanding, between the four managing partners, BHPBilliton, Department of Environment and Heritage SA, the University of Adelaide and he Friends of Arid Recovery. The reserve is locally managed by Arid Recovery project staff and directed by a steering committee with representation from all of the partner organisations.

**Scientific names of primary species being studied:**

*Macrotis lagotis*, *Bettongia leuseur, Leporillius conditor, Perameles bougainville, Tiliqua rugosa, Oryctolagus cuniculus, Felis catus , Vulpes vulpes*

**Key Research Objectives:**

The main objective of Arid Recovery, an ongoing programme, is to research the restoration of ecological processes on a landscape scale in the arid zone after the removal of rabbits, cats and foxes and reintroduction of locally extinct species. Specific research objectives of the Earthwatch component in 2005 were to:

- Determine the most effective methods for population monitoring of reintroduced species.
- Determine the home range of sleepy lizards inside and outside the Reserve and relate patterns to vegetation, habitat use and presence of feral species
- Determine the process by which bilbies and bettong locate seed and their impact on the soil seed bank.
- Determine the nest fidelity and social structure of stick-nest rats at 20 nest sites
- Document the extent of Bilby dispersal into the second expansion and begin to remove them from this control area.

**Date this report was completed:** 21 May 2006

**Data Collection and Results**

a) Give a concise account of the data you have collected during the past field season.

*Monitoring of reintroduced species*

During September 2005, cage traps were set for one night at 84 trap sites within the main exclosure and 29 trap sites in the first expansion. Unfortunately the first expansion trapping night was aborted due to rain and traps were closed in the middle of the night. Captures were weighed, sexed, marked and checked for reproductive condition before being released at point of capture. The number of captures of each species was compared with previous years to determine population trends. 40 burrows and 20 rat nests were monitored to determine activity and modifications to size and shape.

*Effect of reintroduced species on ecosystem processes - Seed experiments*

The April 2005 Earthwatch team assisted with two field experiments as part a Ph.D. project assessing the effects of the reintroductions of bilbies and burrowing bettongs, in particular, on soil seed banks. These trials were designed to help determine how the reintroduced species may impact the soil seed bank by determining whether any of the numerous bilby and bettong foraging diggings at Arid Recovery may be for seeds, and whether they may also dig seeds from the seed caches of harvester ant nests. Digging trials were held to determine the depth and extent to which bilbies and bettongs would dig for seeds. Three separate trials were run involving 24 sites within the Arid Recovery Reserve. Coloured rice was 'fed' into six harvester ant nests. Ant nests were then excavated to determine the size and depth of seed caches.

*Sleepy lizards*

Five lizards were radio tracked during the April expedition, 2 inside and 3 outside the Reserve. Lizards were captured by hand during opportunistic searching. Radio-transmitters were attached to the base of the tail and measurements and weights recorded. Daily fixes were obtained on each lizard and information recorded on movement, habitat, activity and feeding. The position of the lizards was recorded at least once per day during the Earthwatch trip and a minimum of three times per week for up to three months after each Earthwatch trip. In addition to marking the position of the lizard with a GPS the behaviour and habitat (nearest plant and landform) was recorded.

In September 45 sleepy lizard faecal samples were broken down and sorted through for dietary items. We were predominantly interested in seeds, but other items of the diet were also identified. We also attempted to document lizard densities using 4x1km track transects.

*Stick-nest rats*

Five stick-nest rat nests were trapped in April using Elliott and Cage traps set for 3 nights. Each nest was measured and tagged and given an activity score. Captured rats were ear-tagged, sexed, weighed and released. In September an 8km$^2$ area was searched on foot, for evidence of stick nest rats and new rat nests.

*Second expansion bilbies*

Earthwatch volunteers completed 6km of floppy top fencing to help to keep bettong from climbing into the second expansion control area. The whole 8km$^2$ was searched on foot for evidence of bilbies and sites for trapping. Eighteen bilbies were captured over three months using cage traps and were removed from the control area.

b) What progress have you made towards achieving your original objectives?

