WESTERN AUSTRALIAN WILDLIFE MANAGEMENT PROGRAM No. 17

DJOONGARI (SHARK BAY MOUSE), *Pseudomys fieldi*, RECOVERY PLAN

1992-2001

by

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Drawing of Djoongari: Jane McRae

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FOREWORD

Recovery Plans delineate, justify and schedule management actions necessary to support the recovery of a threatened species or ecological community. The achievement of objectives and the provision of funds is subject to budgetary and other constraints affecting the relevant parties, as well as the need to address other priorities. Recovery Plans do not necessarily represent the views nor the official positions of any individuals or agencies represented on the Recovery Team. They represent the position of the Department of Conservation and Land Management only after approval by the Executive Director, the National Parks and Nature Conservation Authority and Minister for the Environment. Approved Recovery Plans are subject to modifications as directed by new findings, changes in species' status and completion of recovery actions.

In 1991 a draft Recovery Plan was prepared for the Djoongari (Shark Bay Mouse), *Pseudomys fieldi* (Orell and Morris 1991), and a recovery team established to oversee the implementation of the plan. During the first year, changes to the schedule for translocations were considered necessary and the Recovery Plan was revised in 1997 (Morris, Speldewinde and Orell, 1997). To enhance the conservation of this extremely restricted native rodent, it was considered that the first translocation should be to another island, rather than to a mainland site. An eight year time frame to implement the recovery actions was also considered too short and this has been extended to 10 years. Delays in the reduction of feral cats have delayed the translocation to Peron Peninsula. A second translocation to Heirisson Prong was planned for 1999 (to be run as a PhD project) but was not undertaken due to lack of a suitable student. A translocation to North West Island in the Montebello Island group was undertaken in 1999. This revised Recovery Plan reflects these changes with some increase to the budget. Information in this plan is accurate at January 2000.

SUMMARY

Current Species Status:
Endangered (Commonwealth *Endangered Species Protection Act 1992);* Rare or likely to become extinct (WA *Wildlife Conservation Act 1950*), Vulnerable (IUCN 1994). Prior to European settlement, the Djoongari occupied most of the south-west quadrant of Australia. It became extinct on the mainland by the late 19 th century and until 1993, was restricted to Bernier Island, in Shark Bay, Western Australia. Population size was estimated at *c*. 6000-7000 animals in 1992. In 1993, 1994 and 1999 Djoongari were translocated to three other sites; Doole Island, Heirisson Prong, and North West Island respectively.

Habitat Requirements and Limiting Factors:
On Bernier Island, the Djoongari inhabits coastal dune vegetation dominated by beach spinifex and coastal daisy bush but also occurs at lower densities in inland *Triodia*/*Acacia* heath. Its preferred habitat on the mainland, especially inland, is not known. Reasons for the decline of the Djoongari and its extinction on the mainland are also unknown but the process may have begun prior to European settlement due to a subtle climatic change. It is also possible that its habit of using above ground nests rather than deep, complex burrow systems has made the Djoongari vulnerable to the physical effects of overgrazing and trampling by domestic and feral stock and to predation by foxes and feral cats, and these may be the primary factors responsible for its decline.

Recovery Plan Objective:
Downlisting to Lower Risk (Conservation Dependent) by 2006.

Recovery Criteria:
(1) Current (1992) distribution and abundance retained on Bernier Island.
(2) A self-sustaining population established on Doole Island.
(3) Two self-sustaining populations established on the Shark Bay mainland.
(4) Viable captive breeding population established at the Perth Zoo.
(5) A self-sustaining population established on North West Island.

Actions Needed:
A Recovery Team comprising members from CALM, CSIRO, Useless Loop Community Biosphere Project Group, Inc. and Environment Australia has been established to coordinate and supervise the following actions:
(1) Research into abundance, distribution and biology of the Djoongari on Bernier Island.
(2) Translocation to Doole Island.
(3) Translocation to Heirisson Prong.
(4) Control of introduced predators, rabbits and goats on Peron Peninsula.
(5) Captive breeding.
(6) Translocation to Peron Peninsula.
(7) Translocation to North West Island.

Estimated Cost of Recovery: 1992-1996:1991 prices in $000 s/year. **1997-2001**: 1996 prices in $000 s /year.
Total cost TC= CALM plus other agency contributions.

Year	1	2	3	4	5	6	7	Total
	TC	TC	TC	TC	TC	TC	TC	TC
1992	71.6							71.6
1993	2.2	57.4						59.6
1994	2.2	37.2	64.3					103.7
1995	2.2	2.0	97.3	190.0				291.5
1996	2.2	2.0	94.4	190.0				288.6
1997	10.5	6.5	46.0	54.0	3.5	64.0		184.5
1998	10.5	6.5	5.0	54.0	3.5	60.9		140.4
1999	10.5	6.5	18.0	54.0	155.0	0.0	45.7	289.7
2000	10.5	6.5	12.0	54.0	155.0	41.6	8.6	288.2
2001	10.5	6.5	12.0	54.0	155.0	39.7	10.0	287.7
Total	**132.9**	**131.1**	**349.0**	**650.0**	**472.0**	**206.2**	**64.3**	**2005.5**

Note: The salary component of the funds has been included in the major action of the year although time will be spent on other actions which are current.

