INTERIM RECOVERY PLAN NO 5

ANTINA (*ZYZOMYS PEDUNCULATUS*) INTERIM RECOVERY PLAN

1996 to 1998

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FOREWORD

Interim Recovery Plans (IRPs) are developed within the framework laid down in Department of Conservation and Land Management (CALM) Policy Statements Nos 44 and 50.

Where urgency and/or lack of information mean that a full Recovery Plan can not be prepared, IRPs outline the recovery actions required urgently to address those threatening processes most affecting the ongoing survival and begin the recovery process of threatened taxa or ecological communities.

CALM is committed to ensuring that Critically Endangered taxa are conserved, through the preparation and implementation of Recovery Plans or Interim Recovery Plans and ensuring that conservation action commences as soon as possible and always within one year of endorsement of that rank, by the Minister.

This IRP was approved by the Director of Nature Conservation on 1 May 1996. Approved IRPs are subject to modification as dictated by new findings, changes in status of the taxon or ecological community and the completion of recovery actions. The provision of funds identified in this Interim Recovery Plan is dependent on budgetary and other constraints affecting CALM, as well as the need to address other priorities.

Approved IRPs are subject to modification as dictated by new findings, changes in species' status and completion of Recovery Actions.

Information in this IRP was accurate at April 1996.

CONTENTS

SUMMARY

Zyzomys pedunculatus, Antina (Central Rock-rat).

Family: Muridae.
CALM Region: Not known. May have occurred in Pilbara and Goldfields Regions.
CALM District: Exmouth (for survey).
Shire: Shire of Exmouth.
Recovery Team: None; Team to be appointed only if species rediscovered.
Current status of taxon: Critically Endangered
Habitat requirements: Granite boulder fields, quartzite screes, eroded sandstone cliffs and similar habitat.
IRP Objective: To locate the species in the wild in Western Australia and to commence recovery actions.
Recovery criteria:
The criteria for success are:
1. the location of one or more populations in the wild;
2. the development of methods of finding, studying and monitoring Antina in the wild;
3. the gathering of sufficient information to begin management actions for the conservation of the species in the wild;
4. an improvement in the status of one or more populations in the wild, as measured by increases in the number of Antina being trapped, and/or the expansion of the area being used;
5. the establishment of a Recovery Team and the writing of a Recovery Plan.

The criterion for failure is: failure to locate Antina after conducting adequate surveys in Cape Range.
Recovery Actions: Recovery actions 2 to 5 will depend on the discovery of the species in Western Australia following completion of Action 1.
1. Conduct field survey
2. Research and monitoring.
3. Captive breeding.
4. Management actions.
5. Appoint Recovery Team

1. INTRODUCTION

1.1 History, Taxonomy and Status

Zyzomys pedunculatus, the Antina (the Australian name recommended for this species, Braithwaite *et al*. 1995) or Central Rock-rat, was described in 1896 from a specimen collected near Alice Springs during the Horn Scientific Expedition (Waite 1896). Since then 33 specimens have been collected, but very few of these are from the twentieth century.

Kitchener (1989) redescribed *Z. pedunculatus* and included *Z. pedunculatus*. [var. *brachyotis*] Waite, 1896 within it, considering the specimen on which it was based to be a juvenile. The only species of *Zyzomys* that is likely to occur in the same areas as *Z. pedunculatus* is the Djoorri or Common Rock-rat (*Z. argurus*). Adult Antina are larger than Djoorri (ca 60 g (range unknown) versus 36 g (26-55 g; but note that Kitchener reports an *argurus* weighing 70 g). They are also larger in body measurements, eg, pes 26.5 mm (25.5 - 27.8) versus 21.0 (18.2 - 23.9); thenar pad 3.8 mm (3.3 - 4.1) versus 2.9 mm (2.2 - 3.5). The thenar pad is shorter relative to pes length (see Figure 5 in Kitchener 1989). Field identification should be based on a combination of body weight, pes length and the ratio of pes to thenar pad length. Confirmation of field identification would be dependent on a specimen being collected so that skull and dental characters can be examined.

