The Role of the Reintroduction of Greater Bilbies (*Macrotis lagotis*) and Burrowing Bettongs (*Bettongia lesueur*) in the Ecological Restoration of an Arid Ecosystem: Foraging Diggings, Diet, and Soil Seed Banks

Janet Newell

School of Earth and Environmental Sciences
University of Adelaide

May 2008

A thesis submitted for the degree of
Doctor of Philosophy

Table of Contents

Abstract

Arid Recovery, a fenced reserve free of feral predators in arid South Australia, has successfully reintroduced two critical weight range (CWR) mammals, greater bilbies (*Macrotis lagotis*) and burrowing bettongs (*Bettongia lesueur*) to facilitate the restoration of arid Australian ecosystems. This thesis evaluates the ecological roles of these reintroduced species and their relationship to ecosystem functioning and the restoration of these ecosystems.

Surveys of foraging diggings and soil seed banks, and dietary analysis were used to measure impacts of these species on three main habitats within the Reserve. The results showed that bilbies and bettongs have three major roles in ecosystem functioning: consumers, ecosystem engineers, and dispersers of seeds and fungi.

Both bilbies and bettongs were omnivorous, though their diets were distinctly different, with the bilbies focused more on invertebrates and seeds, while the bettongs consumed a greater proportion of coarser plant materials. The seed portion of the diets of both species during 2003-04 differed from a similar study three years previously, shortly after the animals had been reintroduced to Arid Recovery in 2000-01. During 2003-04, the bilbies consumed a lower proportion of seeds of species of grasses and more of forbs, while seed consumption by bettongs narrowed to be almost exclusively the seeds of shrubs.

The number of bilby and bettong diggings varied significantly both spatially and temporally, with averages of 7,530 ± 820 diggings ha^{-1} in Dunes, 10,560 ± 980 diggings ha^{-1} in Mulga, and 7,120 ± 610 diggings ha^{-1} in Swale. This resulted in an average of 2 to 3% disturbance of soil surface area, which is similar to or higher than reported for other Australian or overseas semi-fossorial species. The temporal variation in rates of digging was correlated with minimum daily temperatures and rainfall but not moonlight. This variation was also correlated with counts of bilby but not bettong tracks, suggesting that the temporal variability of diggings was related to levels of bilby activity.

The persistence of bilby and bettong diggings differed between the three habitat types, with the majority of the diggings in the Mulga (94%) and Swale (87%) persisting for over 12 months, while Dune diggings filled much faster, with only 15% persisting over 12 months. These diggings were shown to accumulate and bury seeds and litter, and, under some conditions, enhance germination.

The seeds of two plant species, the annual grass, *Dactyloctenium radulans,* and the shrub, *Enchylaena tomentosa,* germinated from bilby faecal pellets, and over a third of bilby faecal pellets contained fungal spores. Therefore bilbies have the potential to be dispersers of both seeds and fungi.

All three major roles of the bilbies and bettongs in ecosystem functioning (consumers, ecosystem engineers, and dispersers of seeds and fungi) have the potential to affect the flows of organic, soil and water resources, and therefore vegetation structure and overall productivity. Soil seed bank densities differed between areas with and without bilbies and bettongs. However, the heterogeneity of the system made it difficult to confidently relate these differences to any particular effects of the bilbies and bettongs.

Both bilbies and bettongs were able to locate and dig seeds buried 20 cm deep, and the caches of seed-harvester ants. Experiments showed that in areas of high digging density, 71 to 94% of seed rain accumulated and became buried in diggings. Since bilbies and bettongs have the potential to use buried seed resources, they have the potential to significantly affect soil seed banks through their consumption of seeds, redistribution of seeds through their digging activities and their interactions with other granivorous species.

This study is a first step towards understanding the roles of reintroducing CWR mammals to arid ecosystems. Possible longer term effects of these reintroductions will depend on suitable regulation of animal numbers, and climatic patterns, as restorative effects of diggings would be greatest during periods of good rainfall, whereas droughts would slow restorative processes.

Although the results of this research are unique for Arid Recovery, the principles of evaluating all major ecological roles of reintroduced species and their interactions with their environment could provide guidance for other reintroductions. These interactions are complex and would require longer-term studies over a range of conditions and locations to further understand the role of reintroducing CWR mammals to ecological restoration.

Declaration

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

I give consent to this copy of my thesis, when deposited in the University Library, being available for in all forms of media, now or hereafter known.

Signature

Date

“When we try to pick out anything by itself,
we find it hitched to everything else in the universe”

John Muir

Acknowledgements

First of all, a very special thanks to all the bilbies and bettongs at Arid Recovery for all the insights that they and their diggings have given me on the wonder, beauty and challenges of life in arid Australia.

I would like to thank my supervisors, Dr David C. Paton, Dr Sue Carthew, Dr Jose Facelli and Katherine Moseby for their support and advice.

I would also like to thank the Arid Recovery staff and my other Roxby Downs friends, in particular, Brydie Hill, John Read, Nicki Munro, Jeff Turpin, Adam Bester, Jenny Stott, Bree Galbraith, Pete Paisley, Carly Bishop, and Yvette Mooney, for their support. I would also like to thank the many other volunteers and Earthwatch participants for their field assistance, especially when the work was boring and under difficult conditions.

I would also like to acknowledge the encouragement and support of my fellow postgrads in the Paton lab: Tina Bentz, Colin Baileys, Dan Rogers, Matt Ward, Dragos Moise and Craig Gillespie; Carthew lab: Meredeth Brown, Josh Griffiths; and Facelli lab: Gael Fogarty, Greg Hay.

I am especially grateful for the financial support for this project from The Norman Wettenhall Foundation, Wildlife Conservation Fund, and the University of Adelaide and the in-kind support from Arid Recovery.

Last but definitely not least I would like to acknowledge the support and financial assistance of my parents and family, including my cockatiel Kira. In particular I would like to thank my mother, for without her on-going support, persistence and proof-reading, this thesis would never have been completed.