DRAFT SPECIES CONSERVATION PLAN

BLACK-FLANKED ROCK-WALLABY
(*Petrogale lateralis lateralis*)

CONSERVATION PLAN FOR THE CENTRAL WHEATBELT POPULATIONS 2008-2013

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Black-flanked Rock Wallaby (Photo from CALM (1999)

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AVON CATCHMENT COUNCIL

Department of Environment and Conservation

WWF

FOREWORD

This species conservation plan has been developed by the Department of Environment and Conservation Western Australia (DEC) with support from the Avon Natural Diversity Alliance (ANDA) on behalf of the Avon Catchment Council. ANDA is a joint cooperative between DEC, World Wildlife Fund (WWF) - Australia, and Greening Australia (Western Australia) for the Avon Catchment Council (ACC).

Although this species is found outside the Avon River Basin (ARB), this plan relates to the management of the species within the ARB. The implementation of recommendations and associated costs contained within this plan do not reflect current funding capacity. The availability of funding will determine the capacity to implement this plan

Information in this species conservation plan was accurate at April 2008. This plan will operate from April 2008 to April 2013 but will remain in force until withdrawn or replaced.

ACKNOWLEDGMENTS

The following people have provided valuable advice and comments during the preparation of this conservation plan (*unless specified, all of the above contributors are employees of the Department of Environment & Conservation [DEC]):

Dr. Mark Eldridge (Department of Biological Sciences, Macquarie University), Dr Jack Kinnear (former DEC scientist and now Consultant); Craig Pentland (PhD student, Edith Cowan University), Brett Beecham, Christine Freegard, Steve Gorton, Peter Orell, Dr Peter Mawson, Dr David Pearson, Nicole Willers and Lisa Wright.

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SUMMARY

Family:	Macropodidae
NRM Regions:	Avon, Swan Coastal
DEC Regions:	Swan, Wheatbelt
DEC Districts:	Yilgarn, Avon-Mortlock, Perth Hills
Local Government Areas:	Kellerberrin, Quairading, Bruce Rock
Current IUCN status of taxon:	Vulnerable
Description:	Dark to pale grey-brown fur on the back and shoulders, with paler fur on the chest, and dark brown fur on the abdomen. There is a distinct black eye-stripe and white cheek-stripe, with white at the base of the ears. A white stripe and a dark stripe run along the side of the body. A dark brown to black dorsal stripe runs from between the ears to below the shoulders. The coat is thick and woolly, particularly around the rump, flanks and base of tail and the tail has a slight brush on the end. The pelage often becomes lighter and browner in summer. The male Black-flanked Rock-wallaby has a head and body length of 497-529 mm with a tail length of 483-605 mm, and a weight range of 4.1-5.0 kg. The female has a head and body length of 446-486 mm, a tail length of 407-516 mm, and weight of between 3.1 and 3.8 kg (Eldridge & Close, 1995).
Breeding habitat:	Rockpiles on granite outcrops that are sufficiently weathered or fractured to provide shelter in the form of caves, crevices or fissures against extreme thermal fluctuations and predators.
Feeding habitat:	Areas within close proximity to rock outcrops with annual or perennial grasses, and succulents, herbs, leaves and fruit.
Conservation Plan objective:	In partnership with the community to conserve and, if possible, restore the condition and number of populations of Black-flanked Rock-wallabies in the wild.

Recovery Criteria:
Criteria for success:

- All known Black-flanked Rock-wallaby populations in the Wheatbelt region continue to persist i.e. populations continue to recruit, remain stable or increase. (This will be determined by surveying / monitoring the size and condition of each Black–flanked Rock-wallaby population at least once during the next 5 years).

  And

- Community support has been maintained or increased, with community members actively participating in management programs.
  And
- Fox control is continued where Black-flanked Rock-wallaby sites are currently being baited.

Criteria for failure:

- The decline of one or more known Black-flanked Rock-wallaby population in terms of population size, recruitment and condition.

  Or

- Community support has diminished considerably.

  Or

- Fox control is discontinued at one or more existing sites where Black-flanked Rock-wallaby sites are currently being baited.

Conservation Actions	Predator control Translocations Determine the characteristics of known populations Establish BFRW wheatbelt advisory group Monitoring Habitat enhancement Promote awareness
Advisory group	It is recommended that a Black-flanked Rock-wallaby advisory group is established to provide expert advice and guidance regarding management of the BFRW populations in the Avon River Basin.
Conservation plan time frame:	This plan will be implemented, updated and continually evaluated from 2008-2013

1. INTRODUCTION

The Black-flanked Rock-wallaby (*Petrogale lateralis lateralis)* is found on the Australian mainland and on Barrow and Salisbury islands. A population occurred on Depuch Island until at least 1962, but was extinct by 1982 (Hall & Kinnear, 1991). There are currently 26 recognised taxa of *Petrogale*, a genus endemic to Australia (Eldridge, 1997).

Within *P. lateralis* there are three subspecies (*P. l. lateralis, P. l. hacketti, P. l. pearsoni*) and two chromosomal races ("West Kimberley" and "MacDonnell Ranges") (Eldridge 1997). All subspecies and the two recognized genetic races are listed as "Vulnerable" under the EPBC Act (www.deh.gov.au). The remaining populations are all vulnerable to extinction and require active management to ensure their survival (Eldridge & Close, 1995).

The major threats to the Black-flanked Rock-wallaby are the predation from introduced animals such as the European fox (*Vulpes vulpes*) and to a lesser extent, habitat loss due to land clearing.

This conservation plan focuses on enhancing the management of Black-flanked Rock-wallaby populations that occur within the central Wheatbelt area in the Avon River Basin[1]. This operational-based plan is intended to compliment, rather than duplicate, the national Black-flanked Rock-wallaby recovery plan (David Pearson, in preparation.) which is more strategic in nature.

The plan provides background information on the Black-flanked Rock-wallaby (hereafter referred to as BFRW) populations within the central Wheatbelt including its biology, locations and threats. Methods are discussed to conserve and improve the management of the eight known populations that occur within the central Wheatbelt. In addition, this plan also discusses the impacts that some BFRW populations have on neighbouring land use, and recommends management options to minimize these impacts.

[1] The Avon River Basin refers to the area under the NRM jurisdiction of the Avon Catchment Council in Western Australia.

2. BLACK-FLANKED ROCK-WALLABY

2.1. History and Taxonomic Relationships

There are three described subspecies and two recognised chromosomal races of *P. lateralis* (Eldridge & Close, 1995), of which the following five have been taxonomically described:

- *Petrogale lateralis lateralis*
- *Petrogale lateralis hacketti*
- *Petrogale lateralis pearsoni*
- *Petrogale lateralis* West Kimberley race
- *Petrogale lateralis* MacDonnell Ranges race

The BFRW *(P.l. lateralis)* was first described by John Gould in 1842 from specimens collected by John Gilbert. Although they are sometimes referred to as the Black-footed Rock-wallaby as per the species' common name, the preferred name for this subspecies is the Black-flanked Rock-wallaby (Eldridge & Close, 1995).

2.2 Description

BFRW have dark to pale grey-brown fur on the back and shoulders, with paler fur on the chest, and dark brown fur on the abdomen. There is a distinct black eye-stripe and white cheek-stripe, with white at the base of the ears. A white stripe and a dark stripe run along the side of the body. A dark brown to black dorsal stripe runs from between the ears to below the shoulders. The coat is thick and woolly, particularly around the rump, flanks and base of tail and the tail has a slight brush on the end. The pelage often becomes lighter and browner in summer.

The male BFRW has a head and body length of 497-529 mm with a tail length of 483-605 mm, and a weight range of 4.1-5.0 kg. The female has a head and body length of 446-486 mm, a tail length of 407-516 mm, and weight of between 3.1 and 3.8 kg (Eldridge & Close, 1995). The diet usually consists of grasses, herbs, leaves and fruit.

John Gilbert, who originally collected the subspecies in the Avon Valley, described BFRW as a ”remarkably shy and wary animal, feeding only at night in little open patches of grass and never…going more than two or three hundred yards from its rock retreats” (Eldridge & Close, 1995).

2.3 Distribution, habitat and location descriptions of BFRW within the central Wheatbelt

The BFRW was once widespread in Western Australia, but occurred in scattered rocky habitat across the Great Sandy, Little Sandy, Gibson and northern Great Victoria deserts, the Central Ranges region, Ashburton, North West Cape and the south-west from Kalbarri to the southern Wheatbelt (Burbidge, 2004). This distribution has been greatly reduced, and now this subspecies occurs only in the western part of Western Australia.

BFRW’s live in areas of granite outcrops (*Figure 1*), sandstone cliffs, rock piles, scree slopes, caves, and coastal limestone cliffs.

Figure 1: Black-flanked Rock-wallabies in typical rocky outcrop habitat. (Photo: John Priddam)

Within the Avon Natural Resource Management (NRM) boundary, there are two BFRW sites (*Figure 2*). The first of these sites consist of a group of populations located on private property and nature reserves within the central Wheatbelt. Nature reserves are managed by the Department of Environment and Conservation for the conservation of flora and fauna. Nature reserves are set aside to maintain and restore the natural environment, to protect, care for and promote the study of indigenous flora and fauna, and to preserve any feature of archaeological, historical or scientific interest.

The Wheatbelt populations include:

1. Mount Caroline Nature Reserve (A 11047);
2. Nangeen Hill Nature Reserve (A 23187);
3. Mount Stirling Nature Reserve (A 11048);
4. Gundaring (formally known as "Tutakin") Nature Reserve (A 11039);
5. Kokerbin Nature Reserve (A 11043).
6. Querekin Rock (private property);
7. Sales' Rock (private property); and
8. Gardiner's Rock (private property).

The second BFRW locality contains two translocated populations at the Avon Valley National Park and Paruna Sanctuary (managed by the Australian Wildlife Conservancy) in the Perth Hills District (*Figure 2*).

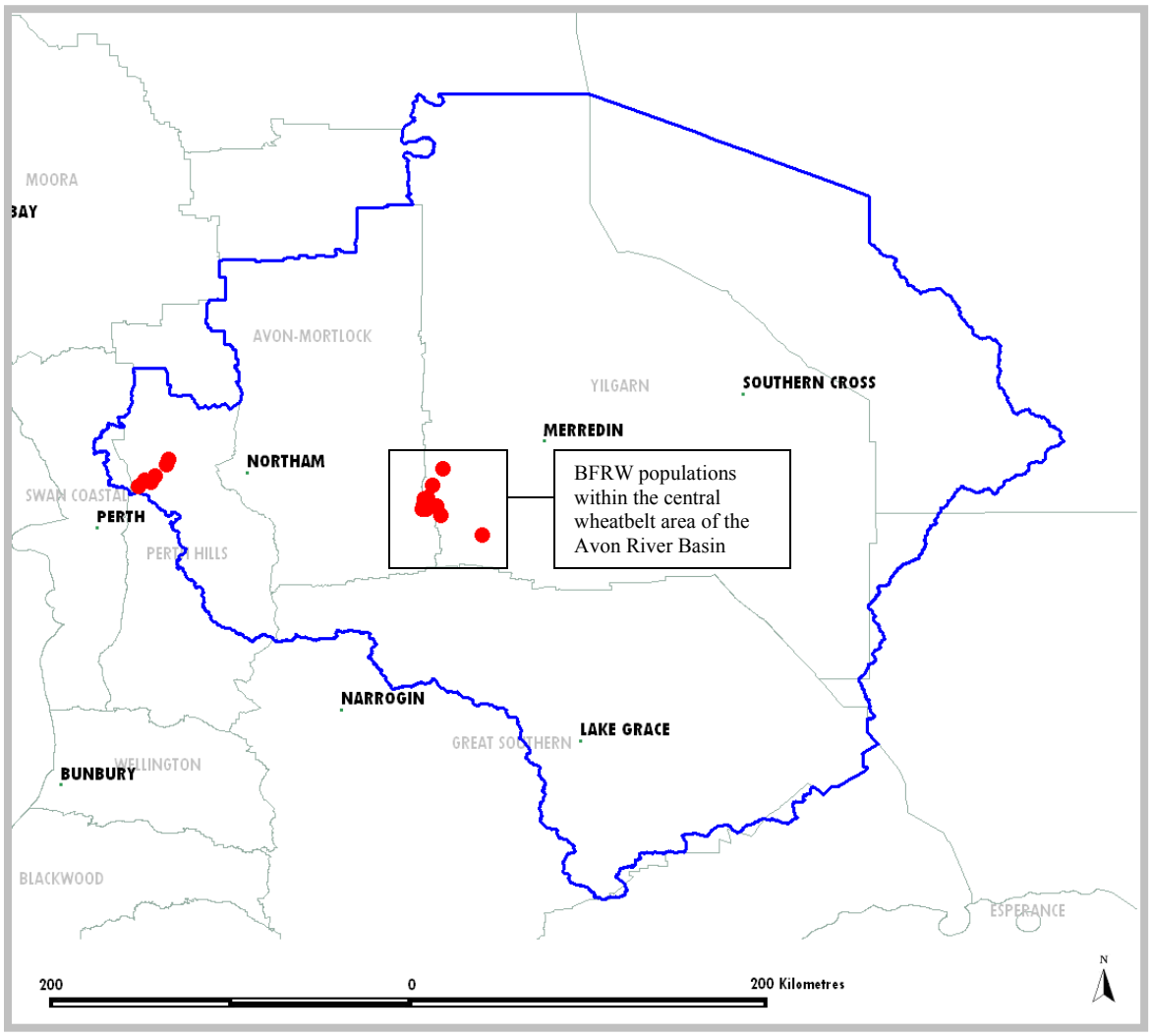


Figure 2: Location of the two geographically distinct locations of Black-flanked Rock-wallaby populations (red dots) within the Avon NRM Region (blue line). The grey areas denote the DEC Districts.

2.3.1 Mount Caroline Nature Reserve

Mount Caroline is a 352 ha DEC-managed nature reserve which supports the largest known BFRW population in the central Wheatbelt.

In 1979, the BFRW population size at Mt. Caroline was estimated at 9 individuals. In 1982, Fox-baiting was introduced to Mount Caroline, and the BFRW population increased to 42 individuals in 1986 and to 276 individuals in 1998 (Kinnear *et al.*, 1988); (Kinnear, 2000) (*Figure 3*). A research project in Mt Caroline has revealed that as of

January 2008, there are 240 individual BFRW known to be alive at Mt Caroline (Nicole Willers, Personal Communication April 2008).

The increase in the BFRW population has lead to individuals seeking refuge and food beyond the reserve boundaries as increasing numbers have placed stress on existing food resources. This has lead to BFRW grazing on crops found on adjacent properties, resulting in conflict with local landowners. A 2.4 km fence was erected on the southern boundary of the reserve to mitigate the impact of these animals and maintain landowner support for conservation. Follow-up spotlight surveys and discussions with landowners demonstrated that other Macropod species (Western Grey Kangaroo, (*Macropus fuliginosus),* and Euro, (*Macropus robustus rubescens*) were also involved in grazing crops.

The lack of both understorey vegetation and new vegetation growth, as well as soil erosion in some areas of Mt Caroline indicate that grazing by herbivores is having an adverse impact on the ecological health of the reserve. This has lead to an increase of weeds that herbivores including BFRW find unpalatable such as Cape Weed (*Arctotheca calendula*). Other factors that may be affecting the vegetation dynamics at Mt Caroline include below average rainfall, vegetation senescence and the lack of germination triggers such as fire.

A Declared Rare Flora (Critically Endangered) species, the Granite Tetratheca (*Tetratheca deltoidea*) is known to only occur in Mount Caroline. This species has in the past been grazed (the relative impact of BFRW, rabbits or kangaroos are unknown) in some seasons, to the extent that they have not produced flowers (CALM, 1999). The *T. deltoidea* population in this reserve has subsequently been fenced as a precautionary measure.