A considerable volume of data has been collected for all of the projects. Whilst some preliminary investigations of analysis have revealed patterns (as presented below), thorough analysis of data is yet to be undertaken. Most of these projects are ongoing.

c) Please provide a summary of your results.

*Monitoring of reintroduced species*
Bettongs were the most common species captured during annual cage trap monitoring (table 1). The low captures of bilbies and rats is unlikely to be indicative of low population size as bettongs are extremely trap happy and enter traps before other species. Bettong numbers have increased inside the Reserve since their release in 2000. Twenty-three bettongs had been captured previously with two males caught four years ago in 2001. Most of the bettongs that had been previously captured were from 2004. One of the bilbies had been previously captured 3 years ago in 2002.

Table 1. Number of each species captured during Arid Recovery Annual Monitoring

| Trapping Session | Bettong | Bilby | Stick-nest Rat | Bandicoot |
|---|---|---|---|---|
| Annual monitoring 2001 | 23 | 0 | 0 | 0 |
| Annual monitoring 2002 | 21 | 2 | 2 | 1 |
| Annual monitoring 2003 | 37 | 0 | 4 | 0 |
| Annual monitoring 2004 | 45 | 1 | 0 | 0 |
| Annual monitoring 2005 | 47 | 3 | 1 | 0 |

Table 2. Year of first capture for each species caught in 2005.

| Species | 2001 | 2002 | 2003 | 2004 | 2005 | New |
|---|---|---|---|---|---|---|
| Burrowing Bettong | 2 M | 1 F | 2 M | 3 F 7 M | 2 F 6 M | 24 |
| Greater Bilby | | 1 F | | | | 2 F |
| Greater Stick-nest Rat | | | | | | 1 F |

*Effect of reintroduced species on ecosystem processes - seed experiments*
The digging trials showed that bilbies and bettongs will dig to at least 30cm deep for seeds, though they prefer to dig for larger, shallower caches (figure). Other observations and experimental data suggest that bilbies and bettongs might also use old foraging diggings as seed supermarkets, eating the seeds that collect there.

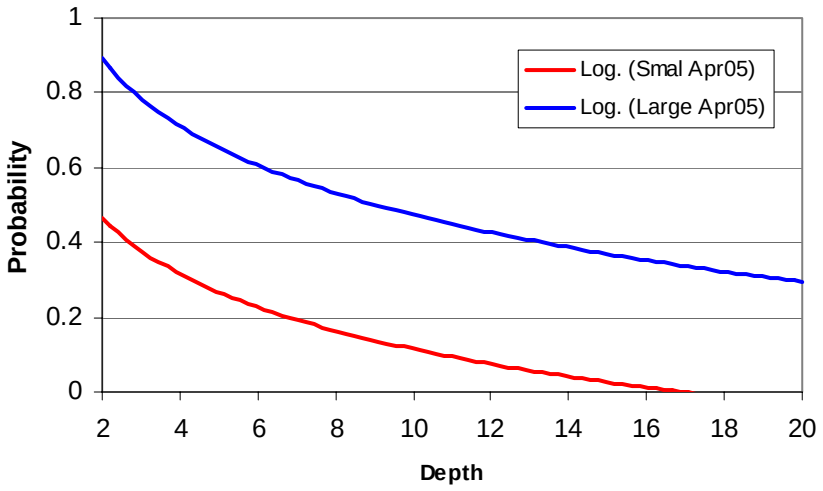


Figure 1: The probability that a buried sample of rice was dug up from different depths by bilbies and bettongs from one of the digging trials. The small samples consisted of three rice grains, while large samples consisted of one teaspoon of rice.

The most conspicuous seed-harvester ant, Pheidole sp nests were dug up. Nest entrances were fairly conspicuous with spoil heaps of seeds and other plant litter around them.

Numerous anecdotal observations have suggested that bilbies at various locations throughout Australia dig up the seed caches of harvester ants for the seeds. In order to confirm this, harvester ant (Pheidole sp.) nests outside the Reserve were 'fed' up to a cup of coloured rice, left overnight, and then carefully excavated to determine where the rice was cached. The rice was found at depths ranging from 1cm to 40cm deep (average 14.7cm, s.e. 1.7), and the caches contained on average 4.1g (s.e. 0.9) of rice.