Biodiversity Benefits: Control programs for introduced predators and competitors will facilitate re-introductions of other threatened fauna in the Shark Bay area. Translocations of the Djoongari will become part of the reconstruction of the original mammal fauna on the Shark Bay mainland.

1 INTRODUCTION

1.1 Description of species

The Djoongari (Shark Bay Mouse) *Pseudomys fieldi* Waite 1896 (= *P. praeconis* Thomas 1910) is a robust, long-haired pseudo-mouse of *c*. 30-50 g in weight (Ride and Tyndale-Biscoe 1962; Watts and Spencer 1978; Watts and Aslin 1981). The dorsal fur is a mixture of pale yellow-fawn underfur and dark guard hairs, giving a grizzly appearance, and the coat colour grades from a delicate buff shade on the sides to white underneath. The feet are white. The tail is slightly longer than head and body, and is bicoloured grey and white with a dark tuft of hairs at the end (Watts and Aslin 1981).

The common name Djoongari, was adopted as a replacement for Shark Bay Mouse following publication of a recommended list of Australian names for Australian Rodents (Braithwaite, *et al.* 1995). The use of this nomenclature for native rodents follows a recent trend to use relevant Aboriginal names for marsupials in Australia.

P. fieldi was first described by Waite in 1896 from a specimen collected near Alice Springs during the Horn Expedition in 1895 (Watts and Aslin 1981). The skull was badly crushed and until recently this was thought to be the only record of the Alice Springs Mouse *P. fieldi*. However *P. fieldi* and *P. praeconis* have been synonymised following many years of examining sub-fossil remains from cave surface deposits at sites from Shark Bay across to Uluru in the Northern Territory (Baynes 1987b; Baynes 1990). Thomas (1910) described *P.* (*Thetomys*) *praeconis* on the basis of a specimen collected at Herald Bight on Peron Peninsula in Shark Bay, Western Australia, in 1858 and a skull collected on Bernier Island, also in Shark Bay, in 1906. Mouse specimens collected from the Victoria Plains near New Norcia, Western Australia, in 1843 were identified by Mahoney (1969) as *P. gouldii* but have since been re-identified by Baynes (1990) as *P. praeconis* (= *P. fieldi*). Although *P. fieldi* has been trapped on Bernier Island on several occasions since (Watts and Aslin 1981), the specimens collected in 1843 (south west Western Australia), 1858 (Shark Bay mainland) and 1895 (central Australia) were the last collected on the mainland

1.2 Distribution and abundance

P. fieldi once had an extensive distribution occupying much of the south-west quadrant of Australia (Figure 1). Examination of cave surface deposits have indicated that the species once occurred throughout the Shark Bay region, including Dirk Hartog Island (Baynes 1990), south along the west coast to Cape Leeuwin (Archer and Baynes 1972; Chapman and Kitchener 1977), across the upper Gascoyne, northern goldfields and Gibson Desert of Western Australia (Baynes 1990), at Uluru, Northern Territory (Baynes 1987b), and the Nullarbor Plain, Western and South Australia (Baynes 1987a). There is no evidence that it occurred in what is now known as the wheatbelt region of Western Australia.

Prior to June 1993, *P. fieldi* was known to be extant only on Bernier Island, a 4 200 ha island 50 km west of Carnarvon in the Shark Bay region of Western Australia. A search for mainland populations was carried out in 1989 with funding from World Wide Fund for Nature, but this failed to detect the presence of the species at selected mainland survey sites in the Shark Bay area (Sanders and Harold 1990). This survey included the Herald Bight area on Peron Peninsula where the Djoongari was last collected in 1858. In June 1993, the Djoongari was translocated to Doole Island in Exmouth Gulf, and in November 1994 it was translocated to Heirisson Prong on the Shark Bay mainland as part of this Recovery Plan (see Sections 3.2 and 3.3).

In 1992 it was estimated that there were *c*. 6 000-7 000 individuals on Bernier Island (Morris and Speldewinde 1992). This population was estimated by determining abundances at five grid trapping sites using a Lincoln Index (Seber 1973) and extrapolating to the total area believed to be occupied by Djoongari. These population estimates should be viewed with caution due to the large errors involved when estimating populations with low capture and recapture rates.