All nineteenth century specimens came from central Australia. The most recent specimen was collected by a stockman in the western MacDonnell Ranges, about 300 km west of Alice Springs, in 1960. The only other twentieth century specimens came from near The Granites in the Tanami Desert in 1952 (Wurst 1995, Watts and Aslin 1981). Finlayson (1961) reported the species from Hugh Creek (1935), Napperby Hills (1950) and Davenport Range (1953).

Antina have never been collected alive in Western Australia. However, their remains are fairly common in sub-fossil deposits in the Cape Range, where the species has been recorded from 12 caves. These deposits are consistent with accumulations deposited by owls (Baynes and Jones 1993) and are considered to be of recent origin. Because of this the species is considered part of the modern Western Australian mammal fauna.

Extensive surveys for Antina in the Northern Territory in 1990, and shorter surveys in the 1970s and early 1980s, failed to locate the species (Wurst 1990).

No specific searches for Antina have been conducted in Western Australia. General vertebrate survey work has been conducted in parts of the Pilbara, some ranges in the Great Sandy Desert (South Esk Tablelands, McLarty Hills, Edgar Range) and in the Carnarvon Basin, including parts of the Kennedy Range and Pell Range. No mammal survey has ever been conducted in the Cape Range, which, with extensive areas of rugged limestone, is different from any area where general vertebrate surveys have failed to locate Antina.

1.2 Distribution and Habitat

The occurrence of the Antina in the central ranges, the Tanami Desert and on North West Cape suggests that it may once have had a distribution that encompassed the desert ranges of Western Australia, including the Pilbara. The species has been recorded from granite boulder fields, quartzite screes and eroded sandstone cliffs (Wurst 1995); these and similar habitat types are fairly widespread in the arid zone.

1.3 Biology and Ecology

Almost nothing is known about the biology or ecology of the Antina. Its biology probably resembles that of other species of *Zyzomys*. Quandongs (*Santalum acuminatum*) may have played an important role as a food item, since old, chewed quandong nuts can be found in rock crevices and on ledges in the central ranges (Wurst 1995). This food is also exploited by congenerics such as the Djoorri (*Z. argurus*).

1.4 Threatening Processes

With an estimated mean adult body weight of about 60 g (Burbidge and McKenzie 1989), the Antina lies within the Critical Weight Range (CWR). Burbidge and McKenzie (*op. cit.*) have demonstrated that such taxa are particularly susceptible to extinction, particularly in arid areas. They suggested that the reasons for the decline and extinction of many CWR mammal species are associated with factors that emulate an increase in aridity by reducing environmental productivity - the diversion of environmental resources to introduced species, a reduction in vegetative cover by exotic herbivores and changed fire regimes, exacerbated by predation by introduced foxes, cats and rats. Morton (1990) extended Burbidge and McKenzie's general hypothesis, viewing arid Australia as a resource-poor landscape through which were scattered resource-rich, productive patches upon which many arid zone mammals were dependent in times of drought. Such patches have been depleted by human activities and by grazing by introduced herbivores, particularly rabbits.

Burbidge and McKenzie's (*op. cit*) analyses showed that species inhabiting rock piles have not declined as much as those restricted to the ground's surface. Thus, the probability that Antina survive is increased compared to many other possibly extinct arid zone mammal taxa.

1.5 Conservation status

The Antina is listed as 'fauna which is likely to become extinct or is rare' under the Western Australian Wildlife Conservation Act. The Commonwealth Endangered Species Protection Act lists the species as 'Endangered'. The Rodent Action Plan (Lee 1995) also lists it as 'Endangered' but states that under the criteria of Mace and Lande (1991) it is "Critical, possibly extinct" (p. 31). In 1995, the Scientific Ranking Panel for Western Australia's threatened flora and fauna allocated the species to the new IUCN category 'Critically Endangered' (IUCN 1994) using methods prescribed in CALM Policy Statement No. 50.

Policy Statement No. 50 requires CALM to ensure that all taxa identified as Critically Endangered are conserved, through the preparation and implementation of Recovery Plans or Interim Recovery Plans and to ensure that conservation action for taxa identified as Critically Endangered commences as soon as possible and always within one year of endorsement of that rank by the Minister. The Minister endorsed the Antina as Critically Endangered in July 1995.

1.6 Strategy for Recovery

Planning for recovery is not possible unless one or more populations of Antina are located. Thus the main strategy of this Interim Recovery Plan is to conduct field surveys in an attempt to locate the species in the wild.