Further trials conducted subsequent to Earthwatch found that most (83%) of the nests that were fed within the Reserve were dug up by bilbies within one night of being 'fed' rice, confirming that bilbies may use harvester ant caches as food resources.

*Sleepy lizards*

Although the whole study area was extensively searched several times only five animals were caught for radio-tracking. This may have been due to the lizards having a rather inactive period during the April expedition which makes them more difficult to find.

Another dry summer preceded the April trip allowed us to determine response of the sleepy lizards to high environmental stress and whether these differed inside compared to and outside the reserve. Lizards in April were again in relatively poor condition compared with those caught in September 2004. Weight relative to length showed lizards to weigh less in April 2004 and 2005 compared to September 2004. However they were not considerably lower than lizards caught in April or September in 2003 figure (2a and 1b). Having only one animal for each sex inside and outside does not really allow comprehensive comparisons. However, it does appear that perhaps April is a harder time of year when there has been little summer rain.

Home range sizes in April 2005 were relatively comparable (table 2). The female radio-tracked inside the reserve had a larger home range than the others but it is still within the size recorded for females both inside and outside in other years. Generally mean home range size of sleepy lizards inside the reserve appears to be larger than outside the reserve. However, this difference may not be statistically significant because of the high variability of the inside lizards, especially for males (range 0.18 – 5.81). Larger ranges inside the reserve may indicate that resources for lizards are more sparsely distributed inside. Alternatively, small home ranges outside may indicate longer periods of "hibernation" or periods of inactivity particularly when resources are limited. Further analysis of data including seasonal variables (such as rainfall) and food resource availability within home ranges will aid in the interpretation of these differences.

Faecal samples showed a large differentiation in food sources throughout the year. Samples from September contained many flowers, particularly poached egg daisies (20%). Ruby salt bush seeds were also common in some samples. Other non-plant material included lizard scales (4%) and insect parts (31%). All seed and insect parts have been collected for identification at a later date.

Track counts were trialled to determine the density of sleepy lizards inside compared to outside of the reserve. Unfortunately, the transects proved too difficult for the volunteers and were therefore determined an unsuitable method for calculating density during the Earthwatch project.

