THE ROLE OF MINING COMPANIES IN MAMMAL CONSERVATION

A WESTERN AUSTRALIAN CASE STUDY [1]

by

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Abstract. The Western Pebble Mound Mouse (*Pseudomys chapmani*) is found throughout the Pilbara region of Western Australia. When first described in 1980, very little was known of tbe biology of this species. This situation, together with an apparent contraction of its range, prompted its declaration on Schedule 1 of the Wildlife Conservation Act (1950) as a species that is rare and endangered and likely to become extinct. The frequent presence of *P. chapmani* on iron ore deposits represented a major conservation issue for mining companies. Early attempts to develop management plans for this species were hampered by a lack of basic biological and life history data. On this basis Hamersley Iron Pty Ltd. and other Pilbara iron ore producers undertook research program to help better understand the biology of *P. chapmani*. Research on *P. chapmani* was broken into 3 separate components. The first involved a long-term regional survey of the Pilbara to fully document the distribution of *P. chapmani* mounds. The second program documented the social structure and patterns of movement of *P. chapmani*. The final program developed and undertook an experimental translocation of *P. chapmani* away from high disturbance mining areas to areas that will not be disturbed. Data from industry based studies were extensively used in a recent review of the conservation status of *P. chapmani*. This review concluded that *P. chapmani* populations in the Pilbara are far more stable than originally tbought. The review recommended that *P. chapmani* should be deleted from Schedule 1 and allocated to the IUCN (1994) Red List category of "Least Concern".

Additional Key Words: translocation, *Pseudomys chapmani*, mining

Introduction

Over the past 20 years there has been a growing awareness within Australia of the importance of biodiversity conservation with particular importance being placed on native mammal conservation. In 1993 Australia became a signatory to the 1992 Convention on Biological Diversity. As a part of this ratification the Australian government has agreed to a number of initiatives including a National Strategy for the Conservation of Australia's Biological Diversity.

The Strategy recognises a number of important facts, including;

- that there are many endangered species and ecosystems that are not protected in the national park system.
- current land tenure arrangements in Australia preclude widespread expansion of the national park system as a means of improving biodiversity conservation

These factors significantly raise the importance of off reserve initiatives and cooperative agreements as a means of promoting biodiversity conservation.

This paper details the level and importance of mining company involvement in endangered species management programs, with particular reference to work conducted by mining companies on the Western Pebble Mound Mouse (*Pseudomys chapmani*).

The Western Pebble Mound Mouse

The Western Pebble-mound Mouse, *Pseudomys chapmani*, (Kitchener 1980) is a small native rodent endemic to the Pilbara region of Western Australia (Figure 1). In the Pilbara *P. chapmani* generally inhabit rocky slopes with little or no soil in which to burrow, but

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with a plentiful supply of pebbles. *P. chapmani* is one of only three species of Australian rodent which builds a permanent above ground structure of pebbles over a subterranean burrow system (Dunlop & Pound 1981). Pebble mounds represent an important resource in the life history of *P. chapmani*, forming the focal point of male and female home ranges, with mice showing long term site fidelity towards home mounds. Within the mound, populations are often large and demographically complex (Anstee *et. al.*, 1997), with one or two mature males, several mature females and a number of juveniles. The genetic relationship between individuals sharing a mound is not known.

After its initial description in 1980 very little research was carried out on the biology of *P. chapmani*. This lack in our understanding of the biology of *P. chapmani,* together with an apparent contraction of its range, prompted its declaration on Schedule 1 of the Western Australian Wildlife Conservation Act (1950) as a species that is rare and endangered and likely to become extinct.

Throughout much of its range *P. chapmani* comes into conflict with iron-ore mine developments, with both the mice and the mining industry having a liking for the same types of topography and geology.

Conservation issues

Since *P. chapmani* was described in 1980 many environmental assessments for proposed projects have identified the presence of *P. chapmani* on land to be disturbed as a conservation issue. Table 1 provides an indication of the number and diversity of projects being proposed in the Pilbara.