2. RECOVERY OBJECTIVE AND CRITERIA

2.1 Objective

The objective of this Interim Recovery Plan for the Antina is to locate the species in the wild in Western Australia and to commence recovery actions.

2.2 Criteria

On the assumption that the Antina still exists in Western Australia, the criteria for successfully achieving the objective are:

1. the location of one or more populations in the wild;
2. the development of methods of finding, studying and monitoring Antina in the wild;
3. the gathering of sufficient information to begin management actions for the conservation of the species in the wild;
4. an improvement in the status of one or more populations in the wild, as measured by increases in the number of Antina being trapped, and/or the expansion of the area being used;
5. the establishment of a Recovery Team and the writing of a Recovery Plan.

If the Antina can not be located in the wild, the criterion for successfully achieving the objective is:

1. Conducting two field surveys, each of at least 2 000 trap-nights, for Antina in Cape Range National Park, encompassing all the major habitat types within rocky country, one in late winter or spring and one in autumn. Each survey will use pitfall and drift fence traps and Elliott traps.

The criterion for failure to achieve the Objective is:

1. Failure to locate Antina after conducting adequate surveys in Cape Range.

3. RECOVERY ACTIONS

This Interim Recovery Plan will remain in force until the criteria for success have been met, or for three years when it will be reviewed if the objective has not been achieved by that time. Costing this interim plan is difficult because all subsequent actions are dependent upon finding one or more populations. The Plan therefore makes the assumption that populations will be found early enough in the life of this plan that the objective can be achieved within three years, and that all actions named in the plan will be funded within that time.

3.1 Conduct field Survey

Field surveys will be conducted in Cape Range National Park. Baynes and Jones (1993) state that Antina “are more abundant in the cave deposits in Cape Range than anywhere else in its original distribution, suggesting that the Range may have provided particularly favourable habitat. It is possible that it still survives there. A survey of the vertebrates of Cape Range should be a high priority.” (p. 207).

There has never been a survey of the mammals of Cape Range National Park (CALM 1987). A survey for Antina would locate many other taxa of mammals. In addition, other animals such as reptiles and a variety of invertebrates would be sampled in traps. Thus, a survey for Antina would provide much information about the distribution of other animals within the Park, improving the knowledge of the area and enabling specific management actions to be implemented if necessary.

Experience with field surveys for vertebrates in Australia shows that surveys in several seasons reveal a greater proportion of the biota than a single survey. In the case of rodents this is partly

due to greater trap success when young become independent and disperse. The breeding season of Antina is unknown. In the wet-dry tropics, Djoorri (Common Rock-rat, *Z. argurus*), Djookooropa (Kimberley Rock-rat, *Z. woodwardi*) and Kodjperr (Arnhem Land Rock-rat, *Z. maini*) breed the year round, but few females are found to be pregnant late in the dry season. These data are, however, from an environment that has predictable, relatively high rainfall. Data on arid zone native rodents suggests that breeding is greatly depressed during drought and that it increases after significant rainfall. Climate in the Cape Range area is arid with hot summers and warm winters. Rain may fall at any time of the year, but substantial falls are most likely in between February and July, while little rain usually falls between September and December (Appendices 1 & 2). Taking this information into account, breeding in Antina seems most likely in late summer, with juveniles dispersing in late winter or spring.

Trap success rates for rodents in the arid zone can vary greatly - after a series of good seasons, trap success rates for small mammals can approach 100%; however, during a drought, trap success rates at the same place can be zero. Thus, in order to maximise the possibility of success, it would be ideal to conduct the survey for Antina in the Cape Range after a series of average to good seasons. The annual average rainfall at Exmouth is 264 mm (80 years) while that at Learmonth is 230 mm (20 years). The rainfall in 1992 and 1995 was above average, while that in 1993 and 1994 was near average (Appendix 1). These data suggest that 1996 would be a satisfactory time to conduct the survey. However, the works programs of CALM staff will not allow work in 1996, so the project will be programmed for 1997.

In 1995, Drs Ken Aplin and Alex Baynes of the Western Australian Museum sought funding via CALM from the Commonwealth Endangered Species Program to carry out a search for Antina in Cape Range. The amount requested was $33 620. This application was unsuccessful. The budget was based on using contract staff to carry out the field work. Utilising existing CALM and Museum staff with absorption of salary costs by the agencies would significantly reduce the cost of a survey.