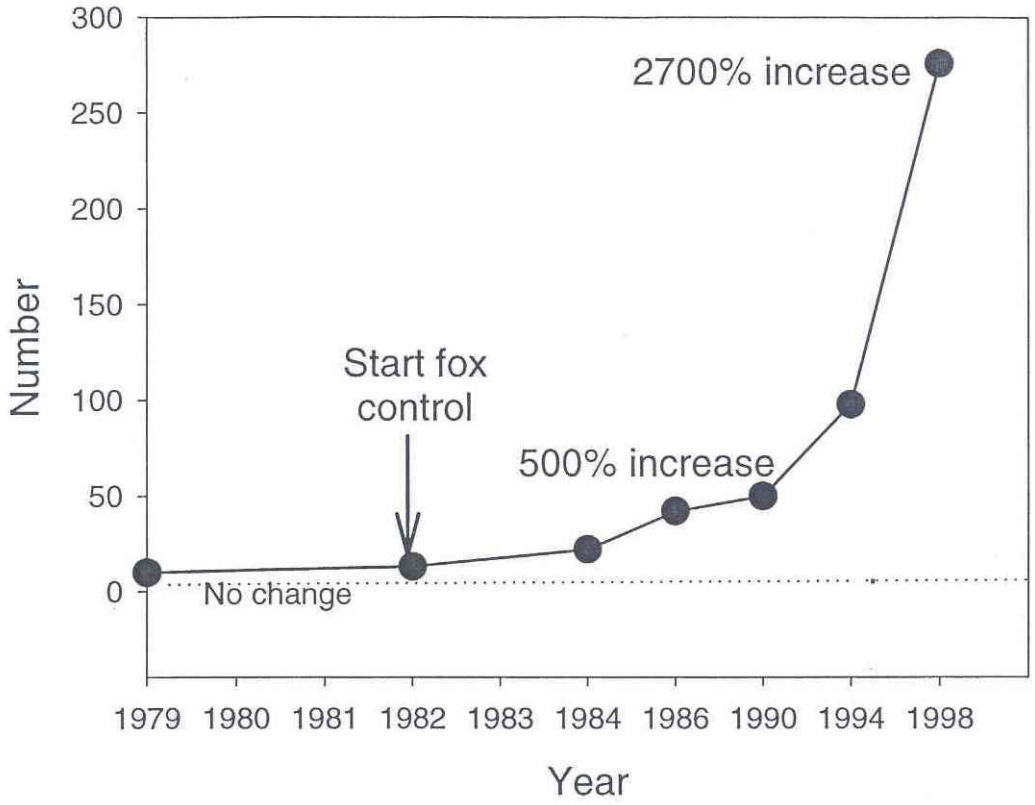


Figure 3: Change in Black-flanked Rock-wallaby population abundance at Mount Caroline Nature Reserve in response to the introduction of fox baits in 1982 (Kinnear, 2007).

A grazing exclusion monitoring project will be implemented at Mount Caroline in 2008 to determine which, if any, of kangaroos, rabbits and BFRW`s are having the greatest impact on the understorey vegetation.

The Mount Caroline population is currently used as a source of animals for small scale translocation projects under the DEC Western Shield program (see section 11.4.2).

Appendix 1 contains a description of the BFRW population, aerial photo and description of this reserve.

2.3.2 Nangeen Hill Nature Reserve

Nangeen Hill is a 178 hectare DEC-managed nature reserve located in the Shire of Bruce Rock. The granite rock at this site is severely fractured on the northern side making it a suitable habitat for BFRW.

The BFRW population at Nangeen Hill has increased markedly since fox-baiting was introduced. Between 1979 and 1990, the BFRW population increased from 18 to 116 individuals (Kinnear *et al.*, 1998).

A recently completed doctoral regarding the effects of behavioral patterns and landscape structure on the movement patterns and resource patch use of BFRW, at Nangeen Hill has been carried out by Craig Pentland from Edith Cowan University. During this study, 99 BFRW's were trapped (Personal communication, Craig Pentland, March 2007). It is believed this constituted the entire catchable population.

Appendix 2 contains a description of the BFRW population, aerial photo and description of this reserve.

2.3.3 Mount Stirling Nature Reserve

The BFRW population in the DEC-managed Mount Stirling Nature Reserve (225 ha) is known to inhabit both the nature reserve and a remnant on adjacent private property.

Little is known about the population size and trend of this BFRW population. Owing to difficulties with access, fox control was undertaken at Mount Stirling only recently and a small, remnant population persists at this site (Eldridge *et al.*, 2001). There has been no population size estimate undertaken at Mt. Stirling.

Appendix 3 contains a description of the BFRW population, aerial photo and description of this reserve.

2.3.4 Gundaring (Tutakin) Nature Reserve

The BFRW population at Gundaring Nature Reserve has not been intensively studied since 1998. The 1998 survey resulted in the capture of a total of 20 BFRW (see *Figure 4*). The majority of the granite rock profile at Gundaring is unfractured and unsuitable for BFRW habitation. As a result, it is unlikely the population can increase extensively

beyond its previous population estimate of 20 individuals. *Appendix 4* contains a description of the BFRW population, aerial photo and description of this reserve.

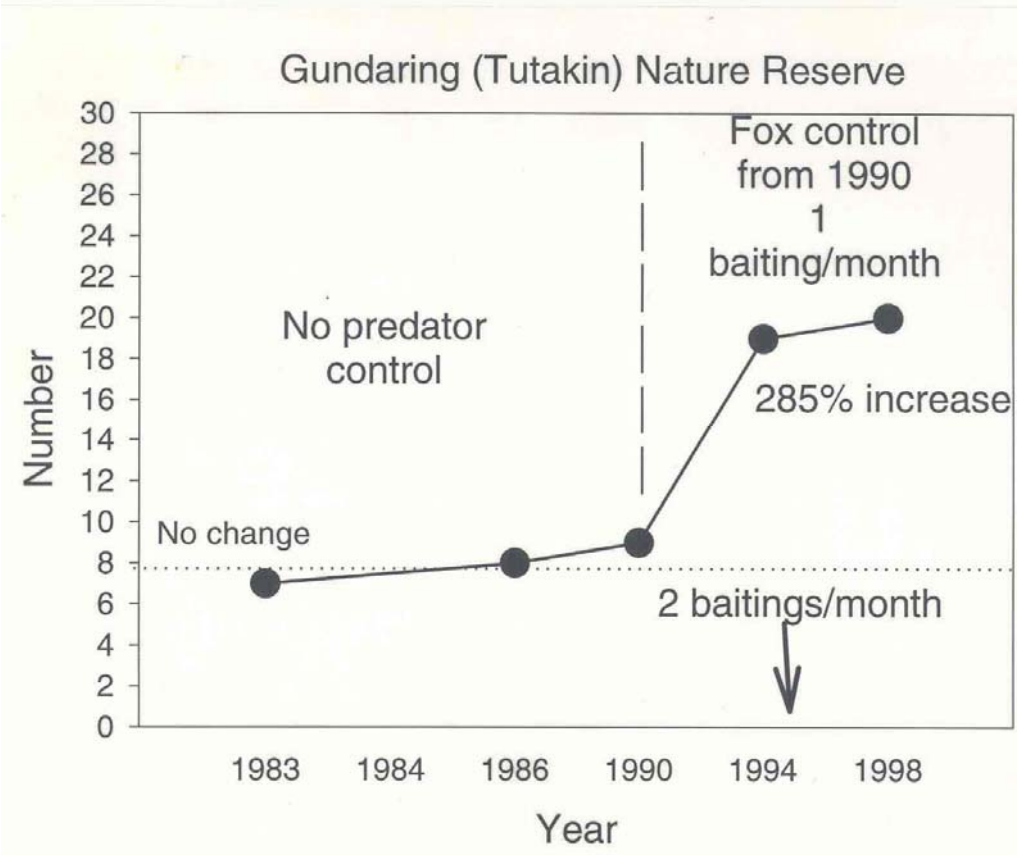


Figure 4: Change in Black-flanked Rock-wallaby abundance at Gundaring Nature Reserve in relation to the introduction of fox-baits in 1990 (Kinnear, 2007).

2.3.5 Kokerbin Nature Reserve

Kokerbin is a 91 ha "A" Class DEC-managed nature reserve in the Bruce Rock Shire. The reserve is dominated by a large granite rock (approx 50% of the reserve area).

BFRW were known to occur in the Kokerbin Nature Reserve until 1969-70, but was then thought to be extinct by the 1980's (Kinnear *et al.,* 1988). In 2004, BFRW's were again trapped at Kokerbin after scats were found along the border of the reserve the previous year. DNA evidence suggests that the three individuals had traveled eight kilometers

across farmland from Gundaring Nature Reserve to recolonise the vacant habitat at Kokerbin (Freegard & Orell, 2005).

Kokerbin Rock is a very popular recreation site attracting large numbers of campers and day use. The DEC and Bruce Rock Shire are undertaking a planning process aimed at managing the current unsustainable impact of recreation on this reserve. The objective of this project is to protect the reserve's conservation values while also providing a safe and enjoyable recreational experience for visitors.

Fox-baiting is not conducted on this reserve due to the relatively small size, and the unacceptability of using the toxin 1080 in the proximity of recreation sites. The code of practice for the safe use of 1080 prescribes the circumstances where 1080 cannot be used.

Issues associated with the recreation include:

1. Foxes being attracted to picnic sites;
2. Visitors bringing dogs to the reserve. Dogs pose a threat by chasing fauna as well as leaving scent which may discourage animals from using the site;
3. Vehicles driving along a track adjacent to the BFRW habitat; and
4. Visitors attempting to interact with BFRW (i.e. attempting to get too close).

These issues will be considered in the recreation development plan for this reserve.

Appendix 5 contains a description of the BFRW population, aerial photo and description of this reserve.

2.3.6 Querekin Rock

This site is a 64 ha remnant of native vegetation and granite outcrop located on private land used for crop production. By 1980, this BFRW population consisted of just 7 individuals (Kinnear *et al.*, 1998), and became extinct shortly thereafter. Two translocations of five individuals were translocated to Querekin from Nangeen Hill the same year in association with the implementation of fox control (Hall & Kinnear, 1991)

(*Figure 5*). The population increased to almost 50 individuals however a survey conducted in April 2007 resulted in only 35 BFRW being caught.

This site has also been associated with impacts on neighbouring agricultural land from the increasing BFRW population. The Querekin land owner has advised that the BFRW's have been entering machinery sheds and fouling farm machinery.

In recent years, animals from Querekin Rock have been translocated to other sites where BFRW are extinct or to replenish existing populations (see section 11.4).

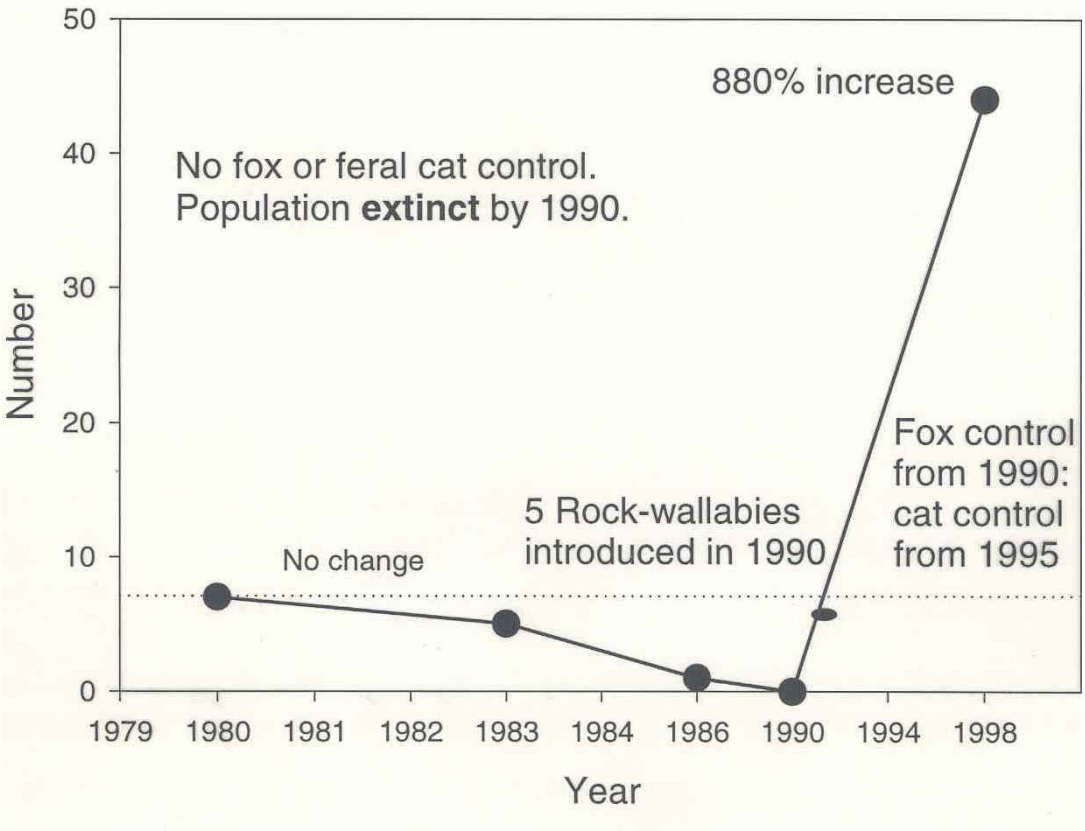


Figure 5: Change in Black-flanked Rock-wallaby abundance at Querekin Rock in relation to the introduction of fox baits and Re-introduction of Rock-wallabies in 1990 (Kinnear, 2007).

Appendix 6 contains a description of the population, aerial photo and description of this reserve.

2.3.7 Gardiner's Rock

Gardiner's Rock is a 10 ha remnant located on private property. The BFRW population at Gardiner's Rock is believed to have been established by a mother, her male joey and a quiescent embryo from Mount Caroline (Eldridge *et al.*, 2001). This small population (6 individuals in 1997) represents the first recorded instance of BFRW dispersing to recolonise habitat from which it disappeared decades ago (Eldridge *et al.*, 2001). It is also one of the few dispersal events documented in any Rock-wallaby species (Sharp, 1997).

Appendix 7 contains a description of the BFRW population, aerial photo and description of this reserve.

2.3.8 Sales' Rock

This BFRW population inhabits a 65 ha remnant on private property in the Quairading shire. The most recent census of this BFRW population was undertaken in 1998. Between 1979 and 1990 (when fox-baiting did not occur at Sales' Rock), the population had fallen to 13 individuals - a reduction of almost 60 per cent (Kinnear *et al.*, 1998). After baiting was introduced to Sales' Rock in 1990, the population recovered to almost 50 individuals (see *Figure 6*). *Appendix 8* contains a description of the BFRW population, aerial photo and description of Sales' Rock.

Table 1 provides a summary of the latest known population sizes for each of the 8 BFRW populations in the central wheatbelt.