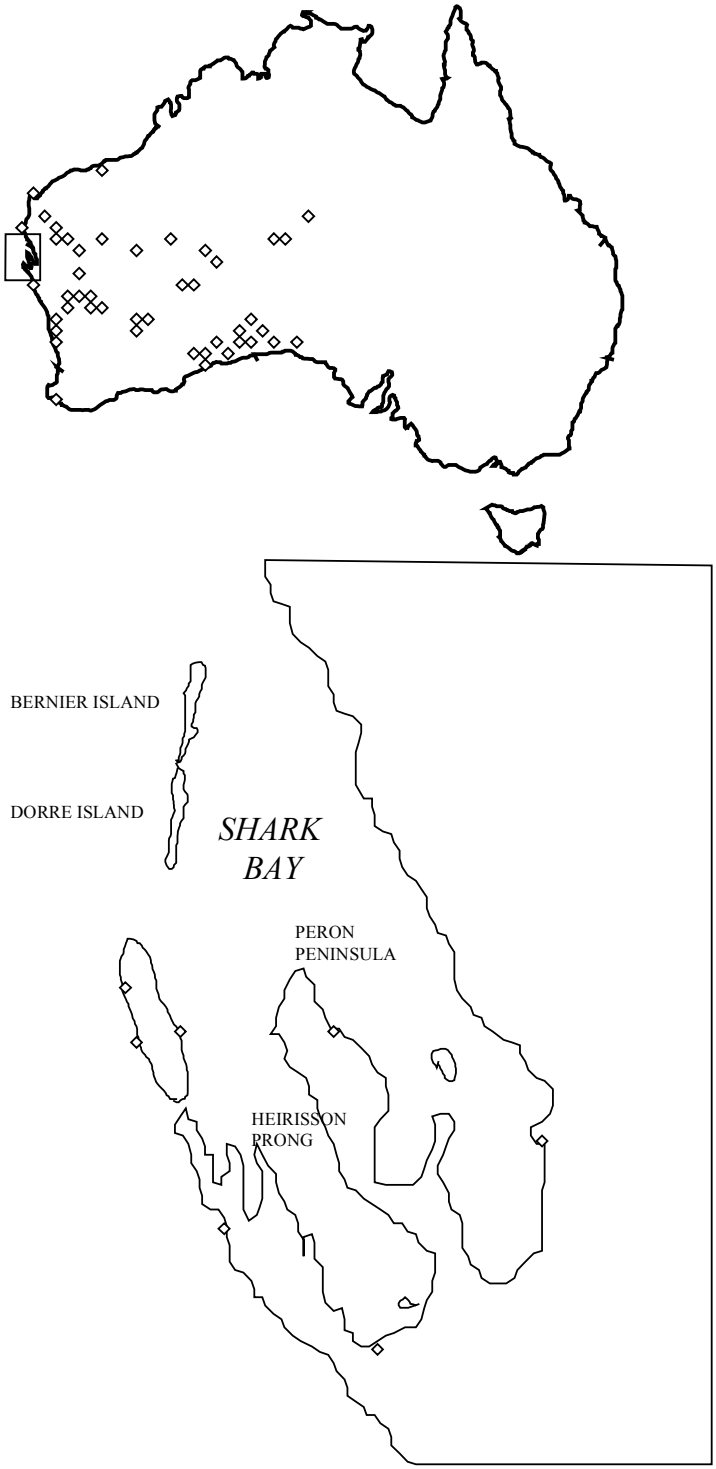

Figure 1: Past distribution of *Pseudomys fieldi* based on subfossil remains from cave surface deposits. Present distribution is limited to Bernier Island and three translocated populations on Doole Island, Heirisson Prong, and North West Island.
Data from A. Baynes

1.3 Habitat

On Bernier Island, *P. fieldi* inhabits coastal dune vegetation dominated by *Spinifex longifolius* and *Olearia axillaris* (Ride and Tyndale-Biscoe 1962; Robinson *et al.* 1976). Recent surveys suggest that the species occurs in most coastal sandy areas around the island (Morris *et al.* unpublished). It also occurs at lower densities in inland *Triodia*/ *Acacia* heath (Robinson *et al.* 1976). Nothing is known of the preferred habitat on the mainland, though it is likely to have been deep sandy soils supporting *Spinifex* and *Triodia* species. On the Shark Bay mainland it was last collected in coastal *Spinifex longifolius* at Herald Bight. Translocated animals on Doole Island also appear to prefer coastal habitats.

Djoongari do not appear to use burrows as commonly as most other *Pseudomys* species. They are known to construct tunnels and runways in heaps of seagrass piled up on Bernier Island beaches during winter storms (Robinson 1983) and use above ground nests as diurnal refuges. More use of burrows is made during the breeding season (Morris and Speldewinde, 1992). Animals translocated to Doole Island used hollows located above high water level in mangrove (*Avicennia marina*) trees as well as sites among rocks and under *Triodia* for daytime refuges.

1.4 Diet

Little is known about the diet of the Djoongari. Scats collected from four individuals on Bernier Island contained petals and anthers from flowers, possibly of *Olearia*, leaf fragments of *Olearia*, leaf or stem parts of a fleshy dicot and insect fragments (Robinson *et al.* 1976). Stomach contents from a single specimen collected by Ride and Tyndale-Biscoe (1962) contained plant material and an insect fragment. They have also been observed eating spiders (Morris, personal observation). Like many native rodent species they appear to be vegetarian/omnivores.

1.5 Reproduction

Most information on the reproduction of the Djoongari has been obtained from observations of captive animals. Watts and Spencer (1978) reported an animal taken from Bernier Island that mated and produced two litters, one of four and one of three, in captivity (litters of five have been recorded, Speldewinde, pers obs.). The oestrus cycle appears to be less than 14 days and the gestation period is about 28 days. The young are born hairless and with ears folded down. At 11 days of age they are well furred and the ears are free but their eyes are still closed. The eyes open after 15 days and by 30 days of age the juveniles are weaned. They are attached to their mother's teats for the first 16 days from birth. The upper and lower incisors erupt by day three. By 100 days of age the mice have reached full adult size. The male was observed to share the nesting box with the female and young when the young were four weeks old. He also behaved protectively towards the young when the female was absent. More recently, successful breeding in captivity has been difficult, with Djoongari mothers being easily disturbed and cannibalising young. Size of the holding pen is probably also important.