The conservation significance of *P. chapmani* came to the fore in 1992 during the preparation of the Environmental Review and Management Plan for Hamersley Iron's Marandoo iron ore project. During the environmental assessment of the Marandoo Project, the community indicated a strong interest and concern in the conservation status of *P. chapmani*. Of the 600 public responses to the ERMP, 133 raised concerns about the effect of the project on the conservation status of *P. chapmani* in the Pilbara.

In response to these concerns, Hamersley embarked on a research program to provide details of *P. chapmani* biology so that effective management programs could be developed for Marandoo and other Hamersley mines.

Table 1 Examples of Pilbara projects affected by the presence of *P. chapmani* (from Start 1996).

Project	Type
Area C	New Mine
Brockman Detritals	New Mine
Burrup Land Use/Mgt Plan	Land use planning
Camel Road Heritage Trail	Nature Trail
Channar Mine	New Mine
Exmouth Borefield	Water Supply
Jimblebar Mine	New Mine
Marandoo	New Mine
Mt Bruce Road	New Road
Mt Whaleback	Mine Management
BHP Ore body 25	New Mine
BHP Ore body 18	New Mine
Tom Price North Road	New Road
Yandi Mine	New Mine
Yandi Railway	New Railway
BHP Yandi Mine Stage 1 & 2	New Mine
BHP Yandi Rail	New Railway
Yarrie Mine	New Mine

Specifically, the research program involved:

- Long term regional survey of the Pilbara to document the actual distribution of *P. chapmani* in the Pilbara.
- Development of a fast reliable system of determining if mounds are actually being occupied by *P. chapmani.*
- An examination of the social structure and patterns of movement of *P. chapmani.*

This work culminated in 1997 with the development and implementation of an experimental translocation study for the removal of *P. chapmani* away from areas of mine site disturbance. The study was implemented as part of the Environmental Management Plan for Hamersley's Yandi Iron Ore Project.

Range and Distribution Surveys

Range and distribution surveys were commenced in 1991 with a number of consultant based surveys being conducted in and around Hamersley's Marandoo project area (Ninox 1991). Early work focused on areas within the Marandoo project area and adjacent Karijini National Park. Broader regional surveys were commenced in August 1992 with a linear survey that extended from

Karratha in the north through to the Collier range in the south (Piggott 1992). In October 1992, the Gregory Range and Rudall River National Park in the eastern Pilbara were surveyed for the presence of *P. chapmani* mounds (Piggott 1992b). A third survey targeting the western Pilbara and northern Gascoyne was conducted in May 1994 (Piggott 1994). These surveys provided the first sets of data that indicated that the perceived range of *P. chapmani* was much greater than originally thought. The August 1992 survey recorded a total of 76 mounds from 5 locations, while the October survey recorded 136 mounds from 2 locations. A breakdown of the number of mounds recorded and mice captured during surveys in 1992 is given in Table 2.

It should be noted that while these surveys played an important role in redefining the range of *P. chapmani* in the Pilbara, they were very focused in their aerial extent and thus were not able to provide much information on the distribution of *P. chapmani* within its range.

One of the major constraints to conducting intensive range and distribution surveys in a region as large as the Pilbara is the high cost of surveying large tracts of land. As part of their normal duties, Hamersley exploration personnel walk, drive and fly over vast areas of the Pilbara. By way of an example, in 1995 exploration personnel walked over 700 line kilometres. With this in mind Hamersley's Environmental Affairs department embarked on a program to involve the company's exploration personnel in the *P. chapmani* research program. A series of newsletters and handouts were produced to inform exploration personnel of the research program and its aims. To facilitate data collection information sheets were issued each employee in the field. The sheets included background information on *P. chapmani* and instructions on how to record a Pebble Mounds position and assess the activity status of the mound.

The use of incidental sightings from exploration personnel resulted in the generation of records of *P. chapmani* distribution on both a regional and local basis. Prior to 1991 the aerial distribution of *P. chapmani* could be calculated from Western Australian Museum specimens as approximately 44 000 km^2. At the completion of the regional surveys, the known distribution (based on the presence of active mounds) had been increased to 114 900 km^2 (Piggott, 1994). By 1996 the distribution of *P. chapmani* in the Pilbara was calculated at 220 400 km^2 (Start, 1996).