Table 1: The latest BFRW monitoring performed at each site in the Wheatbelt region

Site	Size (ha)	Shire	last surveyed	number caught	pop estimate Schumacher-Eschmeyer
Mount Caroline NR	351	Kellerberrin	2008	210	N/A
Nangeen Hill NR	178	Bruce Rock	2007	99	110
Mt Stirling NR	225	Quairading	—	—	—
Gundaring NR	127	Quairading	1997	20	29
Kokerbin NR	91	Bruce Rock	2004	3	N/A
Querekin Rock	64	Bruce Rock	2007	35	35
Sales Rock	65	Quairading	1998	47	47
Gardiner's Rock	10	Kellerberrin	1997	6	N/A

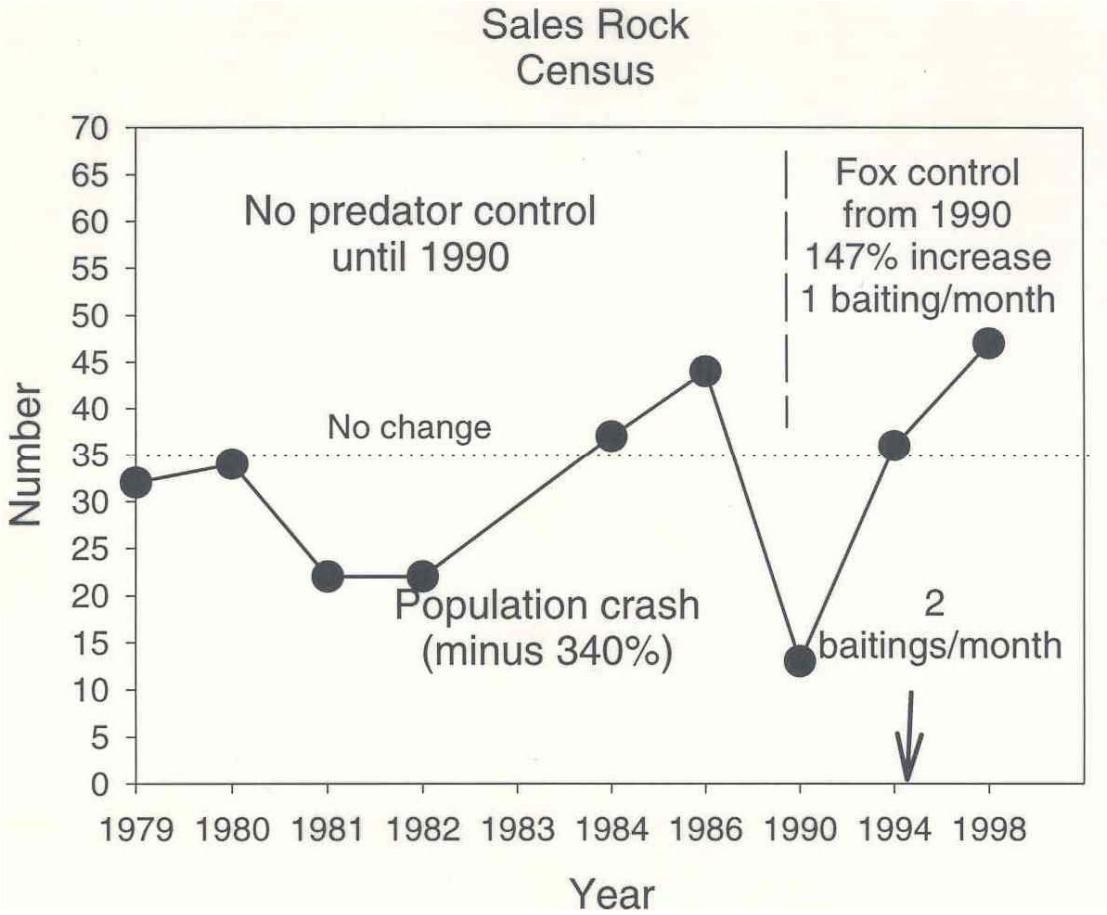


Figure 6: Change in Black-flanked Rock-wallaby abundance at Sales' Rock in relation to the introduction of fox baits in 1990 (Kinnear, 2007).

2.4 Black-flanked Rock-wallaby Biology and Ecology

BFRW attain sexual maturity between one and two years of age, and can live for up to 14 years (Parker, 1990). Breeding can be continuous but varies in response to seasonal rainfall. A feature of this species' reproduction is embryonic diapause, where the developing embryo can become dormant until conditions are more suitable (CALM, 1999a). Diapause embryos are often reactivated when a pouch young is weaned or lost. The stimulus for reactivation is generally lactation based. A female can potentially produce seven to eight young in a lifetime (Kinnear *et al*., 1998).

Once the young have left the pouch, they are deposited in a sheltered location while the mother forages for food, returning regularly to suckle the young until they are weaned (Sharman & Maynes, 1983). Young are weaned at approximately 11 months (Kinnear *et al.*, 1998).

BFRW have 11 pairs of chromosomes, similar to those of the presumed ancestor to all modern Rock-wallabies (Eldridge & Close, 1995).

2.5 Conservation Status

The conservation status of the Black-flanked Rock-wallaby (*Petrogale lateralis lateralis*) is listed under the following legislation:

- Schedule 1 Fauna under the Western Australian *Wildlife Conservation Act 1950.* (Schedule 1 is defined as fauna that is rare or likely to become extinct and is declared to be fauna that is in need of special protection[2]).
- Vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999,* and The World Conservation Union (IUCN) Red list (based on criteria B1+2abce and C2a) (2006 IUCN Red List of Threatened Species, (www.deh.gov.au).

3. HABITAT CRITICAL TO SURVIVAL OF BLACK-FLANKED ROCK WALLABIES

The habitat critical to survival of BFRW includes:

- Areas currently occupied by BFRW (i.e. those mentioned in section 2.3)
- Areas of suitable habitat not currently occupied by BFRW adjacent to areas that are currently occupied by BFRW (within a dispersal range of 10km)

[2] Wildlife Conservation Act 1950, WA

- Areas of suitable habitat to which BFRW may be translocated in the future.

The critical habitat includes areas containing granite outcrop rock-piles and scree for shelter during the day (*Figure 7*). Suitable locations, such as rock ledges or caves, are also important for breeding success as large young are often left in these places while their mothers forage for food.

Fragmented rocky outcrops provide predation and thermal refuge. Historical evidence suggests that sites which are well fractured provide BFRW with a degree of refuge from fox predation at certain sites (Kinnear, 2007).

Figure 7: Example of the type of rock outcrop used by BFRW. (Photo: Rowan Inglis)

Sufficiently fractured rock-piles also insulate BFRW from temperature and climatic extremes thus helping them to maintain energy and water balances. BFRW are independent of free water when sufficient rock-piles are available (Kinnear, 2007).

Uncleared land directly adjacent to the rocky outcrops is an important habitat requirement within the highly fragmented Wheatbelt habitat context, as it allows BFRW populations to extend their foraging range in the absence of foxes.

4. GUIDES FOR DECISION-MAKERS

The current and possible future threats to BFRW's are detailed in Section five. Any developments in the immediate vicinity of BFRW populations or within adjacent critical habitat (definition in section 3) will require assessments to determine any adverse long term impacts on BFRW population health. Proponents should demonstrate that on-ground works will not have an impact on the BFRW population or its critical habitat.

Encouraging landowners / managers to conserve populations occurring on their properties is critical to the protection of these populations. It is therefore essential for landowners to be fully consulted and involved to provide the best level of protection for these animals while also responding to any impacts. DEC will continue to work closely with landowners in conserving BFRW.

The DEC provides advice on the location and protection of threatened species and communities to telecommunication, water and power providers to ensure that these areas are managed as Environmentally Sensitive Areas (ESA).

The DEC is responsible for assessing notifications of intent to clear under the clearing of native vegetation provisions of the *Environmental Protection Act* 1986. The DEC also provides advice to the Commissioner for Soil and land Conservation in respect notifications of intent to drain.

5. THREATS

Habitat clearance in Western Australia for agriculture, predation from foxes and cats, competition from wild introduced herbivores (e.g. rabbits, goats), and altered fire regimes have restricted the occupied area of BFRW populations (Pearson & Kinnear, 1997).

The main threatening processes (not necessarily in order of priority) are:

1. Lack of ecological resources (food) to support viable populations
2. Predation by introduced animals
3. Competition (for food and shelter) from introduced animals
4. Inappropriate fire regimes,
5. Impact of native species (predation and competition)
6. Disease
7. Weeds

5.1 Lack of ecological resources to support viable populations

Lack of ecological resources to support viable populations relates to:

- Availability of basic resources for survival and reproduction, where availability of food, shelter and access to mates limits population size. The survival of populations can be directly threatened when restricted gene flow and insufficient habitat are below the levels necessary to maintain a viable population.

- Restricted gene flow and insufficient habitat can increase a population's susceptibility to other threats. For example, a small remnant may be totally consumed by fire providing no available habitat for the species to persist in before the affected habitat returns to suitable pre-fire condition.

Land clearing is perhaps the most important cause of environmental degradation as well as the loss and depletion of species and ecological communities, both in Australia and

world-wide (Possingham, 1995). The Avon Botanical District in WA is roughly equivalent to the State's Wheatbelt zone. Only seven per cent of the natural vegetation of this district remains, mostly as scattered fragments (see *Figure 8*) (Hobbs & Hopkins, 1990).

Fragmentation of BFRW habitat has heightened a number of factors that could lead to its extinction. In some of the smaller, isolated BFRW populations the risk of inbreeding depression may be a considerable threat. Inbreeding depression is the reduction in survival or fecundity that results from elevated levels of homozygosity (Burgman & Lindenmayer, 1998).

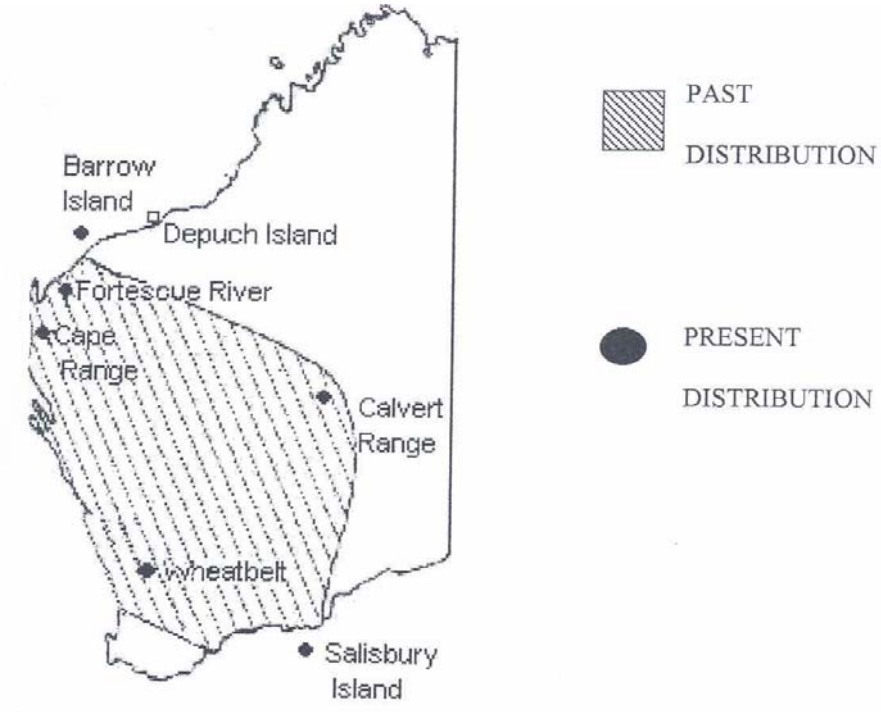


Figure 8: Past and present distribution of BFRW (adapted from Hall & Kinnear, 1991, Davies 2000).

Small breeding populations are more likely to have low allele variability, resulting in a higher rate of genetic homozygosity and reduced population resilience and viability. A lack of interconnectivity between BFRW populations may enhance the effects of inbreeding depression and lead to reduced survival and reproduction rates, particularly in smaller populations (Ralls *et al.*, 1988).

Studies carried out to determine the genetic diversity of the BFRW Wheatbelt populations indicated that genetic diversity was relatively high, but that the Querekin population was significantly less heterozygous (Eldridge *et al.*, 2004). The low genetic diversity of the Querekin population is most likely due to the small size (five individuals) of the founding population in the initial translocation of animals to the site (see *Table 2*).

It is possible that other BFRW populations with low founder numbers, such as Gardiner's Rock and Kokerbin Nature Reserve may also exhibit a degree of low genetic variability.

Table 2: Level of genetic diversity in wheatbelt populations of *P. l. lateralis* (Eldridge *et al.*, 2004)

Population	***P***	***A***	***rA***	$H\varepsilon$	**No. loci**	***N***
Gundaring	1.00	4.0 ± 0.5	0.46 ± 0.21	0.62 ± 0.04	11	19.0 ± 0.0
Sales Rock	1.00	3.5 ± 0.4	0.82 ± 0.34	0.55 ± 0.05	11	31.0 ± 0.0
Mt Caroline-East	0.91	3.3 ± 0.4	0.55 ± 0.41	0.51 ± 0.07	11	32.0 ± 0.0
Mt Caroline-West	0.91	3.1 ± 0.4	0.55 ± 0.39	0.49 ± 0.07	11	19.4 ± 0.6
Nangeen Hill	0.91	2.5 ± 0.3	0.73 ± 0.27	0.41 ± 0.06	11	30.0 ± 0.0
Querekin	0.82	2.2 ± 0.3	0.27 ± 0.14	0.27 ± 0.06	11	42.8 ± 0.2
Wheatbelt combined	1.00	4.9 ± 0.8	1.09 ± 0.51	0.61 ± 0.06	11	131.4 ± 0.6

P, proportion of polymorphic loci; *A*, mean number of alleles per locus; *rA*, mean number of rare alleles (frequency ≤ 0.05) per locus; $H\varepsilon$, expected heterozygosity *N*, mean sample per locus.

Fossil remains have been found between extant habitat locations, indicating that BFRW's were historically capable of long-distance dispersals. However, land clearing has reduced vegetation cover and extent, leaving migrating individuals vulnerable to predation (Eldridge & Close, 1995).

5.2 Predation from introduced species

Since 1912, the European Red Fox (*Vulpes vulpes*) has had a detrimental effect on BFRW and other Western Australian fauna within the critical weight range of 0.035 and 5.5kg (Burbidge & McKenzie, 1989). Single foxes can have a devastating effect at any site. In May 1994, a fox killed 11 BFRW in an open field over several days at Mount Caroline Nature Reserve. Nine were killed within a 100 meter radius of each other (Short *et al.*, 2002).

Experiments carried out between 1982 and 1990 indicated foxes were the principal predator of BFRW in the Wheatbelt region. These experiments involved implementing fox-control at some remnant BFRW locations using poison baits with non-baited sites used as controls (Kinnear *et al.,* 1988, 1998).

BFRW populations were found to be more numerous in areas where baiting took place (see *Figure 9*). These experiments have lead to fox baiting being carried out in other locations, resulting in significantly lower fox densities and higher densities of fauna within the critical weight range. This research indicates that it is vital that fox baiting continues in areas where BFRW populations occur in order to maintain the BFRW population.

While there is evidence that feral cats have taken various subspecies of *P. lateralis* (Pearson, 1992), their impact on BFRW is presently unknown. The rock-piles used for shelter are ineffective in protecting BFRW from feral cats as the cats are smaller and more agile than most predators. A feral cat has been seen standing over a freshly-killed BFRW at Querekin, although it could not be confirmed whether the cat made the kill or not (Kinnear, 2007).

Feral cats have been in Australia since at least 1788 (Burgman & Lindenmayer, 1998), although they may have established in Australia much earlier. Where fox control is implemented, the number of feral cats may increase due to a reduction in competition for

food (Saunders *et al.*, 1995), indicating that control of cats may also be necessary near BFRW populations. At present there is no effective method to control cats in large areas.

5.3 Competition from introduced animals

Rabbits are known to inhabit rock crevices in the same localities as BFRW (Pearson, 1992), and may therefore actively compete with BFRW for food.

This threat to the health of BFRW populations would be heightened at times of drought when grasses of high nutritional value are scarce. Although BFRW do not require water (provided there are a sufficient number of thermal refuges) and have a more varied diet than rabbits, it can be expected that rabbits could have a detrimental impact on the abundance and health of BFRW populations.