The survey for Antina in Cape Range National Park is based on the following assumptions:

1. Three week field trips will be carried out in two seasons, the first in Spring 1997 and the second in autumn 1998. Survey methods will be pit-fall and drift fence trapping (using the modified McKenzie design), Elliott trapping and searching for sign of animals' presence (eg, chewed *Santalum* nuts). Existing stocks of Elliott traps in CALM and WAM will be used. Cape Range lies within the Carnarvon Basin. Trapping methods will, as far as possible, follow the design used in the Carnarvon Basin Survey so the results can be compared with other sample sites further south in the Basin.
2. Staff will be provided by CALM (WATSCU, SID Woodvale and Pilbara Region/Exmouth District) and by the WA Museum. Staff salary costs will be absorbed by the two agencies.
3. A reconnaissance and set up trip will be conducted in winter 1997 to select survey sites and install pit-fall traps. Pit-fall traps will need to be blasted into rocky areas. This will involve the use of a rock drill (held by SID Woodvale) and a person licensed to use explosives (Phil Fuller (SID Woodvale). Two vehicles are needed ex Perth because explosives and detonators can not be carried in the same vehicle. Two survey sites will be chosen. Each will have six sample sites. Each sample site will be trapped with two pit-fence lines, each with six pit traps, and 80 Elliott traps. Traps will be opened for six nights during each sampling session.
4. Costs of running the field trips, including consumables, vehicle running and travelling allowances will be met from a budget allocated by CALM for the implementation of this Interim Recovery Plan.

5. Writing up the surveys will be carried out by CALM and WAM staff at no extra cost. Budget calculations are provided at Appendix 3.

   Responsibility: CALM WATSCU, SID, Pilbara Region and WA Museum
   Cost: $20 175 (reconnaissance and set up trip $7 035; (two x 18 day surveys $13 140)
   Priority: very high.

3.2 Research and monitoring

Should Antina be located within Cape Range National Park, a research project should be initiated without delay. This will entail either the reallocation of existing CALM Science & Information Division (SID) staff or the employment of a contract scientist supervised by CALM SID staff. Assuming the latter, a budget of about $50,000 per annum for three years would be required. This money will be sought from external sources, including the Commonwealth Government's Endangered Species program and sponsorships from the private sector.

Responsibility: WATSCU and SID
Cost: $50,000 per year for three years (from external sources)
Priority: very high if populations are found

3.3 Captive breeding

Most species of Australian rodents are relatively easy to breed in captivity. If a population of Antina is located, a captive breeding colony will be set up. This will provide additional security for the species and may provide animals for future translocations. The site of the captive breeding colony will be decided at the time. A notional budget is necessary to cover costs of cages, food and husbandry. This money will be sought from external sources, including the Commonwealth Government's Endangered Species program and sponsorships from the private sector.

Responsibility: CALM WATSCU and SID
Cost: $5 000 initially, plus $1 000 per year
Priority: very high if populations are found.

3.4 Management actions

Until one or more populations are found and some information gathered about them, it is difficult to identify specific management issues, and impossible to cost them. However, there is one point that can be made on the basis of existing knowledge.

It seems likely that if a population is found, immediate baiting for Red Foxes and Feral Cats would be likely to benefit the survival and expansion of the population. Baiting for foxes is already conducted within a small part (1 250 ha) of Cape Range National Park at an annual cost of $1 600, allocated from the Environmental Protection Branch budget and is proposed to be extended under CALM's project "Western Shield". If Antina are located, CALM will ensure that baiting includes areas of Antina habitat. Assuming an area of 10 000 ha is baited four times per year from the air, the cost will be approximately $6 200 per annum. However, this expenditure would not be necessary if appropriate areas of Cape Range National Park is baited for foxes under "Western Shield".

Responsibility: CALM Environmental Protection Branch and Exmouth District
Cost: $6200 per year
Priority: very high if populations are found.

Techniques for broad-scale Feral Cat control are not currently available. Research aimed at developing broad-scale techniques is underway in CALM and in some other conservation agencies. Should a population of Antina is located, advice will be sought on the best available Feral Cat control methods, which will then be implemented.