Specific Biological Research

While the range and distribution work was important in documenting the extent of occurrence of *P. chapmani* mounds, it was not able to provide detailed information on the basic biology of *P. chapmani*. Answers to key questions (such as how many mice live in a mound and what are the home ranges and spatial separation between mound populations) were seen as vital pre-requisites to the development of a successful management program. In 1994, Hamersley's research program shifted away from dedicated range and distribution surveys to studies that focused on the social structure and patterns of movement of *P. chapmani*.

Within suitable habitats, *P. chapmani* mounds can be found in very high densities. More importantly not all of the mounds within a particular area are occupied at the same time (Anstee *et. al.*, 1997). Trapping of the mound is the most conclusive means of determining if mice occupy a mound. However trapping is a time-consuming process requiring several nights of effort. Because of this, an alternative method was developed to test for the presence

Table 2. The number of active and inactive pebble mounds recorded during *Pseudomys chapmani* range surveys of 7 geographically distinct Pilbara locations.

Location	Date	Active Mounds	Inactive Mounds	Mice Trapped
Chichester Range N.P.	Aug 92	30	21	1
Mt. Bilroth	Aug 92	5	0	0
Karijini N.P.	Aug 92	5	5	0
Pamelia Hill	Aug 92	7	4	0
Collier Range N.P.	Aug 92	1	3	0
Gregory Range	Oct 92	89	0	5
Rudall River N.P.	Oct 92	24	23	2