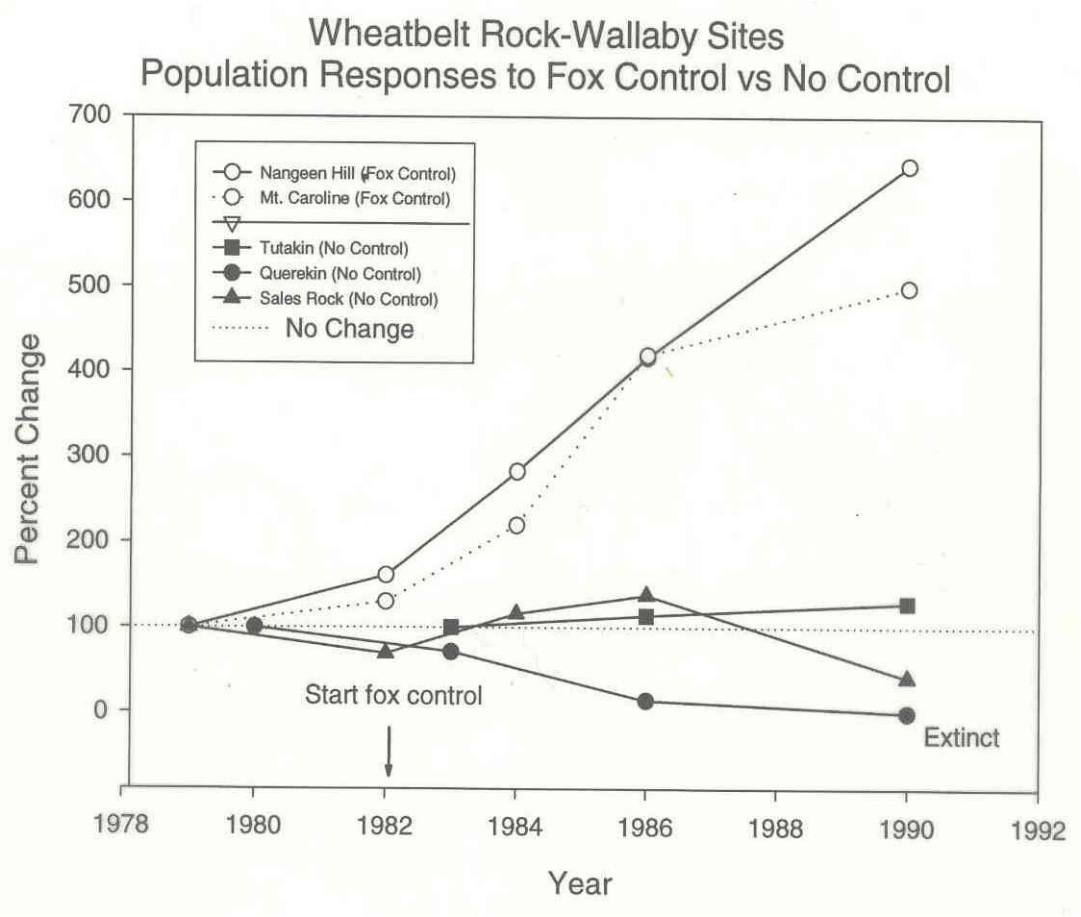


Figure 9: Change in Black-flanked Rock-wallaby abundance in the wheatbelt in relation to the introduction of fox baits in 1982 (Kinnear, 2007).

Other herbivorous introduced fauna, such as goats, could also affect BFRW populations through competition for grazing resources and suitable thermal refuge. At present there are no goats found on BFRW habitat in the Wheatbelt region.

5.4 Inappropriate fire regimes

The indigenous human inhabitants of Australia practiced burning of limited areas of bush in a mosaic pattern, depending on seasonal conditions (Burgman & Lindenmayer, 1998). Their displacement from much of their territory by European settlers altered this fire regime. With the cessation of patch burning and the consequent increased amount of unburnt vegetation, there has been an increase in fuel loads, and an increase in the intensity and frequency of wildfires (Hill, 1991). In contrast, fire has been largely excluded from Wheatbelt reserves, restricting the regeneration of some plant species (Hester & Hobbs, 1992).

The ecological functions of fire include: removing competition, making light / nutrients available, reduces levels of parasites, triggering seed release / germination and maintains balance and diversity of the various components of flora communities

While fire regimes provide a number of important ecological functions, inappropriate fire regimes may threaten the survival of BFRW populations.

Inappropriate fire regimes relate to:

- Frequency Fires that are too frequent or too infrequent
- Season Fires occurring when a species is particularly vulnerable
- Intensity Fires are too intense resulting in high mortality
- Spatial Fires are too large resulting in no or limited unburnt refuge areas

Altered fire regimes may have affected the distribution of populations of BFRW as higher intensity fires may occasionally burn through large areas of rockpiles and BFRW

habitat (Pearson, 1992). Under extreme fire conditions, thick smoke and hot air can penetrate the shelters of Rock-wallabies and result in death of the animals (Ormay, 1996).

Wildfires can also indirectly affect the distribution and survival of BFRW by reducing the abundance of vegetation cover (Hill, 1991). This reduction in food sources may force Rock-wallabies to forage further away from their shelters, increasing the risk of predation (Hill, 1991).

5.5 Impact of native species

Wedge-tail Eagles have been observed to prey on BFRWs (Craig Pentland, personal communication, November 2006). The availability of adequate shelter / refuges is critical to mitigate the impact of this predation.

Euros and Western Grey Kangaroos may compete for available food. In poor seasons this competition may be detrimental to the survival of BFRWs.

5.6 Disease

Little is known about disease in wild populations of BFRW, although it is likely that this species is susceptible to diseases found in other macropods. This includes particularly lethal diseases such as toxoplasmosis. Transmission of this disease is via cysts in the faeces of cats. Small inbred populations, or populations under some environmental stress such as drought, may be particularly vulnerable to this disease because of a depressed immune system (www.dpi.vic.gov.au)

5.7 Weeds

The grazing impact that BFRW have on their habitat potentially allows for weeds to colonise areas in close proximity to rock outcrops. BFRW graze most native shrubs and grasses, but will not eat some invasive plants such as Cape Weed (*Arctotheca calendula*). As a result, Cape Weed flourishes under favourable conditions which include BFRW grazing on competing types of vegetation, as well as having access to surplus water runoff from rock outcrops.

6. INTERNATIONAL OBLIGATIONS

The Black-flanked Rock wallaby (*Petrogale lateralis lateralis*) is not listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

7. AFFECTED PARTIES

The main parties likely to be affected by this Species Conservation Plan are:

- Department of Environment and Conservation (DEC), Western Australia;
- Avon Catchment Council (ACC);
- World Wildlife Fund - WWF Australia;
- Western Australian Museum;
- Western Australian Universities;
- Conservation Commission of Western Australia;
- Local Government Authorities - Shires of Kellerberrin, Bruce Rock and Quairading; and
- Private landholders.

8. INDIGENOUS PEOPLE

The Aboriginal Heritage Sites Register, maintained by the State Department of Indigenous Affairs, will be used to identify significant cultural sites in the vicinity of BFRW populations. It is important to note that not all significant sites are listed on the Register, necessitating local consultation.

Where actions recommended by the plan have the potential to impact on Noongar cultural values, further consultation will be undertaken to ensure such impact is avoided. Opportunities for Noongar individuals / groups to be involved with implementing actions

including cultural interpretation and awareness of the species/community will be considered.

The advice of one or more of the following indigenous / indigenous affairs groups will be sought to assist in the identification of Noongar cultural values for land occupied by threatened species, or groups with a cultural connection to land that is important for the species / communities conservation. Continued liaison with the Noongar community will identify areas in which collaboration will assist implementation of recovery plans

- The relevant NRM indigenous reference group (s)
- South West (Yamatji – Midwest) Aboriginal Land and Sea Council, and/or
- Department of Indigenous Affairs, and/or
- Native title claimants
- Specific groups/individuals identified as having an interest

9. BENEFITS

The BFRW has been identified as a potential focus of eco-tourism in the Wheatbelt (Moncrieff, 2000). Community / shire groups such as the Granite Way Committee are keen to see the species conserved and its presence promoted as part of the tourism potential of the region.

Additional benefits include the effect that grazing by BFRW has in decreasing fuel accumulation and minimizing the risk of fires within and areas surrounding its habitat.

10. SOCIAL AND ECONOMIC IMPACTS

As previously mentioned (sections 2.3.1 and 2.3.6), there are reports of BFRW populations impacting on the economic returns of neighbouring agricultural properties by grazing on crops and fouling harvesting machinery. This results in lower crop prices for

the property owner and increases operational costs, both of which have a negative economic impact on their income.

BFRW have potential iconic appeal to the general public in the Avon River Basin due to their appearance, their threatened status and because it is possible to view them during daylight hours. At present, there are no tourism businesses operating in the Wheatbelt focusing on BFRW (wildflower tours are a relatively well-established form of tourism in the Wheatbelt). Since fox-baiting was introduced at Cape Range National Park, a conspicuously abundant population of BFRW has contributed to the tourism potential of the Exmouth region (Kinnear, 1995). However, the long term persistence of BFRW populations should not be compromised by tourism. Encouraging tourism can lead to restrictions on baiting which could in turn impact on BFRW populations.

11. CONSERVATION OBJECTIVES AND CRITERIA

The key conservation objective of this Species Conservation Plan is:

In partnership with the community, to conserve and (wherever possible), restore the condition and number of populations of Black-flanked Rock-wallabies in the wild.

11.1. Recovery Criteria:

Criteria for success:

- All known Black-flanked Rock-wallaby populations in the Wheatbelt region continue to persist i.e. populations continue to recruit, remain stable or increase. (This will be determined by monitoring the size and condition of each BFRW population at least once during the next 5 years).

  And

- Community support has been maintained or increased, with community members actively participating in management programs.

  And

- Fox control is continued where BFRW sites are currently being baited.

11.2. Criteria for failure:

- The decline of one or more known Black-flanked Rock-wallaby population in terms of population size, recruitment and condition.

  Or

- Community support has diminished considerably.

  Or

- Fox control is discontinued at one or more existing sites where BFRW sites are currently being baited.

11.3 Evaluation

The Department of Environment and Conservation, in consultation with the Black-flanked Rock-wallaby Study / Advisory Group (see Section 12.5); will evaluate the performance of this species conservation plan. The plan will be reviewed within five years of its implementation. The conservation actions carried out, and any changes to these actions, will be documented accordingly.

12 CONSERVATION ACTIONS

Conservation actions are the recommended measures to ensure the survival and maintenance of BFRW populations. Due to the specific nature and needs of each population, a detailed description of each population, previous / current and proposed conservation actions are contained within *Appendix 1*.

The implementation of these actions will be subject to additional funding. The estimated cost provided for each conservation action is indicative only and could be subject to change.

The conservation actions common to all populations include;

1. Predator control
2. Translocations
3. Determine the population characteristics of known populations
4. Establishment of Black-flanked Rock-wallaby Wheatbelt advisory group
5. Monitoring
6. Habitat enhancement
7. Promote awareness
8. Fire contingency planning

12.1 Predator Control - Fox-baiting

The impact of the red fox and the effectiveness of controlling red fox numbers in and around BFRW habitats have been discussed on pages 25-26 of this plan.

Currently, the most effective method to control foxes is through poison meat baits and dispersing them throughout the sites. Fox-baiting with 1080 baits is performed by the Department of Environment and Conservation under the "Western Shield" program. Western Shield was commenced in 1996 with the intention of controlling introduced predators and aiding the recovery of threatened animal species. Populations of BFRW in the Wheatbelt that are currently baited are listed in *Table 3*.

In addition to the existing onsite baiting regime, consideration could be given to implementing "buffer baiting" whereby neighbouring landowners to BFRW sites are encouraged to bait on a regular basis. Funding to supply landowners with 1080 dried meat baits could be considered to enhance the effectiveness of baiting occurring on the reserves/remnant vegetation. The supply of baits to neighbouring landowners may provide an incentive for landowners to partake in buffer baiting.

The impacts of BFRWs on these and neighbouring properties would need to be carefully considered prior to work being undertaken. WWF - Australia is currently investigating

how it can be involved with encouraging landowners in close proximity to BFRW habitat to continually and effectively bait their property.

Table 3: Annual fox-baiting program on private property and nature reserves where BFRW are known to be present (adapted from Armstrong, 2004).

Location	Tenure	Area (Ha)	No. baits per year
Gardiner's Rock	Private property	10	364
Gundaring	Nature Reserve	127	455
Mount Caroline	Nature Reserve	351	1430
Mount Stirling	Nature Reserve	224	845
Nangeen Hill	Nature Reserve	178	1040
Querekin Rock	Private property	64	546
Sales' Rock	Private property	65	520
TOTAL		**1017**	**5200**

Action: Establish and maintain adequate predator control

Completion date: On-going

Responsibility: DEC with support from Non-Government Organisations

Cost: $10,000 (bait purchase) annually

12.2 Translocations

Translocation involves the transfer of plants and animals from one part of their range to another (Kleinman, 1989).

BFRW have been the subject of several translocation programs in recent years. Mount Caroline Nature Reserve and Querekin Rock have been the two major sources for these translocations. Translocations have been both from within the Wheatbelt (i.e. to re-populate Querekin Rock) and to more distant locations (Cape Le Grande and Avon Valley National Parks as well as the Paruna Sanctuary) in an attempt to establish new populations in areas where these animals have become regionally extinct. Records of the most recent translocations through the Western Shield program are provided in Table 4.

Table 3: **Translocation programs sourcing BFRW populations in the central wheatbelt** (Personal communication, Peter Orell from DEC)

Date	Source population	Destination	No. BFRW's translocated
29/5/2001	Mt. Caroline NR / Querekin Rock	Paruna Sanctuary	10
31/8/2002	Mt Caroline NR	Paruna Sanctuary	12
2002	Mt Caroline NR / Querekin Rock	Walyunga NP	29
7-9/10/2003	Mt. Caroline NR / Querekin Rock	Paruna Sanctuary	20 (plus2 pouch young)
7-9/10/2003	Mt. Caroline NR / Querekin Rock	Avon Valley NP	18 (plus3 pouch young)
5-8/04/2004	Mt. Caroline NR / Querekin Rock	Walyunga NP / Cape Le Grand NP	45 (plus 12 pouch young)
8-9/12/2005	Querekin Rock	Paruna Sanctuary	15 (plus 7 pouched young)
4-5/4/2007	Mount Caroline	Paruna Sanctuary	8
19-20/4/2007	Querekin Rock	Paruna Sanctuary	10 (plus 4 pouched young)
TOTAL			167 (plus 28 pouch young)

The following criteria are recommended for identifying optimum sites for BFRW translocations in the Avon River Basin (note that both ecological and managerial aspects have been considered):

- The site should have a secure conservation tenure (e.g. Nature Reserve, National Park, Conservation Park or suitably secure – and adequately managed freehold land);
- The risk of off-site impacts to adjacent landowners needs to be low or manageable.

- The site must have a suitable habitat in the form of thermal refuges and food source to support a sustainable population size. Refuges may be in the form of fractured boulders breaking away from larger granite boulders or outcrops;
- Effective predator (fox) control needs to be established and with capacity to continue predator control in the long term.

Action: Undertake an assessment of potential BFRW translocation sites within the Avon through GIS analysis, ground-truthing and risk assessment for the use of 1080 baits.

Completion date: Ongoing

Responsibility: DEC

Cost: $4,000

12.3 Determine the population characteristics of known populations

It is essential that adequate baseline information is available to ensure that we fully understand the characteristics of the habitat, population and associated threats.

Significant research has been conducted on the populations at Mount Caroline, Nangeen Hill and Querekin.

Further study is required at the following populations:

- Mount Stirling Nature Reserve;
- Gundaring (formally known as "Tutakin") Nature Reserve; and
- Kokerbin Nature Reserve.
- Sales' Rock (private property); and
- Gardiner's Rock (private property);

Action: Describe habitat and threats for each population

Completion date: On-going

Priority Action: Undertake a trapping survey of Mount Stirling Nature Reserve,

	Gundaring (formally known as "Tutakin") Nature Reserve, Kokerbin Nature Reserve, Sales' Rock and Gardiner's Rock to determine population characteristics (population size, condition, recruitment)
Completion date:	2009
Responsibility:	DEC
Cost:	$15,000 per year[3]

12.4 Monitoring

It is recommended that BFRW population abundance and health in the central Wheatbelt be monitored a minimum of once every one to four years depending on the site-specific population management objectives. Population monitoring can be performed by either DEC staff or other parties (e.g. Research students).

A realistic population abundance estimate is critical for determining site-specific BFRW population management priorities and strategies. A base population abundance estimate will allow for the monitoring of the effectiveness of management strategies and actions.