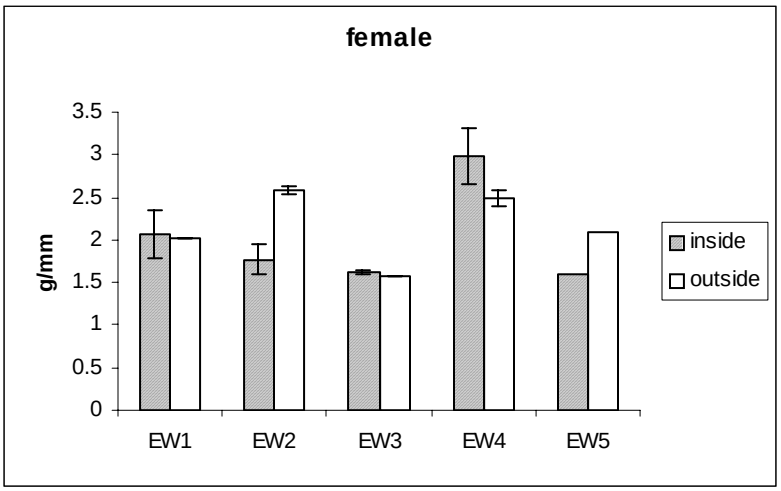

Figure 2a. Mean weights of female sleepy lizards

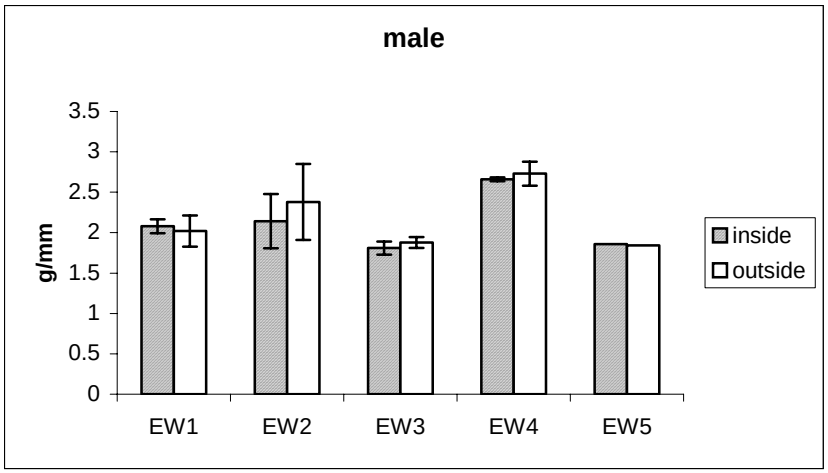

Figure 2b. Mean weights of male sleepy lizards

Table 2. Home range sizes of sleepy lizards inside and outside the Arid Recovery Reserve in April 2005

| | | inside | outside |
|---|---|---|---|
| Male | April 2005 | 0.49 ha | 0.69 ha |
| Female | April 2005 | 1.41 ha | 0.52 ha |
| Immature | April 2005 | | 0.61 ha |

Mean home range sizes of sleepy lizards inside and outside the Arid Recovery Reserve (standard error figure in brackets)

| | inside | outside |
|---|---|---|
| Male | 2.98 ±0.84 ha | 1.3 ± 0.27 ha |
| Female | 1.01 ± 0.33 ha | 0.47 ± 0.07 ha |

*Stick-nest rats*

Five individual stick-nest rats were captured during trapping at 20 permanent nest trapping sites in the main exclosure of the Reserve during 2005. This number is much lower than that of previous years (except 2004), and is not believed to be a true indication of the number of Stick-nest rats within the main exclosure due to trap interference by bettongs. During the April session there was extensive interference with traps by bettongs and only five sick-nest rats were trapped, despite evidence (both vocal and faecal) to support stick-nest rat activity in 85% of the nests monitored. Trapping for stick-nest rats was abandoned in September and assessments of nest activity were used as a surrogate for rat abundance. Again a high proportion of nests were active (90%).

One hundred and forty-two Stick-nest rats have been captured at the 20 nest sites since March 2000. More stick-nest rats were captured during the September trapping than the April trapping which is consistent with an annual trend of more rats captured in Spring than Autumn (in spite of bettong interference). This is likely to be due to breeding over the mid-year winter period as well as an annual summer die-off due to high temperatures. The three female rats caught in April showed signs of reproductive activity but with no obvious sign of producing offspring (all were perforate with button teats). Retraps were most common within 12 months of capture and there were very few recaptures at a nest after 1 year.

Table 3. The number of individual rats captured at the 20 nest sites

| Date | No.individual rats captured at 20 nests |
|---|---|
| Mar 2000 | 10 |
| Nov 2000 | 23 |
| Mar 2001 | 11 |
| Oct 2001 | 33 |
| Sept 2002 | 18 |
| Apr 2003 | 14 |
| Sept 2003 | 32 |
| Apr 2004 | 1 |
| Sept 2004 | 11 |
| April 2005 | 5 |

The number of recaptured rats caught at nest sites and the time since first capture.

| 6 months | 12 months | 18 months | 2 years |
|---|---|---|---|
| 9 | 7 | 4 | 1 |

Only 9% of captured rats have been retrapped at the same nest site suggesting a high annual mortality rate or low nest fidelity. The maximum number of rats captured at a single nest was 16 over eleven trapping sessions. Only 5 rats have been captured at more than one nest, 3 females and 2 males. Four of these five rats were captured in nests less than 500m apart but one male was captured at 2 nests more than 2 km apart.

Searches were conducted in the first expansion for rat nests. All 8sq km were searched on foot, and only 4 nests were found and measured and scored for activity, 1 inactive nest was also found. Potential rat nest sites were also identified. Only 4 nests were marked in the first expansion. There were far less nests than expected and a few inactive nests were found indicating that the number of Stick-nest Rats in the first expansion may be less than we thought.