On Bernier Island, Djoongari can breed at any time between May and November, with sub-adults (< 30 g body weight) entering the population between November and March (Morris and Speldewinde 1992). Litter sizes up to five have been observed and more use is made of burrow systems during the breeding season. Animals on Bernier Island live for at least two years.

1.6 Conservation status and limiting factors

The Djoongari survived on only one, 42 km^2 island and is one of Australia's most geographically restricted mammals. Until June 1993 it was one of only three Australian mammals restricted to one island, excluding Tasmania (the others are *Leggadina* aff. *lakedownensis* on Thevenard Island and the Bramble Cay *Melomys*). It is listed as a species that is rare, or likely to become extinct under the Western Australian *Wildlife Conservation Act 1950* and is currently listed as Endangered under the Commonwealth *Endangered Species*

Protection Act 1992 and in the Rodent Action Plan (Lee 1995). Using IUCN (1994) criteria the Djoongari would be classified as Vulnerable, although it nearly meets criterion B for Critical; i.e. extent of occurrence less than 100km^2 , known to exist at only one location and extreme fluctuations in number of mature adults. The fluctuation in numbers of mature adults demonstrated by Djoongari does not meet the IUCN (1994) definition of a ten fold variation.

The reasons for the decline of the Djoongari are not known. It has been suggested that cats became established on the mainland prior to European settlement, from 17th century shipwrecks on the west coast (Burbidge *et al.* 1988). These may have been responsible for the decline and extinction of many species, particularly rodents, on the mainland. Burbidge and Fuller (1979) report that the Aborigines in the Warburton area attribute the disappearance of native animals in this area to the cat, however the Aborigines of the central deserts regard the cat as always having been present (Burbidge *et al.* 1988) and value it as a food item.

The advent of the pastoral industry is closely associated with the date of last collection of specimens of *P. fieldi* both in central Australia and Shark Bay. A decrease in environmental productivity and loss of nutrients caused by grazing and trampling by domestic stock has been suggested as a mechanism for the extinction of Australian fauna (Burbidge and McKenzie 1989) and this mechanism may have been involved in the extinction of *P. fieldi* on the mainland. Morton (1990) suggests that the rabbit has been a major factor in mammal extinctions in the arid zone. Both native and exotic mammals in the arid zone depend on pockets of relatively fertile and productive habitat (for example, around water holes, salt lakes or drainage lines) to survive droughts. Competition and habitat degradation caused by increases in rabbit numbers are exacerbated by successive droughts which eventually leads to the destruction of drought refuges and inevitably to extinctions. Altered fire regimes and predation by foxes and feral cats are cited as secondary factors.

The construction of deep, complex burrow systems may be an important factor in the survival of native rodents and this attribute is shared by all extant species on the Shark Bay mainland (*Pseudomys albocinereus, Pseudomys hermannsbergensis, Rattus tunneyi* and *Notomys alexis*). It appears that the Djoongari does not construct substantial burrow systems but rather builds tunnels and runways amongst vegetation (Robinson 1983; Watts and Aslin 1981) and shallow burrows during the breeding season (Speldewinde and Morris, 1993). On the mainland, this behaviour would have made it particularly vulnerable to cat and fox predation and the physical effects of stock and rabbit grazing and trampling.

1.7 Existing Conservation Measures

Currently, the only established Djoongari population is protected from the above threats on Bernier Island as this is part of the Bernier and Dorre Islands Nature Reserve (Class A Reserve No 24869). Feral goats were eradicated in 1984 and the island is free of exotic predators. Public access to Bernier Island is limited to day visits.

Due to its restricted occurrence, however, the species is highly vulnerable to extinction and protection of a single population on Bernier Island is not considered sufficient to ensure long term survival. Under this Recovery Plan, the Djoongari has been translocated to two other exotic predator-free island nature reserves, Doole Island in Exmouth Gulf (June 1993), North West Island (June 1999) and to Heirisson Prong, Shark Bay (November 1994) (Figure 2). None of the translocated populations was considered to be self sustaining at the time of revision of this recovery plan.