One possible cost-effective method to monitor BFRW abundance could be to determine the feasibility of undertaking annual scat density and distribution sample inspections at all or certain population sites. Photo-monitoring can be used in conjunction with the annual scat inspection, and the combined scat density and photo monitoring results can then be used to determine the need and timing for a more intensive trapping program.

Action:	Monitoring of BFRW habitat and population condition
Completion date:	On-going
Responsibility:	DEC
Cost:	$15,000 per year[4] (when performed by DEC. Research students may produce results which provide suitable information)

[3] Note that this cost is the total for two weeks effort annually and is not determined on location.
[4] Note that this cost is the total for two weeks effort annually and is not determined on location.

12.5 Establish a Black-flanked Rock-wallaby Wheatbelt advisory group

An advisory group should be organized to provide input and advice on how to ensure that the BFRW central Wheatbelt populations are managed in an ecologically sustainable manner.

This advisory group should comprise of:

- DEC Wheatbelt Regional staff
- DEC Science Division staff
- DEC Species and Communities staff
- Relevant researchers
- Community members
- Natural Resource Management groups (i.e. Avon Catchment Council)

The function of this study group will be to:

- Coordinate the implementation of this plan
- Provide advice a on site-specific BFRW conservation and management actions by taking into account the highly fragmented wheatbelt land use context; and
- Evaluate and recommend ways to minimize offsite impacts of BFRW populations on neighbouring agricultural assets.

Action: Establish a BFRW Wheatbelt advisory group
Completion date: On-going
Responsibility: DEC
Cost: $500

12.6 Promote public awareness

The level of public awareness of the presence of and need to conserve BFRW is varied. Community and neighbour support is essential for the conservation of this species.

A public awareness campaign has been initiated to inform the wider community about the importance of BFRW and other threatened fauna species. The aim of this campaign is to raise public awareness while also encouraging the reporting of potential new populations. This campaign involves the mail out of a brochure to over 12,000 addressees, in 23 shires within the Avon River Basin. A poster containing the same information is in the process of being distributed to schools to further promote awareness of the BFRW.

In recognising the public's interest in the conservation of this species, every effort needs to be made to involve community groups, schools and neighbours with conservation work, particularly trapping surveys.

Information on the management of these animals should be provided to community and school groups who have expressed an interest.

Neighbouring landowners should be kept up-dated on the condition and work being undertaken on adjacent populations.

Action:	Promote public awareness
Completion date:	On-going
Responsibility:	DEC with assistance from Non-Government Organisations
Cost:	$2,000

12.7 Habitat enhancement

The condition of available habitat needs to be considered with a view to improving both the size and connectivity of these remnants.

All Wheatbelt BFRW populations are surrounded by agricultural properties. As mentioned previously the support of these landowners is critical to the success of conservation actions. Through the cooperation of these landowners it may be possible to improve the adequacy of habitat and the connectivity between habitats through:

a) Revegetation on private land;
b) Conservation initiatives to establish corridors; and
c) Purchase of land by a conservation group / agency.

It is important to recognize the landowner's needs in achieving an outcome which improves the conservation of the BFRW and benefits the land owner.

This action may involve other agencies such as the National Trust of Australia and WWF – Australia in terms of liaison with local landowners to generate an outcome that benefits all stakeholders.

Action:	**Habitat enhancement** a) Identify freehold land / crown reserves suitable as a buffer or corridor; b) Approach landowner / land manager; and c) Negotiate if viable
Completion date:	**On-going**
Responsibility:	DEC with assistance from Non-Government Organisations
Cost:	$5,000 (excludes any costs associated with the possible purchase of freehold land to enhance BFRW habitat).

12.8 Fire contingency planning

In the event that a wildfire that eliminates all food sources for BFRW at any one site, DEC may supplement the BFRW food source with Lucerne. The amount of Lucerne and duration of this exercise will be subject to the intensity of the fire, the perceived amount of vegetation lost to the fire and BFRW population size.

Action:	Supplementation of BFRW food source in the event of wildfires
Completion date:	N / A
Responsibility:	DEC
Cost:	Determined by the amount of Lucerne / time required

12.9 Determine the impact of herbivores at Mt Caroline Nature Reserve

As discussed in section 2.3.1, there is a lack of understorey vegetation in many areas of Mount Caroline Nature Reserve. Of particular concern are those areas directly next to rock outcrops where BFRW are known to graze.

A scientific-based grazing exclusion monitoring project at Mount Caroline (in association with climate monitoring data), will be required to determine which, if any, of the grazing herbivores at Mount Caroline are having the greatest impact on understorey vegetation. The project will consist of excluding each herbivore (kangaroos, rabbits and BFRW) from a grazing exclusion quadrant with the use of fencing. Each grazing exclusion quadrant will have an unfenced control.

The type of data that will be collected from the exclusion quadrants includes the amount of biomass grazed at regular intervals, correlation of biomass with rainfall and temperature data, and the use of photo-monitoring data. The amount of biomass in each quadrant that is grazed, in association with other indicators such as faeces, should assist with determining which herbivore is contributing the most towards the decline in understorey vegetation.

Possible actions that could be considered at the conclusion of this project may include introducing a rabbit / kangaroo control program at Mount Caroline.

Action:	Determine the impact of herbivores at Mt Caroline Nature Reserve.
Completion date:	2008 – 2010 (and possibly to 2012) depending on the need for collecting additional monitoring data from the exclusion quadrants.
Responsibility:	DEC
Cost:	$15,000

13. REFERENCES

Armstrong, R. (2004). Baiting Operations: Western Shield Review-February 2003. *Conservation Science Western Australia*. **5**(2): 31-50.

Burgman, M.A. & Lindenmayer, D.B. (1998) Conservation *Biology for the Australian Environment.* Surrey Beatty & Sons, Chipping Norton, NSW.

Burbidge, A. (2004) Threatened *Animals of Western Australia*. Department of Conservation and Land Management, Perth Western Australia.

Burbidge, A.A. & McKenzie, N.L. (1989) Patterns in modern decline of Western Australia's vertebrate fauna: Causes and conservation implications. *Biological Conservation* **50:** 143-98.

CALM. (1999) Bush Telegraph. Threatened Animal Eats Threatened Plant. *Landscope* **14**(3): p5.

CALM. (1999a) NatureBase – Rock-wallabies. http://www.calm.wa.gov.au/plants_animals/mammals_rock_wallabies.html

Davies, M. (2000) *Macropod Conservation and Wildlife Tourism: A Case Study of the Black-flanked Rock-wallaby, **Petrogale lateralis lateralis**, in Western Australia*. School of Environmental Science. Murdoch University. WA

Department of Sustainability and Environment. Flora and Fauna Guarantee Action Statement #19. Brush-tailed Rock-wallaby ***Petrogale penicillata.*** *Department of Sustainability and Environment*. Online at (http://www.dpi.vic.gov.au/CA256F310024B628/0/FF1A75E7A39B40E5CA257092001FB923/$File/019+Brush-tailed+Rock+Wallaby+1992.pdf)

Eldridge, M. & Close, R. (1995) Black-footed Rock-wallaby. In: *The Mammals of Australia*, ed. R. Strahan, pp.377-81. Reed Books, Sydney, New South Wales.

Eldridge, M.D.B., Kinnear, J.E. & Onus, M.L. (2001) Source population of dispersing rock-wallabies (***Petrogale lateralis*)** identified by assignment tests on multilocus genotypic data. *Molecular Ecology* **10:** 2867-2876.

Eldridge, M.D.B., Kinnear, J.E., Zenger, K.R., McKenzie, L.M. & Spencer, P.B.S. (2004) Genetic diversity in remnant and "pristine" island populations of three endemic Australian macropodis (Marsupialia): ***Macropus eugenii, Lagorchestes hirsutus*** *and* ***Petrogale lateralis***. *Conservation Genetics* **5:** 325-338.

Freegard, C. & Orell, P. (2005) Rock-Wallabies re-discovered at Kokerbin Nature Reserve. *Landscope* **20**(3): 6-8.

Hall, G.P. & Kinnear, J.E. (1991) *Recovery Plan for the Black-flanked Rock-wallaby* ***Petrogale lateralis lateralis*** *(Gould).* Department of Conservation and Land Management, Perth, Western Australia.

Hester, A.J. & Hobbs, R.J. (1992) Influence of fire and soil nutrients on native and non-native annuals at remnant vegetation edges in the Western Australian wheatbelt. *Journal of Vegetation Science* **3:** 101-108

Hill, F.A.R. (1991) A research recovery plan for the Brush-tailed Rock-wallaby ***Petrogale penicillata penicillata*** (Gray 1825), in South-eastern Australia, unpublished report to the Australian National Parks and Wildlife Service, Department of Conservation and Environment, Victoria.

Hobbs, R.J. & Hopkins, A.J.M. (1990) From *Frontier to Fragments: European Impact on Australia's Vegetation*. Pp 93-114 In: *Australian Ecosystems: 200 Years of Utilisation, Degradation and Reconstruction.* Surrey Beatty & Sons, Chipping Norton, NSW.

Kinnear, J.E., Onus, M.L. & Bromilow, R.N. (1988) Fox Control and Rock-Wallaby Population Dynamics. *Australian Wildlife Research* **15:** 435-450.

Kinnear, J.E. (1995) Rock-wallabies of Yardie Creek: Research and tourism go hand in hand. *Landscope* **11**(2): 36-37.

Kinnear, J.E., Onus, M.L. & Sumner, N.R. (1998) Fox Control and Rock-Wallaby Population Dynamics – II. An Update. *Wildlife Research* **25:** 81-88.

Kinnear, J.E. (2007). Monitoring *and Managing Wheatbelt Rock-wallaby (Petrogale lateralis) Populations*. Unpublished.

Kleinman, D.G. (1989) Reintroduction of captive mammals for conservation. *Bioscience* **39:** 152-161.

Moncreiff, D. (2000) Managing tourism and recreation on Wheatbelt granite outcrops, Journal of the Royal Society of Western Australia. **83:** 187 - 196

Ormay, P. (1996) Status of the Brush-tailed rock-wallaby (***Petrogale penicillata***) in the Australian Capital Territory. Technical Report 13, ACT Parks and Conservation Service, Canberra.

Parker, S.P. (Ed) (1990) Grizmeck's *Encyclopedia of Mammals.* McGraw-Hill Inc., USA.

Pearson, D.J. (1992) Past and present distribution and abundance of the Black-footed Rock-wallaby in the Warburton region of Western Australia. Wildlife *Research* **19:** 605-622.

Pearson, D.J. & Kinnear, J.E. (1997) A review of the distribution, status and conservation of Rock-wallabies in Western Australia, Australian *Mammalogy* **19**(2): 137-152.

Possingham, H. (1995) Is there a useful theory for conservation? *Xanthopus* **13**(3): 6-7.

Ralls, K., Ballou, J.D. & Templeton, A.R. (1988) Estimates of lethal equivalents and the cost of inbreeding in mammals. *Conservation Biology* **2:** 185-193.

Saunders, G., Coman, B., Kinnear, J. & Braysher, M. (1995) *Managing Vertebrate Pests: Foxes,* Australian Government Publishing Service, Canberra.

Sharman, G.B. & Maynes, G.M. (1995) Rock-*wallabies*. In: *The Mammals of Australia,* Ed. R. Strahan, pp. 377- 381 Reed Books, Sydney.

Sharp, A. (1997) Insights into the dispersal patterns of yellow footed rock-wallabies, ***Petrogale xanthopus***. *Australian Mammalogy* **19:** 229-238.

Short, J., Kinnear, J.E., Robley, A. (2002) Surplus killing by introduced predators in Australia- evidence for ineffective anti-predator adaptations in native prey species? *Biological Conservation* **103:** 283-301.

Wildlife Australia. (1996). Action *Plan for Australian Marsupials and Monotremes.* Department of the Environment and Heritage, Canberra. Online at http://www.environment.gov.au/biodiversity/threatened/publications/action/marsupials/index.html#contents

APPENDIX 1: **Summary – Mt Caroline Nature Reserve**

Mount Caroline Nature Reserve

Tenure	Class A[5] DEC-managed Nature Reserve (Reserve no 11047)
Shire	Kellerberrin
Area	352 ha
Predator control (Fox)	Commenced in 1982. (1430 baits allocated annually).
BFRW Population	1979 – 10 individuals 1982 – 13 1984 – 22 1986 – 42 1990 – 43 1994 – 50 1998 – 276 2003 – 54[6] 2007 - 53[7] 2008 - 210
Habitat	Mostly *Allocasurina* and *Acacia* vegetation communities surrounding fractured granite outcrop.
Site Description	Much of the rock outcrop has screes favourable for BFRW habitation with the majority of the BFRW population living in the central and southern regions of the reserve where screes can support more individuals. A Fence-line is adjacent to BFRW habitat on South-eastern and South-western regions of reserve.
Current Research	Fertility control, Population dynamics and genetics in Rock Wallabies (*Petrogale lateralis* sub sp. *lateralis*) – Nicole Willers (University of Western Australia and DEC).
Threats	Predation (foxes and possibly cats); Lack of ecological resources; Competition from introduced animals; and Inappropriate fire regime

[5] An "A" class nature reserve is crown land reserved and protected for the conservation of flora and fauna
[6] (estimate – between 196-477 Petersen & Jolly-Seber method)
[7] (estimate – between 196-477 Petersen & Jolly-Seber method)

Off-site impacts	Impact on agricultural production (grazing crops) – southern & western neighbours.

Previous management actions:

1982 – Fox control commenced
2000 – "shoo-roo" used as BFRW deterrent on adjacent property
2001- ex-gratia payments to land owner as compensation for crop loss
2002-2003- fencing of southern section of Mt Caroline NR
2005-2006 – Spotlight surveys

Conservation Actions (Current)	Predator Control (on reserve); Translocations under the DEC Western Shield Program
Conservation Actions (Recommended)	Predator Control (off reserve); Habitat enhancement through establishing buffers and corridors;
Conservation Actions (Recommended – cont)	Population monitoring; Assess habitat condition by undertaking a grazing trial; Promote public awareness.

Background

Mount Caroline is a 352 ha nature reserve which supports the largest population of BFRW in the central wheatbelt. This is possibly due to the large amount of suitable habitat (i.e. rock crevices and foraging space) found at the reserve.

In 1979, the BFRW population size at Mt. Caroline was estimated at 9 individuals. In 1982, Fox-baiting was introduced to Mount Caroline, and the BFRW population increased to 42 individuals in 1986 and to 276 individuals in 1998 (Kinnear *et al.*, 1988) (see *Figure 2*).

The increase in the BFRW population has lead to individuals seeking refuge and food elsewhere as the increasing numbers placed stress on existing food resources. This has lead to BFRW grazing on crops found on adjacent properties, resulting in conflict with local landowners. A 2.4 kilometer wallaby proof fence was erected on the southern boundary of the reserve to mitigate the impact of these animals and maintain landowner support for conservation. Follow-up spotlight surveys and discussions with landowners demonstrated a high population of western grey kangaroos (*Macropus fulignosus*) and euros (*Macropus robustus rubescenes*) grazing in paddocks.

The lack of understorey plants in some locations within the nature reserve may be due to increased BFRW grazing pressure, although kangaroos and rabbits are found on the reserve.

The BFRW population at Mount Caroline may either singularly, or in association with the other herbivores, be contributing towards the perceived lack of understorey vegetation. Recent below average annual rainfall could also impact on the growth of understorey vegetation.

A Declared Rare Flora (Critically Endangered) species, the Granite Tetratheca (*Tetratheca deltoidea*) is known to only occur in Mount Caroline. This species has in the past been grazed (not known whether BFRW`s, Rabbits or Kangaroos or a combination of them were responsible) in some seasons to the extent that they have not produced flowers (CALM, 1999). The *T. deltoidea* population in this reserve has subsequently been fenced in as a precautionary measure.

A scientific-based grazing exclusion monitoring project at Mount Caroline (in association with the monitoring of climate data), will be required to determine which, if any, of the grazing herbivores at Mount Caroline are having the greatest impact on the understorey vegetation.