Responsibility: WATSCU, CALM Environmental Protection Branch and Exmouth District
Cost: unknown
Priority: high if populations are found.

3.5 Appoint Recovery Team

Should a population of Antina be located, a Recovery Team will be set up to revise this Interim Recovery Plan, and coordinate research and management actions. Members will be appointed to represent relevant land managers, scientists and funding agencies. Appointment of persons from the local conservation community will be considered. The Recovery Team will report annually to CALM's Corporate Executive and funding agencies.

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Appendix 1. Rainfall data for Exmouth Gulf (provided by Bureau of Meteorology)

1915	0.0	88.7	0.0	94.8	0.0	79.0	8.7	0.0	0.0	0.0	0.0	0.0	271.2
1916	74.9	48.7	56.7	0.0	30.5	67.9	1.0	0.0	0.0	12.7	0.0	0.0	292.4
1917	39.1	0.0	41.9	0.0	14.0	20.8	0.0	4.3	0.0	2.8	0.0	0.0	122.9
1918	2.5	584.9	0.0	0.0	85.6	61.7	10.4	2.3	0.0	0.0	0.0	0.0	747.4
1919	0.0	0.0	13.5	0.0	0.0	5.3	0.0	22.8	0.0	0.0	0.0	0.0	41.6
1920	0.0	0.0	39.4	76.0	27.4	40.4	18.8	9.2	20.6	0.0	0.0	0.0	231.8
1921	0.0	210.3	131.8	0.0	44.4	5.8	9.7	37.1	0.0	0.0	0.0	0.0	439.1
1922	0.0	0.0	58.9	3.8	79.8	26.4	2.0	0.0	0.0	0.0	0.0	0.0	170.9
1923	188.9	0.0	304.1	233.4	47.5	23.0	14.2	0.0	0.0	0.0	0.0	2.5	813.6
1924	0.0	1.0	0.0	6.8	10.9	85.3	0.0	0.0	0.0	0.0	0.0	0.0	104.0
1925	5.1	45.0	10.4	0.0	76.0	20.9	0.0	3.0	3.3	0.0	0.0	0.0	163.7
1926	0.0	13.2	56.6	0.0	48.7	5.1	0.0	0.0	0.0	0.0	0.0	17.8	141.4
1927	0.0	0.0	209.7	0.0	33.3	173.8	34.4	0.0	0.0	0.0	0.0	0.0	451.2
1928	0.0	0.0	0.0	13.0	32.5	84.8	4.3	0.0	0.0	0.0	0.0	15.4	150.0
1929	0.0	32.8	242.3	0.0	149.2	12.4	0.0	20.0	0.0	0.0	0.0	0.0	456.7
1930	0.0	0.0	45.4	0.0	0.0	151.4	0.0	6.9	1.3	0.0	0.0	0.0	205.0
1931	11.7	0.0	2.3	8.9	169.9	91.0	66.0	13.2	0.0	11.5	0.0	0.0	374.5
1932	0.0	0.0	11.7	19.8	80.2	29.0	0.0	19.3	0.0	0.0	0.0	5.1	165.1
1933	0.0	0.0	511.3	8.2	28.4	7.6	25.4	63.1	3.0	0.0	0.0	1.3	648.3
1934	27.8	57.7	275.1	23.9	40.9	25.4	0.0	0.0	0.0	0.0	0.0	0.0	450.8
1935	45.0	8.6	30.5	0.0	0.0	0.0	4.3	15.7	0.0	0.0	0.0	0.0	104.1
1936	0.0	0.0	0.0	55.2	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0	58.8
1937	8.9	150.8	0.0	38.1	58.2	18.9	0.0	11.5	8.9	0.0	0.0	0.0	295.3
1938	0.0	0.0	0.0	5.3	66.7	3.3	7.9	7.9	0.0	0.0	0.0	0.0	91.1
1939	6.1	21.0	23.9	0.0	44.5	32.5	5.0	3.0	0.0	0.0	19.1	7.4	162.5
1940	38.0	0.8	0.0	0.0	3.0	39.3	16.5	0.0	0.0	0.0	0.0	0.0	97.6
1941	0.0	0.0	13.9	18.5	45.0	40.1	48.1	241.8	0.0	0.0	0.0	15.0	422.4
1942	8.6	0.0	6.6	3.8	117.9	47.2	23.2	0.0	0.0	0.0	27.2	0.0	234.5
1943	1.3	181.9	17.8	0.0	20.8	52.8	17.8	4.6	0.0	0.0	2.0	0.0	299.0
1944	0.0	2.3	64.3	3.3	5.3	0.0	2.5	9.7	0.0	0.0	0.0	0.0	87.4
1945	0.0	165.1	7.1	0.0	5.6	36.5	0.0	1.3	10.2	0.0	0.0	0.0	225.8
1946	82.6	49.8	31.5	57.6	9.4	21.1	9.4	0.0	0.0	0.0	1.0	0.0	262.4
1947	0.0	84.5	7.4	0.0	58.2	29.5	46.5	6.6	0.8	9.2	0.0	0.0	242.7
1948	0.0	41.7	2.5	54.2	0.0	178.1	61.7	0.0	6.1	0.0	0.0	6.9	351.2
1949	0.0	82.1	26.2	24.3	190.0	71.2	1.5	11.5	14.7	0.0	40.6	1.0	463.1
1950	0.0	2.1	0.0	0.0	77.4	25.4	16.0	0.3	0.0	0.0	2.5	0.0	123.7
1951	0.0	15.7	27.9	5.9	7.1	186.6	9.2	0.3	0.0	0.0	0.0	0.0	252.7
1952	2.5	154.4	0.0	2.3	66.3	0.0	89.4	0.0	0.0	0.0	0.0	0.0	314.9
1953	2.3	0.0	184.2	12.2	138.4	55.7	26.2	0.0	0.0	0.0	0.0	0.0	419.0
1954	0.0	2.6	0.0	0.0	15.1	64.3	10.2	0.0	0.0	8.1	0.0	0.0	100.3
1955	23.6	3.8	0.0	0.0	113.3	0.8	3.8	44.9	4.1	0.0	0.0	0.0	194.3
1956	4.8	2.0	166.2	9.7	16.5	51.0	18.1	42.1	0.0	0.0	0.0	0.0	310.4
1957	2.3	71.4	14.0	0.0	80.2	94.5	1.8	0.0	0.0	0.0	0.0	0.0	264.2
1958	12.7	0.0	104.9	0.0	48.3	16.8	4.8	0.0	2.8	0.0	1.8	3.6	195.7
1959	0.0	0.0	0.0	0.0	19.6	3.8	34.4	0.0	0.0	0.0	0.0	0.0	57.8
1960	33.5	15.7	66.8	0.5	3.0	65.7	48.0	1.5	0.0	0.0	0.0	0.0	234.7
1961	37.9	206.2	86.6	140.5	10.4	33.3	3.0	8.9	0.0	0.0	0.0	0.0	526.8
1962	34.6	8.7	0.0	13.4	37.7	4.0	7.1	0.0	0.0	0.5	0.0	0.0	106.0
1963	99.3	112.0	14.7	14.0	118.2	12.7	43.9	0.0	0.0	0.0	0.0	0.0	414.8