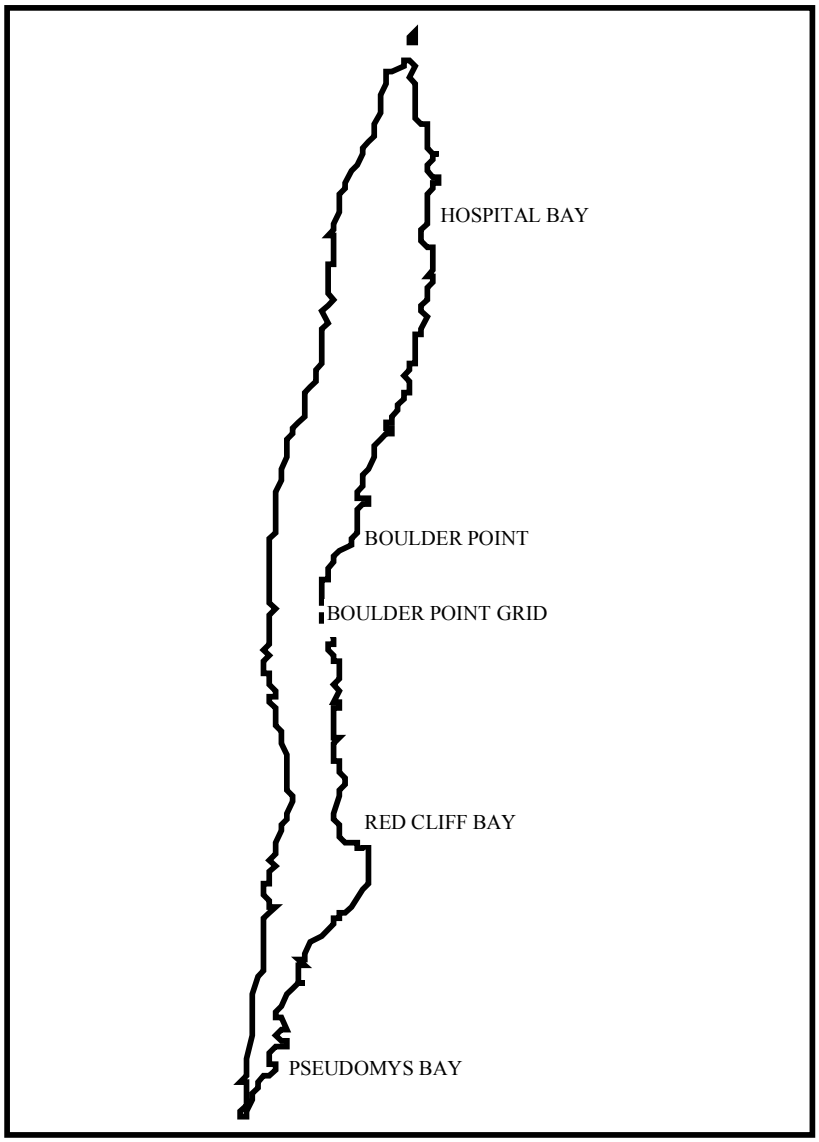

Figure 2: Map of Bernier Island showing monitoring sites at Red Cliff, Pseudomys Bay and Boulder Point

1.8 Strategies for Recovery

This recovery plan guides the recovery of the Djoongari for 10 years from 1992 - 2001 inclusive. Four primary strategies are being pursued during this term and these are presented below in chronological order. Once commenced, the implementation of these strategies run concurrently. Details of the actions already undertaken can be found in the Djoongari Recovery Team annual reports and in the five year summary report on progress on the recovery of Djoongari (Speldewinde, 1996).

Strategy 1 **Initiate research into population size, distribution and biology of *P. fieldi* on Bernier Island, 1992 -1993.**
This was an important first step as it has provided sound knowledge of the biology and requirements of the Djoongari and was used to determine whether the population is large enough to support a translocation program. It also assisted in determining the key requirements for successful translocations. The Bernier Island population is monitored twice annually for the duration of the recovery plan.

Strategy 2 **Undertake translocation to Doole Island and monitor population, 1993 - 2001.**
This action aimed to establish a second population and provide added security for the species, without the expense of exotic predator control. Captive breeding was required to support this and other translocations. This action commenced in 1993. Several translocations have taken place to this island to restock the population.

Strategy 3 **Undertake translocation to Heirisson Prong (Shark Bay mainland) and monitor population, 1995 - 2001.**
This action aimed to establish a mainland population for the first time in 140 years, and provide information for subsequent translocations to mainland sites. Intensive feral animal control had been undertaken before translocation was attempted. This action commenced in 1995 and appears unsuccessful.

Strategy 4 **Undertake translocation to Peron Peninsula (Shark Bay mainland) and monitor population, 1997 - 2001.**
This initially involved a program to control rabbits, goats, foxes and cats at acceptably low levels (1995-1997) followed by a translocation and monitoring program (1997-1999). The translocation will only occur after successful control of exotic predators and competitors has been achieved and is part of a program to re-establish the former fauna of these areas. Herald Bight, the site of the last Shark Bay mainland record of Djoongari will probably be the site for this translocation. This action has not yet commenced due to high feral cat numbers.

Strategy 5 **Undertake translocation to North West Island (Montebello Islands) and monitor population, 1999-2001**
This is intended to establish a third secure island population. Captive breeding will be required to support this and other translocations.

A Recovery Team was appointed in 1992 to coordinate the implementation of this recovery plan. From April 1996 it has comprised representatives from the Department of Conservation and Land Management (CALM) CALMScience, Western Australia Threatened Species and Communities Unit (WATSCU) and Mid West Region, CSIRO Division of Wildlife and Ecology, Useless Loop Community Biosphere Project Group, Inc. and Environment Australia.

2 RECOVERY OBJECTIVE AND CRITERIA

2.1 Objective

The objective of this Recovery Plan is to achieve down listing of the conservation status of the Djoongari from Vulnerable to Lower Risk (Conservation Dependent) (IUCN 1994) within 10 years by successfully:

(i) maintaining the Bernier Island population, taking into consideration annual fluctuations in population parameters,
(ii) establishing two other island populations; and
(iii) re-establishing the species in at least two other sites within its previous distribution on the Shark Bay mainland.

2.2 Criteria for success

Achievement of the above objective will be assessed on the following criteria:

(1) That there is no decrease in the abundance and distribution of Djoongari on Bernier Island over the recovery period. This will take into account the expected annual population fluctuations.