The Mount Caroline population is currently used as a source of animals for small scale translocation projects under the DEC Western Shield program (see section 11.4.2).

Habitat condition
The understorey in localities close to BFRW habitation appears to be heavily grazed. Annual weeds found in the area include Cape Weed (*Arctotheca calendula*) and Deadly Nightshade (*Solanum nigrum*)

Managing off-site impacts
The grazing impact on the adjacent farming properties is of concern. Although BFRW are able to access private property it is not clear if it is the BFRW, Euro or Western Grey Kangaroos that are responsible for most of this damage. Spotlight surveys undertaken by DEC staff have resulted in a greater proportion of euros and kangaroos being observed in these properties adjacent to Mt Caroline compared to BFRW's.

A 2.4 km barrier was placed on the southern boundary of the Mount Caroline population of BFRW in March 2002. The structure of the fence was modified in 2003 to address damage caused by western grey kangaroos (*Macropus fuliginosus*) which allowed BFRW to cross the fence.

Actions to manage off-site impacts

The following actions are recommended to maintain community support by managing the off-site impact of BFRWs (the implementation of these actions will be subject to available future funding):

1. **Private land owners may wish to offer affected parts of their property for sale and inclusion into the Mount Caroline Nature Reserve.** Flexible arrangements may be considered where the land may then be leased back to the

Completion date: On-going
Cost: $ To be determined

2. **Purchasing and revegetating land between Mt Caroline and other BFRW populations to expand habitat and connect these populations**. Re-vegetation of this type of land parcel may increase the food supply for BFRW as well as creating a corridor between two populations.

   Completion date: On-going
   Cost: $ To be determined

3. **Continue with ongoing maintenance of the fence by DEC staff and the adjacent landowner**

   Completion date: On-going
   Cost: $1,500

4. **Private landowners may apply for a "damage license" which permits the landowner to use devices to scare the BFRW only.**

   Completion date: On-going
   Cost: $1,000

Conservation Actions to manage BFRW at Mount Caroline Nature Reserve

The following actions are recommended to enhance the conservation of the species at Mount Caroline (the implementation of these actions will be subject to available future funding):

1. **Determine population condition by means of a trapping program.**
   Completion date: On-going
   Cost: $15,000

2. **Determine if the understorey is being over-grazed through grazing exclusion trials.** If the understorey is being overgrazed, determine the animal or group of animals responsible. This may result in further action such as rabbit / kangaroo control.

   Completion date: On-going
   Cost: $15,000

3. **Maintain the current practice of using this population as a source for translocations to other appropriate BFRW locations.**

   Completion date: On-going

Cost: $1,000

4. **Supporting adjacent landowners to bait their properties at the recommended frequency** (subject to the availability of funding).

   Completion date: On-going
   Cost: $2,000

5. P**romote public awareness by informing and involving neighbours and the community in conservation work.**

   Completion date: On-going
   Cost: $1,000

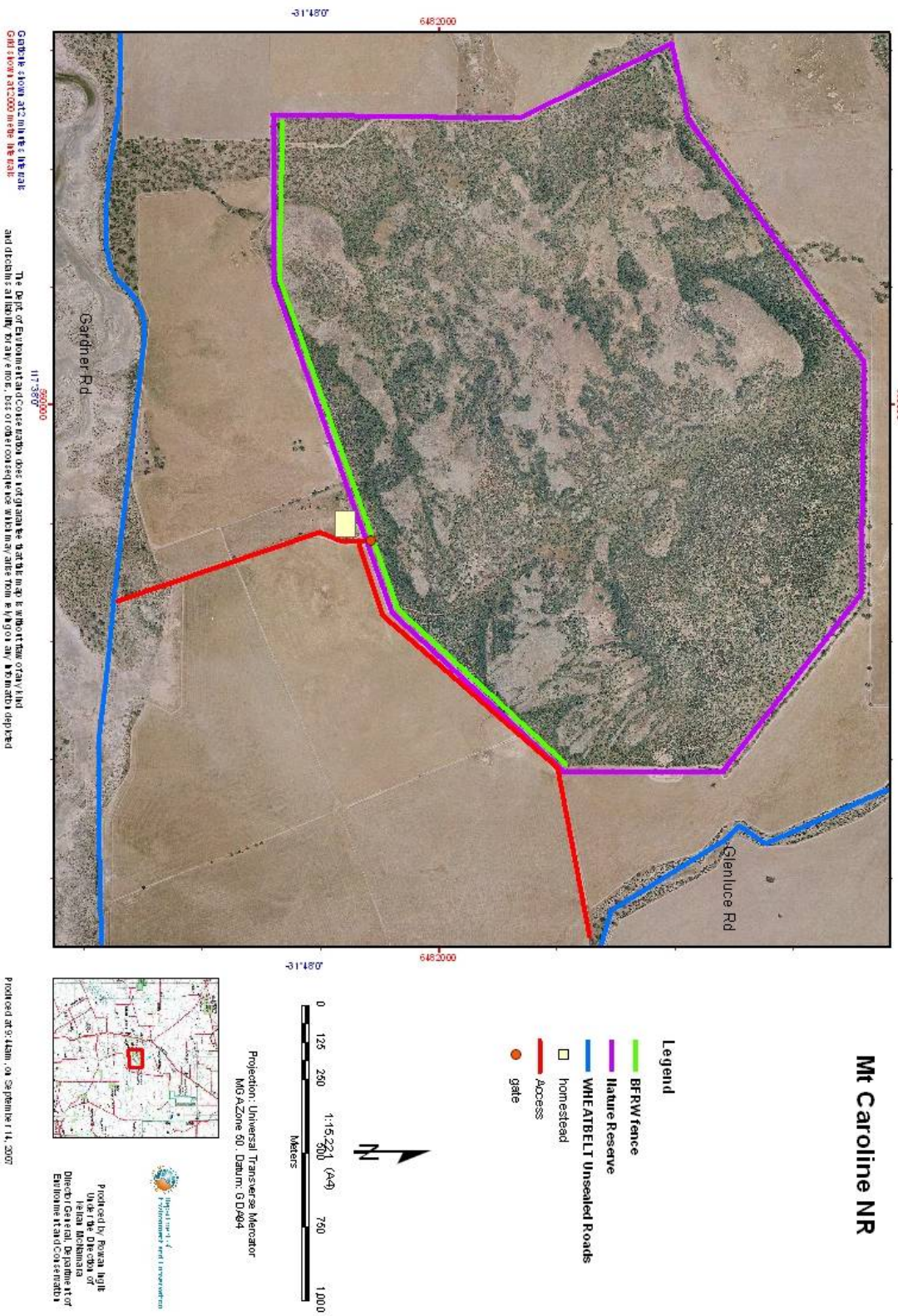
Future Conservation Actions

These actions may be considered in the future at Mt Caroline pending the results of current research projects (the implementation of these actions will be subject to available future funding):

1. Consider regulating the population through contraception as a means of maintaining a healthy population condition.

   Completion date: On-going
   Cost: TBD

Aerial photo of Mount Caroline NR showing fence, reserve and access



APPENDIX 2: **Summary – Nangeen Hill Nature Reserve**

Tenure	Class A DEC-managed Nature Reserve (Reserve no 23187)
Shire	Bruce Rock
Area	178 ha
Predator control (Fox)	Commenced in 1982 (1040 baits allocated annually).
Population	1979 – 18 individuals 1980 – 21 1982 – 29 1984 – 51 1986 – 75 1990 – 116 1994 – 79 1998 – 82 2007 - 99
Habitat	Mallee woodland is dominant. Annual grasses within 50m of rock profile which is severely fractured on northern half.
Current Research	Behaviour and population dynamics of translocated populations of the black-flanked rock wallaby, *Petrogale lateralis lateralis* (Craig Pentland – Edith Cowan University). Physiological Ecology of Macropod Mammals. Evaporative water loss and relative water economy of marsupials (Sylvie Schmidt – University of Western Australia).
Threats	Predation (foxes) Lack of ecological resources Competition from introduced animals Inappropriate fire regime
Off-site impacts	None
Previous management actions	**1982 –** Fox control commenced
Conservation Actions (Current)	Predator Control (on reserve)

Conservation Actions (Recommended)	Predator Control (off reserve) Population monitoring Promote public awareness

Background
Nangeen Hill nature reserve is a 178 ha crown reserve in the Bruce Rock shire. The granite rock at this site is severely fractured on the Northern side making it an ideal habitat for BFRW.

The BFRW population at Nangeen Hill has increased markedly since fox-baiting was introduced. Between 1979 and 1990, the BFRW population increased from 18 to 116 individuals (Kinnear *et al.*, 1998).

A PhD study regarding the effects of behavioral patterns and landscape structure on the movement patterns and resource patch use of BFRW at Nangeen Hill has recently been carried out by Craig Pentland from Edith Cowan University. During this study, 99 BFRW's were trapped (Craig Pentland, personal communication, March 2007). It is believed this constituted the entire catchable population.

Habitat Condition
The reserve is heavily grazed within 50m of the rock profile where there are annual grasses present A number of trees on the reserve have had their bark stripped off (unsure whether BFRW are involved).

Managing off-site impacts
There appears to be minimal off-site impacts at the reserve.

<u>Conservation Actions</u>

These actions are recommended to enhance the conservation of the species at Nangeen Hill (the implementation of these actions will be subject to available future funding):

1. **Determine population condition by means of a trapping program.** This info can then be used to estimate the ecologically sustainable BFRW population size range for this site;

   Completion date: On-going
   Cost: $15,000

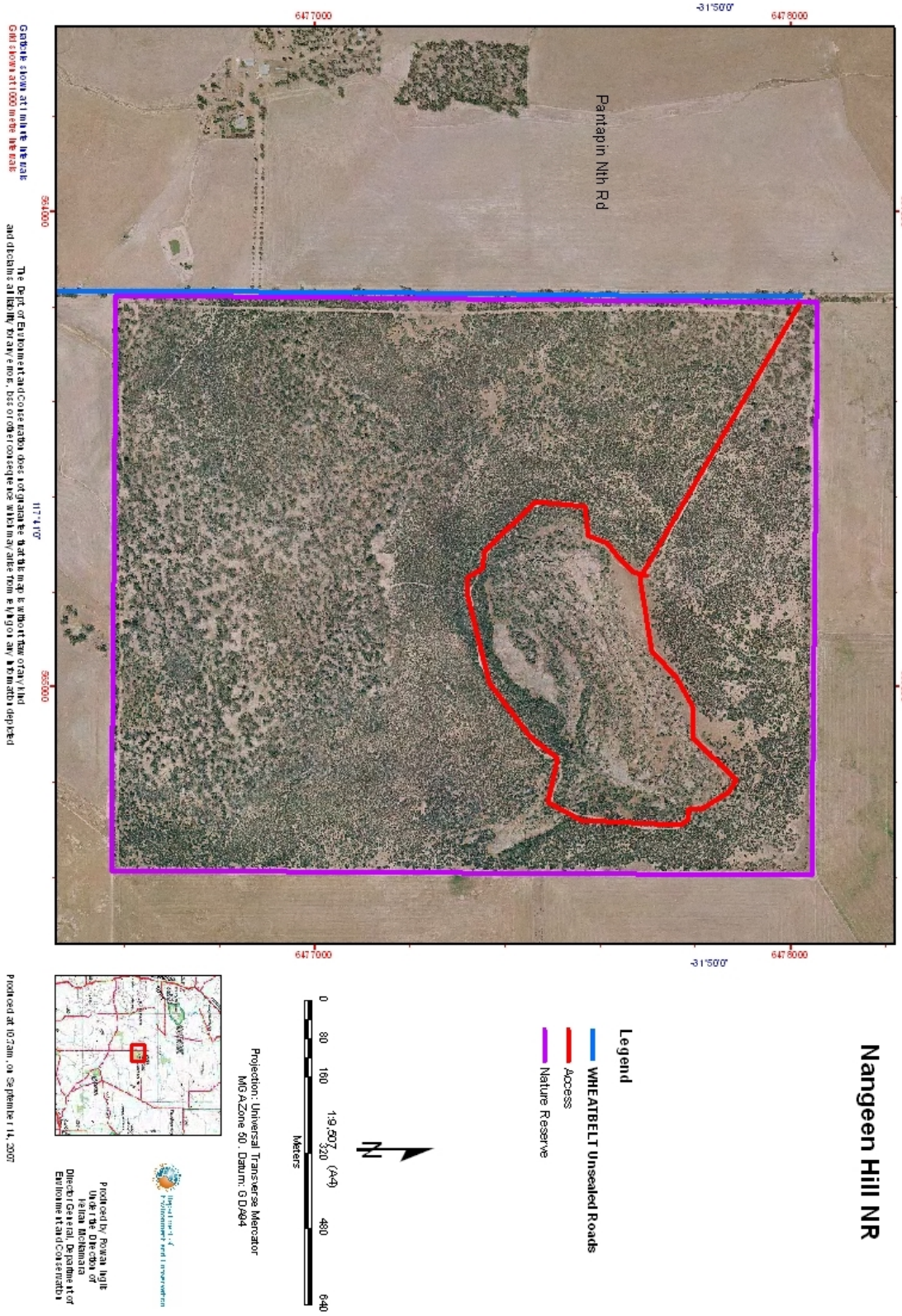
2. **Supporting adjacent landowners to bait their properties at the recommended frequency.**

   Completion date: On-going
   Cost: $2,000

3. **Promote public awareness by informing and involving neighbours and the community in conservation work.**

Completion date: On-going
Cost: $1,000

Aerial photo of Nangeen Hill NR showing reserve and access



APPENDIX 3: **Summary – Mt Stirling Nature Reserve**

Mount Stirling Nature Reserve

Tenure	Class A DEC-managed Nature Reserve (Reserve no 11048)
Shire	Quairading
Area	225 ha
Predator control (Fox)	Commenced in 2001 (845 baits allocated annually)
Population	Unknown
Habitat	Mostly Acacia and Eucalypt woodland. Much of the rock profile is domed with few breakaways. The site is difficult to access due to steep rock profiles, dense vegetation on outskirts and borders onto private property around much of the reserve.
Current Research	None
Threats	Predation (foxes) Lack of ecological resources Competition from introduced animals Inappropriate fire regime
Off-site impacts	Unknown
Previous management actions	**2001** – Fox control commenced
Conservation Actions (Current)	Predator Control (on reserve)
Conservation Actions (Recommended)	Predator Control (off reserve) Population monitoring Promote public awareness

Background

Little is known about the population number and health of this BFRW population. Owing to difficulties with access, fox control was undertaken at Mount Stirling only recently and a small, remnant population persists at this site (Eldridge *et al.*, 2001). At present there has been no population size estimate undertaken at Mt. Stirling.

Habitat Condition
Much of this site is dominated by domed granite rock with relatively few breakaway sections suitable for BFRW habitation. Acacia woodland is the dominant vegetation type.

Managing off-site impacts
There appears to be minimal off-site impacts at the reserve.

Conservation Actions
These actions are recommended to enhance the conservation of the species at Mt Stirling (the implementation of these actions will be subject to available future funding):

1. **Determine population condition by means of a trapping program.** This info can then be used to estimate the ecologically sustainable BFRW population size range for this site.