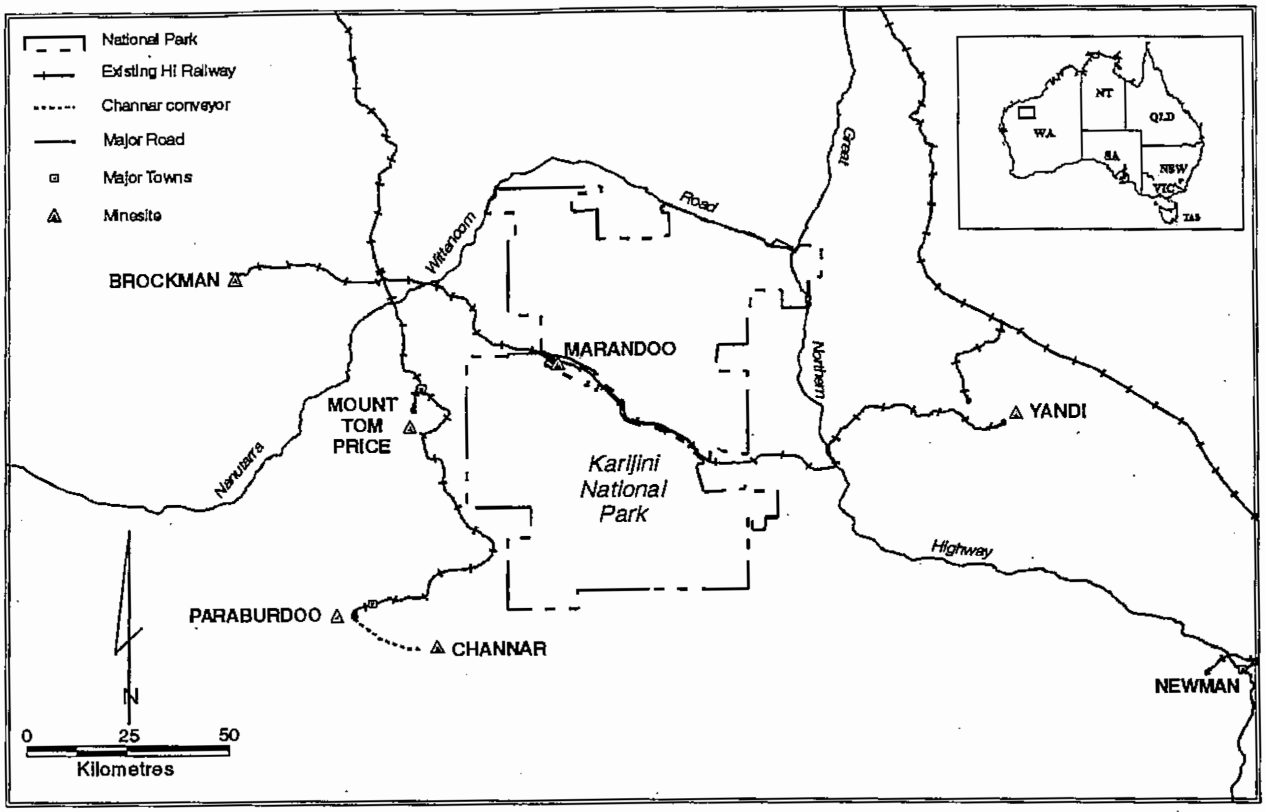

Figure 1 The Pilbara region of Western Australia showing the location of Hamersley's operations and the Pseudomys chapmani study sites.

of *P. chapmani* in a mound. The system used the external features of the pebble mound to determine if the mound was occupied by *P. chapmani* (Anstee 1996). The scoring system proved to be an effective predictor of the presence of *P. chapmani* with active mounds having a significantly higher score than inactive mounds. More importantly it proved to be an effective way of assessing the status of a large number of mounds in a very short time.

Results of an intensive trapping and radio tracking program at Marandoo (Anstee *et. al.*, 1997) and Yandi in 1997, indicated that *P. chapmani* maintain complex social groups within the mounds. Mounds often contained relatively large numbers of animals (Figure 2), with a typical break down of the population structure being one reproductive male, two or three reproductive females at different stages of their reproductive cycle and a number of non-reproductive adults and juveniles of both sexes

The harmonic mean method (Dixon & Chapman 1980) was used to calculate the home range and core area of radio tracked mice. We deemed the home range of an animal to be the area contained within the 95% isopleth. The 50% isopleth was used to define the core area of the mice. Home-range analysis revealed that *P. chapmani* maintains large home ranges, with males (mean = 14.4 ± 6.7 ha) covering much more ground than females (mean = 4.6 ± 2.7 ha). Core-areas for both males and females were considerably smaller than their respective home ranges. For males, the mean home range and core area sizes were significantly larger than those recorded for females (home range $t_8 = 3.268$, $P < 0.05$; core area $t_9 = 4.68$, $P < 0.05$). A particularly important aspect of the home ranges of *P. chapmani* was the amount of range overlap between individuals from different mounds at both the home range and core-area levels. While considerable overlap of home ranges was recorded between individuals from the same and different mound overlap at the core area level occurred only between individuals from the same mound (Anstee *et. al.*, 1997).

The size and overlap of home ranges and core areas have important implications for management programs directed at *P. chapmani.* In addition, the high level of social complexity indicates that management policies should be directed at the level of the social group rather than at the level of the individual. In cases were translocations are proposed the chances of success should be increased by moving the entire mound groups rather than groups made up of individuals that are unknown to each other.

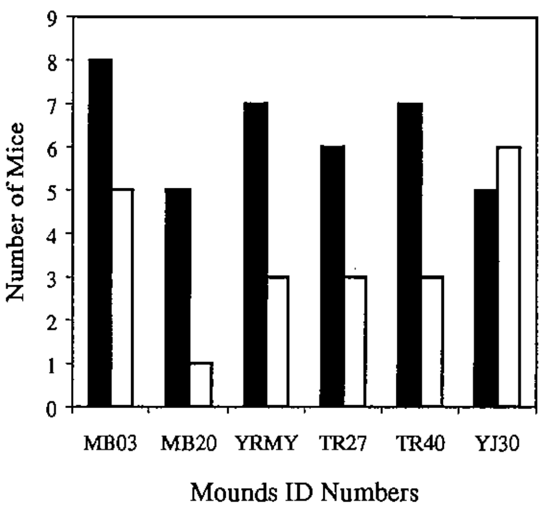

Figure 2. The number of male (open bar) and female (closed bar) *Pseudomys chapmani* captured at selected mounds at Yandi and Marandoo study sites. MB mounds were located at Marandoo YR, YJ & TR mounds were located at Yandi