(2) A self-sustaining population established on Doole Island by 1998 with some demonstration of population growth.

(3) Two self-sustaining populations established on the Shark Bay mainland by 2001 with some demonstration of population growth at each.

(4) A self-sustaining population will be established on North West Island with demonstration of population growth.

Population abundance is assessed using a standardised monitoring program that was developed in the first four years of the recovery plan.

3 RECOVERY ACTIONS

Recovery actions for the Djoongari are presented below. Costings for 1992 to 1996 were calculated at 1991 prices. Costings for 1997 to 2001 were calculated at 1996 prices. A contract zoologist has been employed to undertake the prescribed actions as indicated. Unless otherwise stated, CALM contributions include supervision of the contract zoologist (10% of a Research Scientist's time) and payment of the vehicle standing fees ($2500/year). Details of recovery plan actions carried out up to 1996 can be found in Speldewinde(1996).

3.1 Action 1 - Research and monitoring on Bernier Island

3.1.1 Research into population size, distribution and biology of the Djoongari on Bernier Island

Before translocations could be undertaken, information was required on population size and distribution on Bernier Island, nesting habits and requirements, diet, genetic variation and reproduction. As well as aiding the appropriate management of Bernier Island Nature Reserve, this information enabled the Recovery Team to determine whether the population on the island can support a translocation program or whether captive breeding is required. It enabled better habitat assessments for translocation sites based on dietary and nesting requirements and preferred habitat on Bernier Island. Knowledge of reproductive biology was important for the translocation program as it helps to determine the most appropriate timing for translocations and aids in the subsequent monitoring.

This research was commenced 1992 by a contract zoologist with the assistance of volunteers and required four trips to Bernier Island, each of three weeks duration. The research involved systematic trapping using Elliott traps, radio-tracking individuals to find nest sites or burrows, scat analysis to determine diet, and

taking blood samples from mice at four separate locations on the island for DNA fingerprinting to determine genetic relatedness.

CALM's contribution included $2 000 for camping equipment plus supervision and vehicle standing fees. Other funds were required for the contract zoologists' salary, equipment and support including a portable HF radio, radio telemetry equipment, DNA fingerprinting, 200 Elliott traps, travel expenses, boat hire, field allowance and consumables.

	1992
Total cost	$ 71 600

3.1.2 Monitoring the Bernier Island population

Monitoring of the Djoongari population on Bernier Island is undertaken twice annually through grid trapping, following the completion of the above research. This provides information on the well-being of the population and on long-term population dynamics. This is undertaken by a contract zoologist and volunteers and requires four weeks (two trips) per year on Bernier Island for trapping and survey work. Standardised monitoring protocols were developed so they can be used consistently for assessing all Djoongari populations both during and after this recovery plan has been completed.

Other funds are required for the cost of annual monitoring, primarily travel and boat charter costs. Costs for using the Fisheries patrol vessel for transport to Bernier Island increased significantly in 1995 as Fisheries Western Australia moved towards full cost recovery on its services. Salary for the contract zoologist is included under other recovery actions.

	1993-6	1997-2001
Total cost	$ 2 200	$ 10 500

3.2 Action 2 - Translocation to Doole Island

3.2.1 Undertake translocation

The establishment of another population of Djoongari was seen as required to provide much needed security for the species. Translocation to Doole Island was undertaken due to the island not having the risks and expense of vermin control. Djoongari were trapped and removed from Bernier Island for release onto Doole Island. Initial monitoring post-release, by radiotracking, trapping and track counts, was carried out every six weeks for the first six months, and every three months for the next 12 months. Due to the small population size on Doole Island several restockings have been required to maintain the population.

Other funds were required for the contract zoologist's salary for two years, travel expenses including boat charter, radio telemetry equipment, DNA fingerprinting and consumables.

	1993	1994
Total cost	$57 400	$37 200

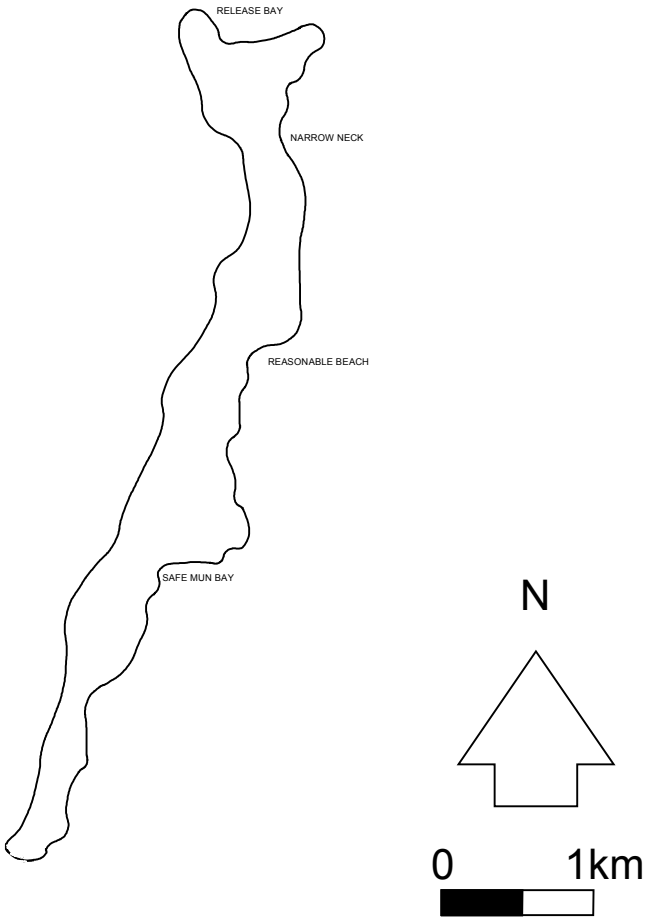

Figure 3: Map of Doole Island showing release site at Release Bay, and monitoring sites at Release Bay, Reasonable Beach and Safe Mun Bay.