*Removal of second expansion bilbies*

Tracking and mapping of bilby burrows within the second expansion revealed many burrows suitable for trapping. A number of bilbies were captured and removed during Earthwatch teams. At the time of this report we believe there to be only 4 bilbies left in the second expansion. The broad scale mapping of burrows made a significant contribution to removing the bilbies and returning the second expansion area to a control area. The maintenance of the control area is pivotal for the experimental design of many research project conducted at the reserve.

**Significance/Benefits of Research**

a) What is/are the significance/benefits of your research at the following levels?

- Local (in the area of the research site)

Locally the research conducted by this program can provide information about how ecosystem recovery can improve land condition. Results of the research are provided to the local natural resource management board and local NRM groups.

- National

At a national level the research conducted at arid recovery provides highly significant information about the impact of national pest species (rabbits, cats and foxes) on ecological processes and in addition to actively establishing locally extinct populations of nationally threatened species, research conducted on these populations provides information to assist the national recovery of these species.

- International

On an international level research conducted is significant for both providing information on arid zone ecosystems and ecological restoration techniques. Some technologies developed by arid recovery have already been used in restoration programmes in other countries.

b) How do your findings contribute to issues of sustainability?

Our findings provide transferable knowledge, information and technology for broadscale environmental management of Australia's arid lands. The results also demonstrate how mining, pastoralism and conservation organisations can work together to achieve tangible benefits from sustainable conservation.

**Dissemination of Results**

A presentation was made at one conference in 2005:

Newell J, Paton D.C., Moseby K. E., Carthew S. and Facelli J. (2005). "The reintroduction of bilbies and burrowing bettongs: What about the Soil Seedbanks?" Ecological Society of Australia Conference, Adelaide.

A number of papers are also in preparation and are expected to be published in 2006 and 2007.

Diet of the re-introduced Greater Bilby (*Macrotis lagotis* : Peramelidae) and Burrowing Bettong (*Bettongia lesueur* ; Potoroidae) in the Arid Recovery Reserve, northern South Australia. Katherine Moseby and Jackie Bice.

Seedling germination and growth rates of selected perennial species under rabbit, cattle and native mammal grazing regimes. Nicki Munro, Katherine Moseby and John Read (Funding obtained from the Native Vegetation Fund).

A comparison of monitoring methods for reintroduced threatened mammal species in northern South Australia.

*Previously published research:*

Bolton, J. and Moseby, K.E. (2004). The activity of Sand Goannas *Varanus gouldii* and their interaction with reintroduced Greater Stick-nest Rats *Leporillus conditor*. Pacific Conservation Biology 10(3) 193-201.

Finlayson, G.R. and Moseby, K.E. (2004) Managing confined populations: The influence of density on the home range and habitat use of re-introduced Burrowing Bettongs (*Bettongia lesueur*). Wildlife Research 31:457-463.

Moseby K.E. and Bice J. (2004). A trial reintroduction of the Greater Stick-nest Rat (*Leporillus conditor*) in arid South Australia. Ecological Management and Restoration 5(2):118-124.

Moseby, K.E and O'Donnell, E. (2003). Reintroduction of the greater bilby, *Macrotis lagotis* (Reid) (Marsupialia : Thylacomyidae), to northern South Australia: survival, ecology and notes on reintroduction protocol. Wildlife Research 30:15-27.

Moseby, K.E., Selfe, R. and Freeman, A. (2004). Attraction of auditory and olfactory lures to Feral Cats, Red Foxes, European Rabbits and Burrowing Bettongs. Ecological Management and Restoration 5(3) 228-231.

Read, J.L. (2004). Catastrophic Australia following intensive cattle browsing. J. Arid Environs 58: 535-544.

Ryan, S.A, Moseby, K.E. and Paton, D.C. (2003). Comparative Foraging Preferences of the Greater Stick-nest Rat (*Leporillus conditor*) and the European Rabbit (*Oryctolagus cuniculus*): Implications for Regeneration of Arid Lands. Australian Mammalogy 25: 135-146.