Translocation Study

As part of the development of Hamersley Iron's Yandi Iron Ore Project, a management plan was developed that incorporated research on methods to reduce the impact of the development on *P. chapmani.* The management plan centred around a translocation study, the aim of which was to test if *P. chapmani* could be removed from areas affected by the project's development and relocated to areas where they would not be disturbed by future mining activities. Ideally translocations should be designed to reintroduce animals back into areas where they have become locally extinct. At the time of planning for this study it was believed that a successful re-introduction of *P. chapmani* into an area of its former range was not possible. Of primary concern was *P. chapmani's* apparent inability to quickly colonise old degraded mounds, like the ones found in areas where it was locally extinct. Previous translocation experiments (Anstee, unpublished data; Endersby & Teal, in prep.) released mice onto old, degraded mounds that did not have readily useable burrow systems. These studies indicated that *P. chapmani* could not quickly establish a burrow system in an old mound and that access to a structurally competent burrow system was an important factor in translocation success. Structurally competent burrow system can only be found where *P. chapmani* are present.

With this fact in mind, the current translocation was undertaken as a trial that would hopefully provide data on the biology of *P. chapmani* and its response to translocation procedures that could be used to design future re-introductions of *P. chapmani* into areas of its former range. The trial translocation had two specific aims. The first was to determine if translocated *P. chapmani* could successfully colonise, structurally competent, but unfamiliar mounds. The second aim focused on what effect individual familiarity between members of the translocation group would have on translocation success. A previous study (Anstee *et. al.*, 1997) indicated that *P. chapmani* was a highly gregarious species with little tolerance of strangers. It was therefore hypothesised that that high levels of familiarity within the translocation's founder groups should lead to high group cohesion which will in turn increase the likelihood of long term translocation success by preventing the disintegration and dispersal of the founder group.

Work commenced in July 1997 to clear mice from active mounds within the proposed Yandi Project area, in particular the rail line and initial mining areas. Volunteers from the Australian Trust for Conservation Volunteers and postgraduate students from the University of Western Australia played an important role during this phase of the study. Mice were collected from a total of 45 mounds over a 1-month period. All mice captured during this period were transported to a holding camp where they were separated into founder groups of 5 to 12 mice for later translocation to mounds in the study area.

Founder groups were allocated to one of three translocation treatments based on a combination of two variables. The familiarity of individuals in a founder group to each other and the familiarity of the founder group as a whole to the structure of the burrow system in the mound they were being translocated too. The combinations of variables that make up each treatment are detailed in Table 3.

Table 3.The level of individual and mound structure familiarity associated the three founder groups T1 -T3 and the control group T4. Each of the founder groups was replicated four times. Numbers in brackets are the number of individual mice in each treatment.

Treatment	Between individuals familiarity	Mound structure familiarity
T1 Unrelated away (32)	All individual unfamiliar with each other.	All mice unfamiliar with the structure of the mound
T2 Related away (33)	All individuals familiar with each other.	All mice unfamiliar with the structure of the mound
T3 Related at home (36)	All individual familiar with each other.	All mice familiar with the structure of the mound
T4 Resident mice (73)	All individual familiar with each other, but not part of founder group.	All mice familiar with the structure of the mound, but not part of founder group.

A critical part of the experiment required us to translocate the founder groups into mounds with sound burrow systems. Past work indicated that mounds with sound burrow systems always had a resident population living in them. To avoid confounding effect of translocating mice into mounds that already contain a resident population it was necessary to trap the 12 mounds we had selected as our translocations mounds to remove all the mice living in them. This meant that there were now 12 mounds in the study area with sound burrow systems, but no resident mice, available to be repopulated by the founder groups.

Mice trapped and removed from the target mounds were transported the holding camp and used to increase the number of mice in the translocation treatments. Which treatment mice were used in was dependant upon the size of the group of mice captured in each mound, they were allocated to treatments in the following way:

- The four largest groups were kept together as distinct founder groups, at the time of release these four groups were released onto the mound from which they were originally captured (treatment T3 Related at Home).
- The next largest group was also kept together as a distinct founder group, at the time of release this group along with three other groups captured along the rail line and initial mining areas were released onto a different mound from which they were originally captured (treatment T2 Related away).
- The remaining mice were added to different founder groups in which all the mice were unfamiliar to each other these groups were then released onto mounds that were unfamiliar to all the mice in the founder group (treatment T1 Unrelated away).