   Completion date: On-going
   Cost: $15,000

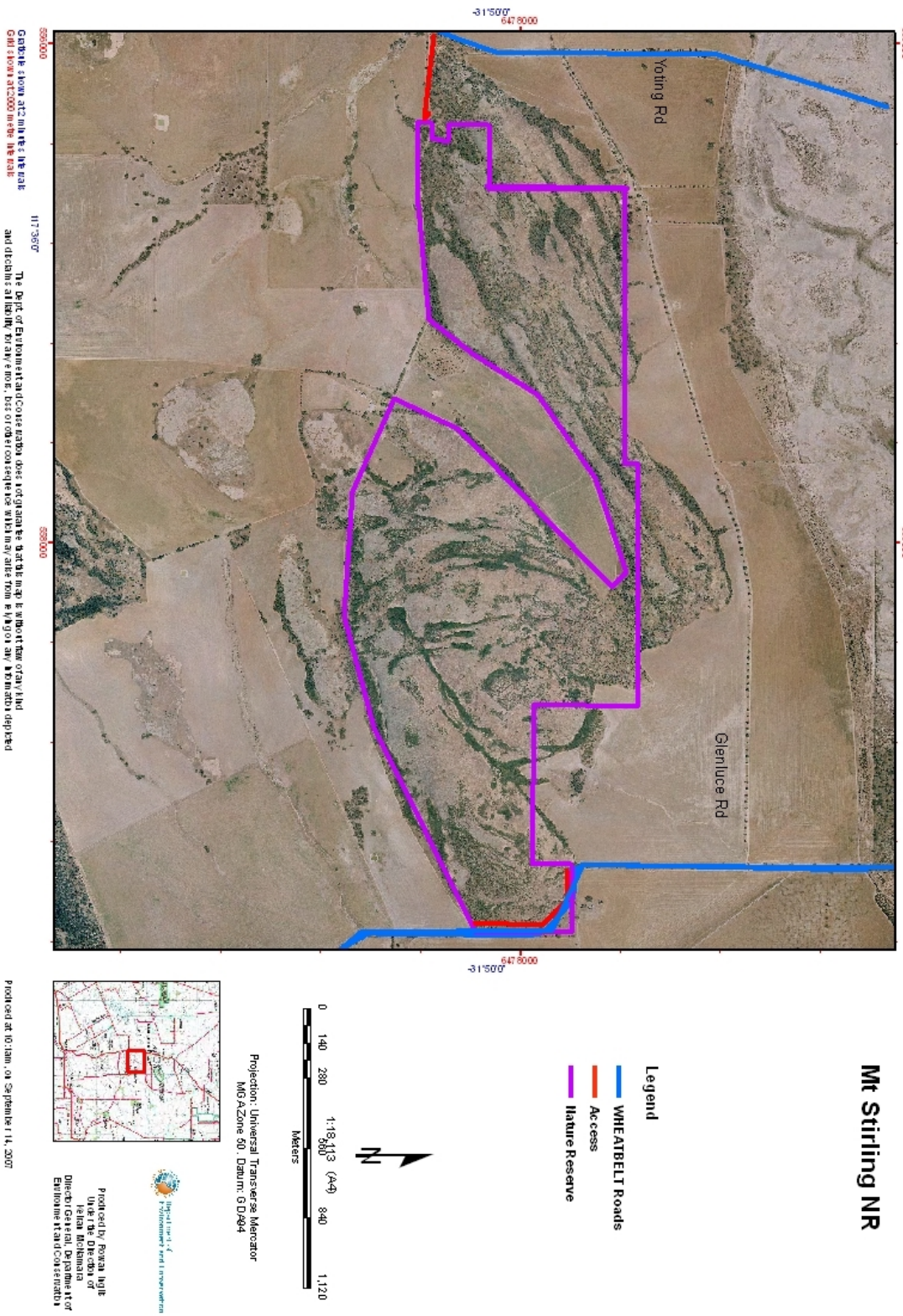
2. **Supporting adjacent landowners to bait their properties at the recommended frequency.**

   Completion date: On-going
   Cost: $2,000

3. **Promote public awareness by informing and involving neighbours and the community in conservation work.**

   Completion date: On-going
   Cost: $1,000

Aerial photo of Mt Stirling NR showing reserve and access



APPENDIX 4: **Summary – Gundaring Nature Reserve**

Gundaring Nature Reserve

Tenure	Class A DEC-managed Nature Reserve (Reserve no 11039)
Shire	Quairading
Area	127 ha
Predator control (Fox)	Commenced in 1990 (455 baits allocated annually)
Population	1983 – 7 individuals 1986 – 8 1990 – 9 1994 – 18 1998 - 20
Habitat	Mostly Acacia and Eucalypt woodland.
Current Research	None
Threats	Predation (foxes) Lack of ecological resources Competition from introduced animals Inappropriate fire regime
Off-site impacts	Unknown
Previous management actions	**1990** – Fox control commenced
Conservation Actions (Current)	Predator Control (on reserve)
Conservation Actions (Recommended)	Predator Control (off reserve) Population monitoring Promote public awareness

Background

The BFRW population at Gundaring Nature Reserve has also not been intensively studied since 1998. The 1998 survey resulted in a total of 20 BFRW (see *Figure 3*). The majority of the granite rock profile at Gundaring is unfractured and unsuitable for BFRW habitation. As a result, it is unlikely the population can increase extensively beyond its previous population estimate.

Habitat Condition
Much of this site is dominated by domed granite rock with relatively few breakaway sections suitable for BFRW habitation. Eucalypt woodland is the dominant vegetation type.

Managing off-site impacts
There appears to be minimal off-site impacts at the reserve.

Conservation Actions
These actions are recommended to enhance the conservation of the species at Gundaring (the implementation of these actions will be subject to available future funding):
:

1. **Determine population condition by means of a trapping program.** This info can then be used to estimate the ecologically sustainable BFRW population size range for this site.

   Completion date: On-going
   Cost: $15,000

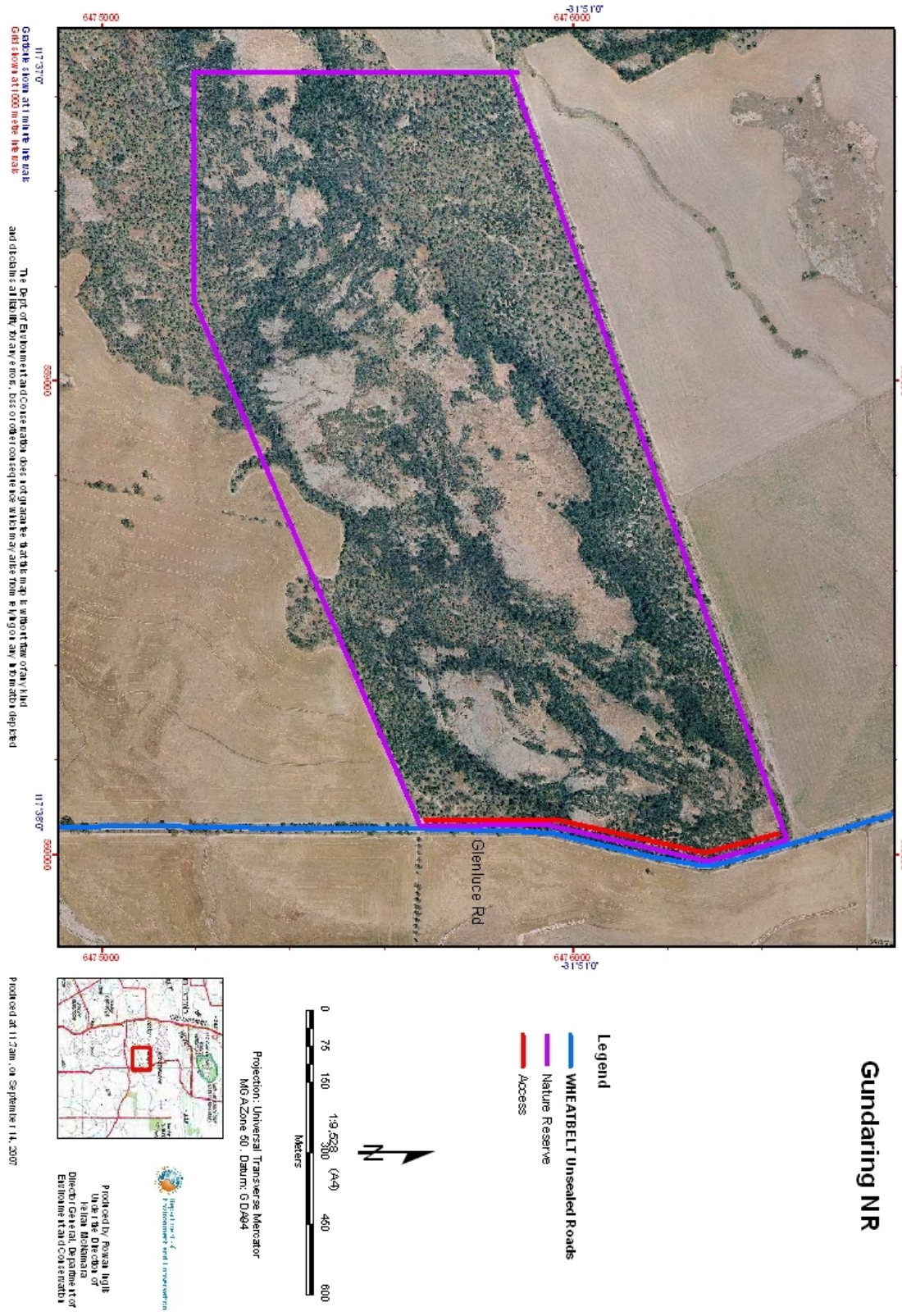
2. **Supporting adjacent landowners to bait their properties at the recommended frequency.**

   Completion date: On-going
   Cost: $2,000

3. **Promote public awareness by informing and involving neighbours and the community in conservation work.**

   Completion date: On-going
   Cost: $1,000

Aerial photo of Gundaring NR showing reserve and access



***APPENDIX 5*: Summary – Kokerbin Nature Reserve**

Kokerbin Nature Reserve

Tenure	Class A DEC-managed Nature Reserve (Reserve no 11043)
Shire	Bruce Rock
Area	91 ha
Predator control (Fox)	None
Population	2004 - 3
Habitat	Mostly Acacia and Eucalypt woodland. Fractured rock suitable for BFRW habitat found in Northern section of reserve.
Current Research	None
Threats	Predation (foxes) Lack of ecological resources Competition from introduced animals Inappropriate fire regime Possible human impacts who camp at reserve
Off-site impacts	Unknown
Conservation Actions (Current)	None
Conservation Actions (Recommended)	Predator Control (off reserve) Population monitoring Promote public awareness Put up sign at reserve encouraging visitors to look at Rock-wallabies from afar and abstain from activities that encourage foxes to the area

Background

Kokerbin Nature Reserve is a 90 ha "A" Class reserve in the Bruce Rock Shire. The reserve is dominated by a large granite rock (approx 50% of the reserve area). The majority of the suitable BFRW habitat is found in the north-east section of the reserve.

BFRW were known to occur in the Kokerbin Nature Reserve until 1969-70, but later the population was thought to be extinct (Kinnear *et al.,* 1988). In 2004, BFRW's were again trapped at Kokerbin after scats were found along the border of the reserve the year

before. DNA evidence suggests that the three individuals had traveled eight kilometers across farmland from Gundaring Nature Reserve to recolonise the vacant habitat at Kokerbin (Freegard & Orell, 2005).

Kokerbin Rock is a very popular recreation site attracting large numbers of campers and day users. The DEC and Bruce Rock Shire are undertaking a planning process aimed at managing the current unsustainable impact of recreation on this reserve. The objective of this project is to protect the reserves conservation values while also providing a safe and enjoyable recreation experience for visitors.

Fox-baiting is not conducted on this reserve due to the relatively small size and the code of practice for the safe use of 1080 prohibiting the use of 1080 within 500 meters of a recreation site.

Issues associated with the recreation include:

1. Foxes being attracted to picnic sites
2. Visitors bringing dogs to the reserve. Dogs pose a threat by chasing the fauna as well as leaving scent which can discourage animals from using the site
3. Vehicles driving along a track adjacent to the BFRW habitat
4. Visitors attempting to interact with the wallabies (i.e. attempting to get too close)

Habitat Condition

Much of this site is suitable for BFRW habitation however it is expected that the fox population limits the local abundance of BFRW. Acacia woodland is the dominant vegetation type. Portions of this site are severely degraded due to impact from visitors and people who camp on site

Managing off-site impacts

There appears to be minimal off-site impacts at the reserve.

Conservation Actions

These actions are recommended to enhance the conservation of the species at Kokerbin (the implementation of these actions will be subject to available future funding):

1. **Determine population condition by means of a trapping program**. This info can then be used to estimate the ecologically sustainable BFRW population size range for this site.

   Completion date: On-going
   Cost: $15,000

2. **Supporting adjacent landowners to bait their properties at the recommended frequency.**

   Completion date: On-going
   Cost: $2,000

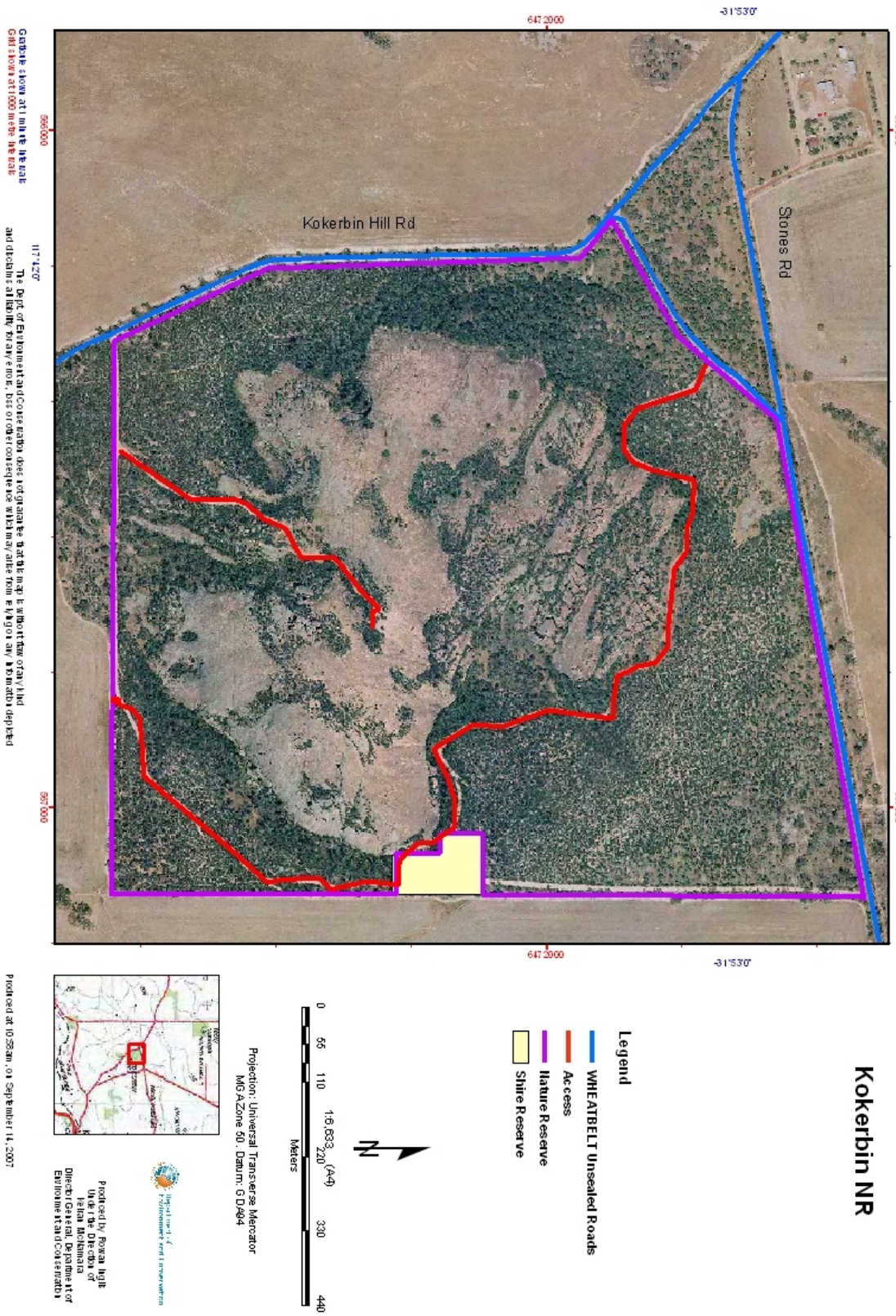
3. **Promote public awareness by informing and involving neighbours and the community in conservation work.**

Completion date: On-going
Cost: $1,000

4. **Introduce signage displaying BFRW information and encouraging behaviour that reduces fox numbers at the reserve**

Completion date: 2008
Cost: $2,000

Aerial photo of Kokerbin NR showing reserve and access



***APPENDIX 6*: Summary – Querekin Rock**

Querekin Rock

Tenure	Private Property
Shire	Bruce Rock
Area (Querekin Rock)	64 ha
Predator control (Fox)	Commenced in1990 (546 baits allocated annually).
Population	1980 – 7 1983 – 5 1986 – 1 1990 – 0 1990 – 5 (translocated) 1998 – 44 2007 - 35
Habitat	Mostly Acacia and Eucalypt woodland**.** Suitable BFRW habitat is found on the eastern side and either side (where suitable rock fractures are present) of the unused homestead (see map)
Current Research	None
Threats	Predation (cats and foxes) Lack of ecological resources Competition from introduced animals Inappropriate fire regime
Off-site impacts	BFRW known to enter machinery sheds and foul farm machinery

Previous management actions

1990 – 5 BFRW were translocated from Nangeen Hill to re-populate site after localised extinction in conjunction with the commencement of fox control
2000 - "shoo-roo" used as BFRW deterrent on adjacent property
2006 - Partial fencing by Cons. Employee Howard Robinson in association with Pingelly Scout group

Conservation Actions (Current)	Predator Control (on reserve) Translocations under Western shield program
Conservation Actions (Recommended)	Population monitoring Promote public awareness On-going maintenance of BFRW fence On-going rabbit control

Background

This site is a 64 ha remnant located on private land used for crop production. Approximately 50 % of Querekin Rock is dome-shaped, while the other half is fractured and suitable for BFRW habitation. By 1980, this BFRW population consisted of just 7 individuals (Kinnear *et al.*, 1998), and became extinct shortly thereafter. Five individuals were translocated to Querekin from Nangeen Hill the same year in association with the implementation of fox control (Hall and Kinnear, 1991 see Figure 4). The Querekin Rock population had increased by the year 2000 to an estimated 150 animals as a result of the above translocation and on-going fox-baiting, (J. Kinnear, pers. com. 10/11/2006).