3.2.2 Monitoring of translocated population on Doole Island

After the initial 18 month monitoring period, the Doole Island population is monitored once a year for the duration of the recovery plan to determine the success of the translocation. This is undertaken by a contract zoologist with volunteer assistance and will require two weeks (two trips) of trapping per year on the island. Other funds are required for field allowance, travel costs and consumables. Funds for DNA fingerprinting were required in 1999.

	1993-96	1997-98	1999	2000-01
Total cost	$ 2 000/yr	$ 5 000/yr	$ 6 000	$ 5 000/yr

3.3 Action 3 - Experimental Translocation to Heirisson Prong

3.3.1 Undertake experimental translocation

Translocation of the Djoongari to Heirisson Prong (Figure 2) was undertaken in 1994 to establish the first mainland population in 140 years, as well as to help establish the cause of the mainland extinction of the Djoongari and the management regimes required for successful mainland translocations. Heirisson Prong is currently the site of a Boodie (*Bettongia lesueur*) re-establishment experiment being undertaken by CSIRO Division of Wildlife and Ecology with support from Useless Loop Community and Shark Bay Salt Joint Venture (SBSJV)(Short *et al.*, 1994). The coastal habitat is similar to that found on Bernier Island and rabbit and introduced predator control is currently being implemented as part of the CSIRO project. CSIRO has reintroduced threatened species (Western Barred Bandicoot, Greater Stick-nest Rat) to this site.

The Djoongari translocation was undertaken from 1994 to 1996 by a contract zoologist with the assistance of volunteers. The translocation required the trapping of *P. fieldi* on Bernier Island, transporting the mice to the translocation site, releasing them at the selected site and then monitoring using radio telemetry and standardised trapping techniques. Due to the possibility of the dispersal of the Djoongari from the release site, an enclosure was built at the release site to contain the Djoongari for one to two weeks while they established before release into the wild. Several monitoring trips were required after the translocation.

The comparative ecology of the Djoongari and two sympatric *Pseudomys* species may also be examined as part of the process of understanding the reasons for the mainland decline of the former. This will be run as a PhD project 2000-2001 when a second attempt will be made to reintroduce Djoongari to Heirisson Prong. This project will be undertaken when an appropriate student is found.

An electric fence has been erected by the Useless Loop Community and CSIRO, 10 km south of Cape Heirisson on Heirisson Prong. This, combined with regular baiting with dried meat baits containing 1080, by CSIRO and the Agriculture Protection Board (APB) will control foxes at the translocation site. Cat control through trapping, shooting and baiting is also being implemented by CSIRO. Monitoring for signs of feral predators is carried out north of the fence.

Other funds were required for the contract zoologist's salary for two years (1995 and 1996), travel expenses including boat charter, radio telemetry equipment, enclosure materials and consumables.

	1994	1995	1996	1999
Total cost of translocation	$64 300	$97 300	$94 400	$ 6 000

3.3.2 Monitoring of translocated population on Heirisson Prong

Multiple trips to Heirisson Prong were required to monitor the established population. Monitoring was undertaken by the contract zoologist with volunteer assistance and required at least one week of trapping per monitoring session. An assessment of genetic variation and changes in the new population through DNA fingerprinting will be required in 2000. Other funds were required for field allowance, vehicle operating costs and consumables.

The 2000 release of Djoongari on Heirisson Prong will be run as a PhD project and the monitoring will examine the comparative ecology of Djoongari, two other species of *Pseudomys* and *Rattus tunneyi*.

	1997	1998	1999	2000 - 01
Total cost	$ 46 000	$ 5 000	$12 000	$12 000/yr

3.4 Action 4 - Control of introduced predators and competitors at Herald Bight

Prior to a translocation to Herald Bight on Peron Peninsula (Figure 2), it is necessary to control the introduced predators and competitors at this site. CALM acquired Peron Station in 1989 and the northern portion is now Francois Peron National Park (FPNP). CALM has commenced a program to remove all sheep and goats and to control foxes, cats and rabbits in the park. A vermin proof fence has been constructed across the narrow neck of Peron Peninsula (Taillefer Isthmus) to further assist in the control of introduced species.

Sheep and goats have been reduced in the FPNP and the rabbits, foxes and cats are being controlled at minimal levels, CALM has begun reconstructing the fauna of Peron Peninsula by translocating several species of threatened mammal species to the area. This operation is called Project Eden. The Djoongari will be one of the first species to be translocated and was planned to be reintroduced to Herald Bight area in 1997. Due to high feral cat numbers this translocation has been postponed. Other funds are required to complement the feral animal control program already underway, monitoring of other small mammal species, and for monitoring to ensure that the release site at Herald Bight is free of introduced fauna species.