A fourth resident non-translocation treatment comprised *P. chapmani*, which inhabited other mounds apart from the 12 target mounds at the release site. These mounds were located within the study area but were not chosen as one of the 12 translocation mounds. They were not trapped prior to the translocation release and no mice were removed or added to these mounds

All the translocation groups were released onto their target mounds during the evening of the 9th of September 1997. The progress of the translocation groups within the mound enclosures was monitored for 7 nights following the release until it was concluded that the mice were utilising the underground burrows of their relocation mounds. The progress of the translocation groups was then monitored through a combination of radio tracking and trapping over an eight month period.

Translocation Results

A total of 101 (58 female and 43 male) *P. chapmani* were translocated to the 12 translocation mounds in the study area. See table 3 for a breakdown of the number of mice in each treatment. Of the 101 *P. chapmani* translocated, 65 (64.3%) were captured in the study area post9 release.

A steady decline in the number of mice known to be alive post release was observed in each of the translocation treatments. By day 176 post release, only 8 (three familiar away, three familiar home, two unfamiliar away) of the original 101 mice were recaptured in the study area.

The ability of *P. chapmani* to colonise unfamiliar mounds was assessed by examining the total and rate of loss of mice from the translocated population (the three translocation treatments combined) and the resident (non-translocated) population (Figure 3). Both the translocated population and the non-translocated population experienced a steady loss of individuals from the study area between the release date in September and the third monitoring period in November 1997, and subsequently, the rate of loss decreased. By day 176-post release, a maximum of 89.1 % of the non-translocated population and 92.1% of the translocation population had been lost from the study area.

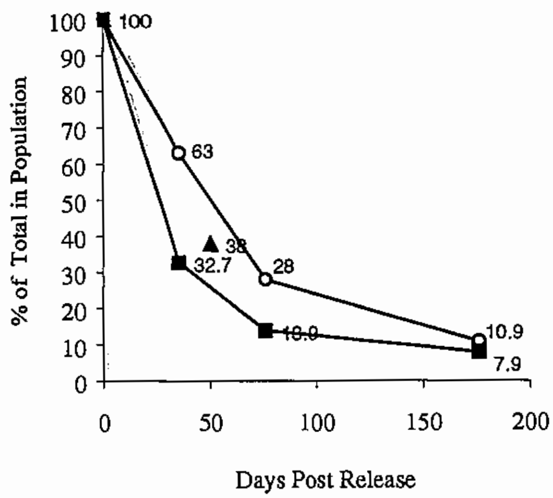

Figure 3. The total and rate of loss for translocated and resident non-translocated mice (open circles = resident non-translocated, closed squares = translocated closed diamond = Marandoo study)

It can be argued that the introduction of the translocated mice into the study area adversely affected the longevity of the resident non-translocated mice, possibly by increasing competition for limited resources such as food shelter etc. If this were the case then the small difference in the rates of loss between the two translocation groups overestimates the translocation groups ability to colonise unfamiliar mounds. The validity of this statement was tested by comparing the rate of loss figures for the resident non-translocated mice at Yandi with the rate of loss figures for a population of mice from Marandoo that were not involved in the translocation. . If the translocation of mice at Yandi was adversely affecting the longevity of the resident mice there should be a marked difference between the rate of recapture for the Marandoo and Yandi populations. What we found was that there was no major difference between the two populations. It appears therefore that the introduction of the mice into the Yandi study area had a minimal effect on the resident non-translocated population.