This site has also been associated with offsite impacts on neighboring agricultural land from increasing BFRW population sizes. The Querekin land owner has reported that the BFRW's have entered machinery sheds and fouled farm machinery.

In recent years, a certain amount of animals from Querekin Rock have been translocated to other locally extinct sites or to replenish existing populations (see section 11.4).

Habitat condition

Much of this site is degraded through litter build-up and a locally abundant rabbit population

Managing off-site impacts

A fence separating the BFRW population from the machinery sheds has been installed in 2007.

Actions to manage off-site impacts

The following actions are recommended to maintain community support by managing the off-site impact of BFRW (the implementation of these actions will be subject to available future funding):

1. **Ongoing maintenance of the fence by DEC staff and the adjacent landowner**

   Completion date: On-going
   Cost: $2,000

2. **Monitor the success of the northern fence-line separating the BFRW`s from the crops and machinery, and at the same time taking into account any negative impacts on BFRW population health**

Completion date: On-going
Cost: On-going

3. **Completion of fence along the southern part of Querekin Rock (if required)**

Completion date: TBD
Cost: $1,000 (fencing material is on site; same volunteers who assisted with the erection of the northern fence around the rock could be requested to assist with the erection of the southern fence)

Conservation Actions

These actions are recommended to enhance the conservation of the species at Querekin (the implementation of these actions will be subject to available future funding)::

1. **Determine population condition by means of a trapping program.** This info can then be used to estimate the ecologically sustainable BFRW population size range for this site.

Completion date: On-going
Cost: $15,000

2. **Maintain the current practice of using this population as a source for translocations to other appropriate BFRW locations**.

Completion date: On-going
Cost: $TBD

3. **Supporting adjacent landowners to bait their properties at the recommended frequency.**

Completion date: On-going
Cost: $2,000

4. **Control the rabbit population in close proximity to BFRW habitat through 1080 baiting of oats and / or fumigation.**

Completion date: On-going
Cost: $5,000

5. **Continue to maintain regular contact with the Querekin landowner to ensure that BFRW offsite impacts are reported and attended to as a matter of priority.**

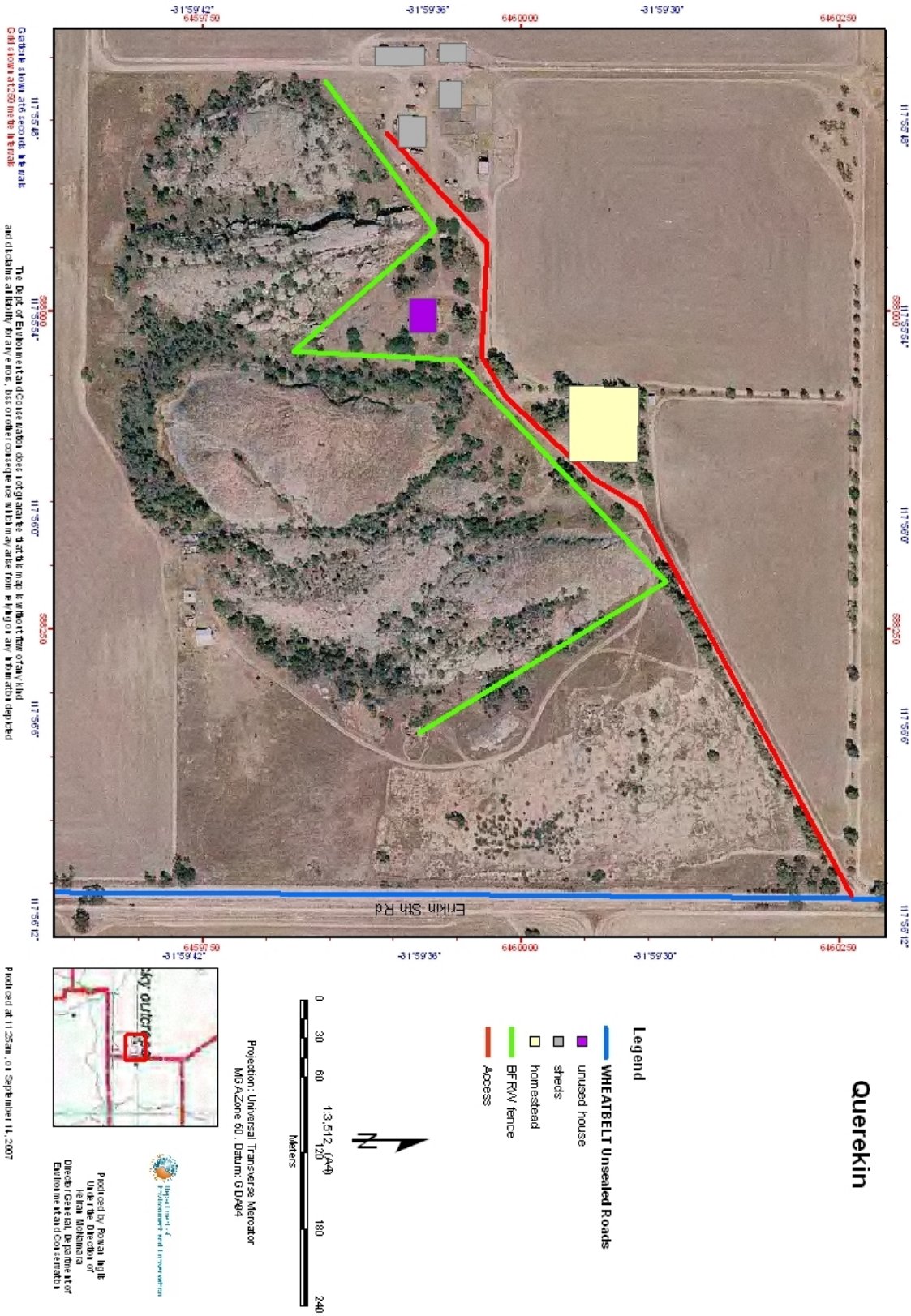
Completion date: On-going
Cost: On-going

6. **Improve the genetic makeup of the population by introducing BFRWs from Mt Caroline, Gundaring and other sites.**

Completion date: On-going

Cost: As this will be done in conjunction with a trapping program, costs derived from this exercise will be incorporated into that budgetary amount

Aerial photo of Querekin Rock showing site, access, infrastructure and BFRW fence



APPENDIX 7: Summary – Gardiner's Rock

Gardiner's Rock

Tenure	Private Property
Shire	Kellerberrin
Area (Gardiner`s Rock)	10 ha
Predator control (Fox)	Commenced – 1995, 364 baits allocated annually
Population	1997 – 6
Habitat	Mostly Acacia and Eucalypt woodland
Current Research	None
Threats	Predation (cats and foxes) Lack of ecological resources Competition from introduced animals Inappropriate fire regime
Off-site impacts	Unknown
Previous management actions:	**1995 -** Fox control commencement
Conservation Actions (Current)	Predator Control (on reserve)
Conservation Actions (Recommended)	Predator Control (off reserve) Population monitoring

Background

Gardiner's Rock is a 10ha remnant located on private property. The majority of suitable habitat is located on the southern edge of this small outcrop. The BFRW population at Gardiner's Rock is believed to have been established by a mother, her male Joey and a quiescent embryo from Mount Caroline (Eldridge *et al.*, 2001). This small population (6 individuals as of 1997) represents the first recorded instance of BFRW dispersing to recolonise habitat from which it disappeared decades ago (Eldridge *et al.*, 2001). It is also one of the few dispersal events documented in any Rock-wallaby species (Sharp, 1997).

Habitat Condition

This site is relatively sound for BFRW habitation however the area (10ha) severely limits the BFRW population

Managing off-site impacts
There appears to be minimal off-site impacts at the reserve. The landowner at present is content with BFRW being on the property.

Conservation Actions
These actions are recommended to enhance the conservation of the species at Kokerbin (the implementation of these actions will be subject to available future funding):

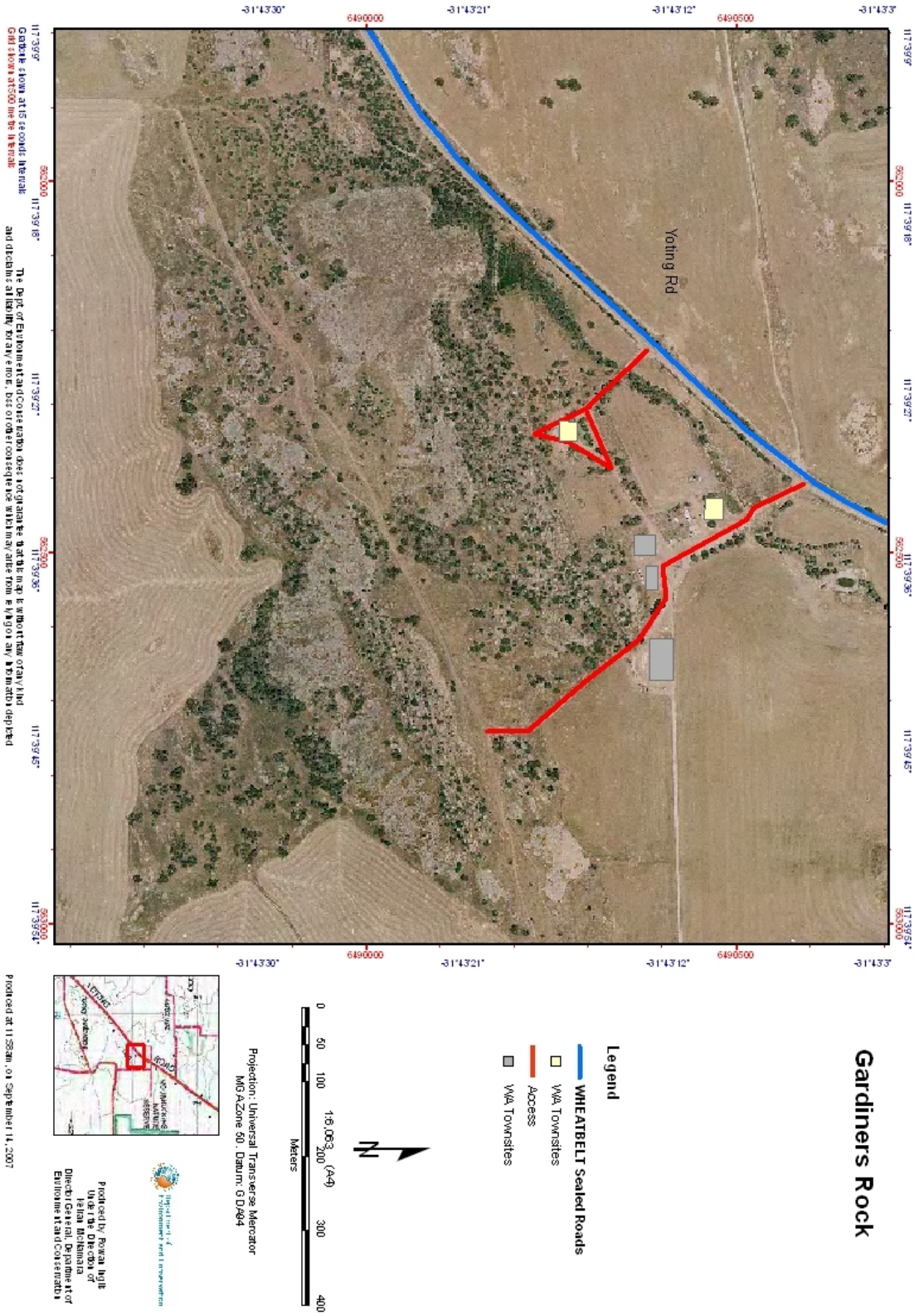
1. **Determine population condition by means of a trapping program.** This info can then be used to estimate the ecologically sustainable BFRW population size range for this site.

   Completion date: On-going
   Cost: $15,000

2. **Supporting adjacent landowners to bait their properties at the recommended frequency.**

   Completion date: On-going
   Cost: $2,000

Aerial photo of Gardiner's Rock showing site, access and infrastructure



APPENDIX 8: **Summary – Sales' Rock**

Sales' Rock

Tenure	Private Property
Shire	Quairading
Area (Sales Rock)	65 ha
Predator control (Fox)	Commenced – 1990, with 520 baits allocated annually
Population	1979 – 32 1980 – 34 1981 – 22 1982 – 22 1984 – 37 1986 - 44 1990 – 13 1994 – 36 1998 - 47
Habitat	Mostly Acacia and Eucalypt woodland
Current Research	None
Threats	Predation (cats and foxes) Lack of ecological resources Competition from introduced animals Inappropriate fire regime
Off-site impacts	Unknown
Previous management actions:	
	1990 - Fox control commencement
Conservation Actions (Current)	Predator Control (on reserve)
Conservation Actions (Recommended)	Habitat enhancement through establishing buffers and corridors Predator Control (off reserve) Population monitoring

Background

This BFRW population inhabits a 65 ha remnant on private property in the Quairading shire. The most recent census of this BFRW population was undertaken in 1998.

Between 1979 and 1990 (when fox-baiting did not occur at Sales' Rock), the population had fallen to 13 individuals - a reduction of almost 60 per cent (Kinnear *et al.*, 1998). After baiting was introduced to Sales' Rock in 1990, the population recovered to almost 50 individuals (see Figure 5).

Habitat Condition
Much of this site is dominated by domed granite rock with relatively few breakaway sections suitable for BFRW habitation. Eucalypt woodland is the dominant vegetation type.

Managing off-site impacts
There appears to be minimal off-site impacts at the reserve.

Conservation Actions

These actions are recommended to enhance the conservation of the species at Kokerbin (the implementation of these actions will be subject to available future funding):

1. **Determine population condition by means of a trapping program.** This info can then be used to estimate the ecologically sustainable BFRW population size range for this site.

   Completion date: On-going
   Cost: $15,000

2. **Supporting adjacent landowners to bait their properties at the recommended frequency.**

   Completion date: On-going
   Cost: $2,000

Aerial photo of Sale's Rock showing site, access and adjacent properties