1964	0.0	0.0	257.1	1.8	6.6	90.5	10.9	5.8	3.6	26.4	0.0	0.0	402.7
1965	0.0	1.5	78.3	0.0	10.7	79.9	10.2	66.6	0.0	0.0	0.0	0.0	247.2
1966	0.0	19.5	0.0	32.0	0.0	5.1	1.6	2.3	0.0	34.0	0.0	1.0	95.5
1967	278.3	6.1	11.6	0.0	28.0	15.7	0.0	12.9	0.0	0.0	0.0	0.0	352.6
1968	3.3	54.8	0.0	3.0	17.0	221.0	0.0	10.2	3.6	0.0	0.0	3.3	316.2
1969	0.0	23.9	0.0	0.0	104.9	46.5	0.0	0.0	0.0	1.5	0.0	0.0	176.8
1970	0.0	158.7	0.0	98.5	220.7	11.6	3.6	1.0	11.4	0.0	0.0	0.0	505.5
1971	231.1	8.6	101.9	0.0	34.8	29.8	54.7	1.0	0.0	0.0	0.5	0.0	462.4
1972	0.3	4.0	0.0	0.0	27.9	34.1	46.5	10.9	0.0	0.0	0.0	15.5	139.2
1973	0.8	0.8	34.6	11.4	30.9	77.5	56.2	48.8	1.0	0.0	0.0	39.2	301.2
1974	84.5	7.6	34.5	4.3	44.4	10.9	86.3	29.9	0.0	63.5	0.0	0.0	365.9
1975	0.0	73.2	129.5	32.0	13.2	6.6	34.7	0.3	0.0	19.1	61.7	11.9	382.2
1976	18.0	58.0	7.0	0.0	6.0	1.0	23.0	26.0	3.0	0.0	0.0	0.0	142.0
1977	5.1	0.0	89.4	29.0	24.3	8.1	0.0	1.3	0.0	0.0	5.0	0.0	162.2
1978	10.9	25.3	8.4	24.0	19.4	3.8	39.0	36.1	0.8	0.0	0.0	0.0	167.7
1979	0.0	10.7	81.1	2.1	9.4	3.0	0.0	40.7	0.0	0.0	0.0	0.0	147.0
1980	61.2	56.4	7.8	79.8	74.0	144.3	65.2	1.5	0.0	1.8	0.0	1.0	493.0
1981	25.0	35.0	28.0	0.0	17.0	59.0	5.0	16.0	0.0	0.0	0.0	2.0	187.0
1982	75.0	5.0	12.0	0.0	96.0	33.0	1.0	11.0	4.0	0.0	0.0	0.0	237.0
1983	3.5	0.0	23.8	0.0	2.0	50.0	1.0	9.0	7.0	0.0	2.0	0.0	98.3
1984	0.9	15.1	9.7	19.2	216.0	0.7	66.2	14.6	2.8	8.2	0.0	0.0	353.4
1985	0.0	31.8	0.0	45.5	49.5	85.0	34.0	0.0	0.0	0.0	0.0	0.0	245.8
1986	0.0	132.4	22.0	4.0	0.0	27.8	14.0	0.2	7.8	0.0	0.0	0.0	208.2
1987	0.0	14.0	0.0	9.0	0.0	73.4	26.9	5.0	0.0	0.0	0.0	0.0	128.3
1988	0.0	0.0	9.3	21.0	31.0	5.0	7.5	45.2	0.0	2.4	10.8	0.3	132.5
1989	0.0	2.2	11.3	0.0	64.0	44.6	0.0	0.0	0.0	0.0	0.0	0.0	122.1
1990	142.6	5.1	27.1	0.0	0.0	9.2	32.8	44.2	0.0	0.0	0.0	0.0	261.0
1991	0.0	37.5	0.0	0.0	34.5	59.2	25.4	0.6	2.0	0.0	0.4	0.0	159.6
1992	0.8	0.0	4.2	34.2	117.6	160.2	0.0	1.0	2.4	0.0	0.0	0.0	320.4
1993	14.0	108.4	0.0	9.4	51.2	39.8	9.2	8.0	2.8	0.0	1.6	0.0	244.4
1994	0.0	169.6	0.2	0.0	0.4	28.8	19.0	9.8	0.0	0.0	0.0	8.0	235.8
1995	0.0	134.6	0.0	43.6	20.4	16.8	32.4	1.2	1.6	0.0	0.4	123.2	374.2
1996	0.0	43.0											
avge	21.6	45.3	48.1	17.9	46.3	45.5	18.0	13.3	1.6	2.5	2.2	3.5	265.7
count	81	81	81	81	81	81	81	81	81	81	81	81	81
mini	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	41.6
maxi	278.3	584.9	511.3	233.4	220.7	221.0	89.4	241.8	20.6	63.5	61.7	123.2	813.6