	1995	1996	1997- 2001
Total cost	$190 000	$190 000	$54 000/year

3.5 Action 5 - Captive breeding

In the initial Djoongari Recovery Plan (Orell and Morris 1991), it was proposed that a captive breeding program should be established to sustain translocations. When a population estimate of 6 000 - 8 000 was derived for Bernier Island (Morris and Speldewinde 1992) the recovery team suggested that the natural population was sufficiently abundant to sustain translocations to Doole Island and Heirisson Prong. This estimate needs to be reassessed on the basis of mature animals only. Due to fluctuations in Djoongari numbers it has often been difficult to capture sufficient numbers on Bernier Island for translocation and as it is likely that Doole Island and Heirisson Prong will require restocking, it is appropriate that a captive breeding colony be established. A captive colony of Djoongari was established at the Perth Zoo in 1998. Prior to this captive animals were housed at the CALM Wildlife Research Centre.

	1997 -1998	1999 - 2001
Total cost	$ 3 500	$155 000

3.6 Action 6 - Reintroduction to Herald Bight

3.6.1 Undertake re-introduction

Reintroduction of the Djoongari to Herald Bight was planned to be undertaken in 1997 by a contract zoologist with the assistance of volunteers following the reduction and control of foxes, feral cats, rabbits and goats. Due to high feral cat numbers this translocation has been postponed. This translocation will involve the same steps as outlined for the translocation to Heirisson Prong using techniques developed from that translocation. The mice will be released into an enclosure at the release site and numbers increased through captive breeding with surplus animals released in groups of at least 20 individuals at Herald Bight. Intensive monitoring will be required in the first 12 months following release. Other funds are required for the contract zoologist's salary, travel expenses and vehicle operating costs, radio telemetry equipment and consumables.

	1997	1998	2000
Total cost	$ 64 000	$ 60 900	$41 600

3.6.2 Monitoring re-introduced population

Monitoring of the established population at Peron Peninsula will be undertaken twice a year for the duration of the recovery plan. This will probably be undertaken in conjunction with the translocation programs for other threatened species on Peron Peninsula. Other funds are required for the contract zoologists salary plus operating costs, primarily travel costs.

	2000-01
Total cost	$ 39 700/yr

3.7 Action 7-Introduction to North West Island

3.7.1 Undertake translocation

Translocation of Djoongari to North West Island was undertaken in 1999 by a contract zoologist with the assistance of volunteers following the removal of rat bait stations. Twenty eight captive bred Djoongari were transported to the release site on North West Island. Intensive monitoring through radiotracking and trapping took place immediately after release. The translocation took advantage of work already taking place on the Montebello group (the monitoring of translocated Mala, rat bait removal programs and feral cat eradication program on Hermite Island) therefore reducing costs. Other funds were required for the contract zoologist's salary, travel expenses and vehicle operating costs, radio telemetry equipment and consumables.

	1999
Total cost	$45 700

3.7.2 Monitoring translocated population

Monitoring of the established population on North West Island is being undertaken twice a year for the duration of the recovery plan. This will probably be undertaken with other work carried out by CALM on the Montebello Islands. Other funds are required for the contract zoologist's salary and operating costs.

	2000-2001
Total cost	$10 000

4. IMPLEMENTATION SCHEDULE (1992-6 costs in 1991 $ 000 s / year; 1997-01 costs in 1996 $ 000 s / year)

Task	Description	Priority	Feasibility	Responsibility	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	TOTAL
1	Research & monitoring Bernier Is.														
1.1	Undertake research	1	100%	CALM	71.6										**71.6**
1.2	Monitor	1	100%	CALM		2.2	2.2	2.2	2.2	10.5	10.5	10.5	10.5	10.5	**61.3**
2	Translocate to Doole Is.														
2.1	Undertake translocation	1	95%	CALM		57.4	37.2								**98.6**
2.2	Monitor translocated population	1	95%	CALM				2.0	2.0	6.5	6.5	6.5	6.5	6.5	**36.5**
3	Translocate to Heirisson Prong														
3.1	Undertake translocation	2	95%	CALM			64.3	97.3	94.4			6			**262**
3.2	Monitor translocated population	2	95%	CALM						46.0	5.0	12	12	12	**87**
4	Exotic predator and competitors control	2	75%	CALM				190.0	190.0	54.0	54.0	54.0	54.0	54.0	**650.0**
5	Captive breeding	2	75%	Perth Zoo/ CALM						3.5	3.5	155	155	155	**472**
6	Reintroduce to Peron Peninsula														
6.1	Undertake reintroduction	2	75%	CALM						64.0	60.9		41.6		**166.5**
6.2	Monitor reintroduction	2	75%	CALM										39.7	**39.7**
7	Introduce to North West Island														
7.1	Undertake translocation			CALM								45.7			**45.7**
7.2	Monitor reintroduction			CALM									8.6	10	**18.6**
	TOTAL				**71.6**	**59.6**	**103.7**	**291.5**	**288.6**	**184.5**	**140.4**	**290.2**	**288.2**	**287.7**	**2006**

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