The results of this experiment indicate that there was very little difference in the total and rate of loss of translocated and resident non-translocated mice. In addition both the translocation and the resident non-translocated treatments were shown to have similar rates of loss to mice from other studies that did not involve the

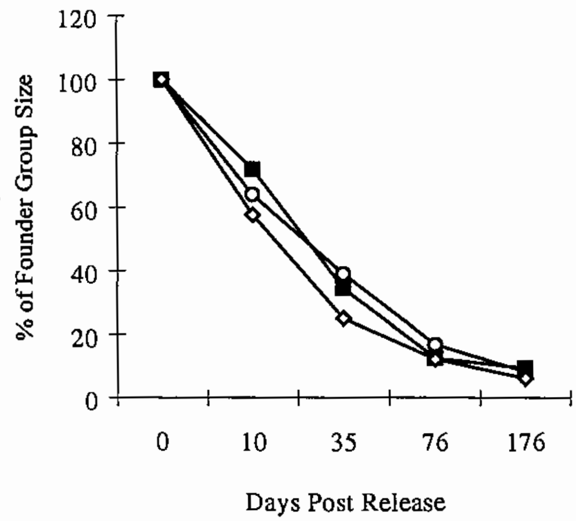

Figure 4. The proportion of captures for each of the three translocation treatments over the 4 trapping periods (open circles = related at home, closed squares = related away, open diamonds = unrelated)

movement of mice into areas that already contain a population.

The effect of familiarity within founder groups on translocation success was examined by comparing the number of mice known to be alive (expressed as a percentage of the total number of mice in each treatment) within each treatment over the 4 trapping periods.

The treatments experienced very similar rates of loss of individuals over the 4 trapping periods (Figure 4). By day 10 post release, a maximum of 42.4 % of the unfamiliar treatment had been lost from the study group, compared with 28.1 % from the familiar at home treatment and 36.1 % from the familiar away treatment. By day 76 post release, a maximum of 87.9 % of the unfamiliar treatment had been lost from the study group, compared to 83.3 % from the familiar at home treatment and 87.5 % from the familiar away treatment.

A statistically significant difference in translocation success between the three familiarity treatments was not detected in this study. We conclude this to mean either that individual familiarity has no effect on translocation success in *P. chapmani* or that the experimental design used in this study lacked the statistical power to detect a familiarity effect. The design of the experiment was constrained by the number of mice inhabiting the areas to be disturbed by the development of the Yandi Project. This in turn limited the size of each founder group and the number of replicates within each treatment. Subject numbers and translocation logistics have been cited as experimental design limitations in other translocation experiments (Armstrong *et. al.*, 1995).

While the effects of familiarity on translocation success remains unresolved, the translocation was considered to be a success overall. *P. chapmani* demonstrated that they were capable of being integrated into unfamiliar mounds and then persisting for an extended period. As a management tool, the translocation project would prove to be an efficient and cost effective means of preserving part of a local population if competent burrow systems were available.

Conclusion

The Australian Federal Government has stated that the contribution of the Private sector as critical to the successful development and implementation of the National Strategy for the Conservation of Australia's Biodiversity (Environment Australia 1998). Within the private sector, the mining industry is recognised as becoming a key contributor to conservation within Australia. To this end the mining industry is already making important contributions through numerous areas:

- Baseline research as part of project approvals constitutes a significant portion of the biological survey work being conducted in Australia.
- Species protection programs that manage and ameliorate the impacts of mining on native plant and animal species.
- Mine site rehabilitation programs that promote the regeneration of native ecosystems.

The work conducted by Hamersley Iron provides an excellent example on how the private sector can enhance the biodiversity conservation work of Government departments. The initial survey works significantly increased the documented range of the species.

In 1996 scientist from the Department of Conservation and Land Management reviewed the conservation status of *Pseudomys chapmani* (Start 1996). The review utilised data from a number of sources, but was particularly reliant on data collected by mining companies. With important data on *P. chapmani* distribution, biology and life history being generated by mining company sponsored or conducted research programs. In the report it was concluded that within suitable Pilbara habitats *P. chapmani* is common, widespread and secure. Start recommended that *P. chapmani* be deleted from the schedule 1 "fauna that is likely to become extinct or is rare" of the Western Australian Wildlife Conservation Act and listed as a Priority 4 species on the CALM reserve list.

Start did note however that much of the work done by mining companies has not been subject to peer review nor formally published, and is therefore not readily available to environmental managers and the scientific community.

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