Appendix 2. Rainfall data for Learmonth (provided by Bureau of Meteorology)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1976	22.6	38.4	5.0	0.0	7.3	4.2	20.0	37.6	3.2	1.4	0.0	0.0	139.7
1977	1.6	0.6	98.0	10.0	59.0	12.4	0.0	6.8	0.0	0.4	1.4	0.0	190.2
1978	4.4	10.2	5.2	33.0	4.8	22.8	36.0	47.0	0.0	0.0	0.0	0.0	163.4
1979	0.0	0.0	91.4	4.2	10.4	3.4	0.0	45.4	0.0	0.0	0.0	0.6	155.4
1980	13.8	41.2	1.0	90.2	60.2	124.8	63.2	0.4	0.0	2.2	0.0	0.4	397.4
1981	18.0	19.4	38.2	0.0	33.0	46.4	0.4	4.2	14.4	0.0	0.6	0.6	175.2
1982	85.0	27.8	13.6	2.6	71.6	27.0	0.2	4.4	10.0	0.0	0.2	0.0	242.4
1983	0.0	0.0	8.6	7.2	15.0	45.8	8.6	13.0	10.4	0.0	3.8	0.0	112.4
1984	0.0	54.0	23.8	5.0	230.8	12.0	89.0	14.6	1.4	10.0	0.0	0.6	441.2
1985	0.0	32.0	0.0	36.4	51.4	58.8	68.0	1.2	0.0	2.0	0.0	0.0	249.8
1986	2.2	97.6	29.2	0.0	8.6	39.0	9.8	3.4	7.8	2.4	0.0	0.0	200.0
1987	0.0	33.6	0.8	2.0	11.6	74.0	26.4	1.4	0.0	0.4	0.0	0.0	150.2
1988	0.0	0.0	11.0	11.8	40.0	14.2	28.2	54.8	0.2	2.4	11.4	0.8	174.8
1989	0.2	2.6	13.8	0.8	55.8	66.2	1.0	0.0	0.0	0.0	0.2	0.0	140.6
1990	143.0	1.0	47.0	0.0	0.4	8.0	29.0	38.8	0.0	0.0	0.0	0.0	267.2
1991	0.0	32.2	22.6	0.4	47.6	86.0	18.4	2.6	0.0	0.0	0.4	0.0	210.2
1992	0.4	0.0	11.8	48.6	137.2	152.6	0.0	2.4	3.2	0.2	0.0	0.0	356.4
1993	11.6	118.0	0.0	11.8	33.8	40.6	8.8	9.0	1.4	0.0	4.0	0.0	239.0
1994	0.0	158.2	0.0	0.0	4.0	28.4	11.0	17.2	0.0	0.0	0.0	0.0	218.8
1995	0.0	138.4	0.0	15.6	7.4	37.0	20.6	0.6	2.8	0.0	0.0	153.0	375.4
1996	0.0	51.6											
avge	35.6	46.2	33.7	16.1	45.2	43.5	22.1	13.9	2.2	2.3	1.5	6.6	230.0
count	20	20	20	20	20	20	20	20	20	20	20	20	20
mini	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	112.4
maxi	361.1	238.7	257.5	129.5	230.8	223.5	89.0	64.0	14.4	45.7	31.6	153.0	441.2

Appendix 3. Budget calculations

1. Reconnaissance and installation trip

4 staff ex Perth (CALM & WAM), two 4WD vehicles

2 Pilbara Region/Exmouth District staff, one 4WD vehicle (vehicle costs met by Pilbara Region)

ex Perth TA 4 x 2 day @ $58/day	465
ex Perth TA 4 x 12 days @ $33/day	1585
ex Karratha/Exmouth TA 2 x 10 days @ $33/day	660
14 days commuted overtime (@ $42/day)	600
Toyota running 4 000 km @ 30 c + $150	1350
Pajero running 3 000 km @ 20 c + $100	700
explosives ($2.50 / hole, 144 holes)	360
rock drill costs	300
24 lines of pit traps and lids (@ $23.50 / line of 6)	565
12 sets drift fences and McKenzie funnels (@ $24 per line)	450
TOTAL	**7035**

2. Each 18 day field trip

3 staff ex Perth (CALM & WAM), 2 ex Pilbara/Exmouth, one 4WD ex Perth, one from Exmouth. Pilbara Region/Exmouth District vehicle costs met by Region

ex Perth TA for 3 people, 10 days @ $58 / day	1740
ex Perth TA for 3 people, 8 days @ $33 / day	790
ex Perth vehicle running 4000 km @ $0.30 + $150	1350
ex Region TA for 2 people, 10 days @ $58 / day	1160
ex Region TA for 2 people, 8 days @ $33 / day	530
consumables (bait, preservative, batteries, etc)	1000
TOTAL PER TRIP	**6570**