Review of Environmental Factors

Proposed construction and operation of conservation fencing and associated infrastructure and reintroduction of locally extinct mammals in Mallee Cliffs National Park

A report prepared for Australian Wildlife Conservancy on behalf of NSW Office of Environment and Heritage

SEPTEMBER 2017

Report No. 17.REF-027

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This project is being delivered under the NSW Governments *Saving our Species* program, which aims to secure threatened species in the wild for the next 100 years.

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Envirokey Pty. Ltd.

PO Box 7231 Tathra NSW 2550 t 02 6494 5422

www.envirokey.com.au info@envirokey.com.au

ABN 35150812570

Definitions & Acronyms used within this REF

APZ	Asset Protection Zone
ASL	Above Sea Level
AWC	Australian Wildlife Conservancy
CFAI	Conservation fencing and associated infrastructure
CMA	Catchment Management Authority
CPE	Canid Pest Ejector
EEC	Endangered Ecological Community
EMA	Extinct Mammal Agreement
EP&A Act	NSW Environmental Planning and Assessment Act 1979
EPBC Act	Commonwealth Environment Protection and Biodiversity Conservation Act 1999
EHMF	Ecological Health Monitoring Framework
ESD	Ecologically Sustainable Development
FM Act	NSW Fisheries Management Act 1994
HBT	Hollow-bearing tree
LEP	Local Environmental Plan
LGA	Local Government Area
Likely	Taken to be a real chance or possibility
Locality	The area within a 10 km radius of the proposal
Local population (migratory or nomadic fauna)	The population comprises those individuals that are likely to occur in the study area from time to time.
Local population (resident fauna)	The population comprises those individuals known or likely to occur in the study area, as well as any individuals occurring in adjoining areas (contiguous or otherwise) that are known or likely to use habitats in the study area.
Local population (threatened flora)	The population comprises those individuals occurring in the study area or the cluster of individuals that extend into habitat adjoining and contiguous with the study area that could reasonably be expected to be cross-pollinating with those in the study area.
Migratory species	A species specified in the schedules of the EPBC Act
NES	National Environmental Significance
NP	National Park
NP&W Act	NSW National Parks and Wildlife Act 1974
NPWS	NSW National Parks and Wildlife Service
OEH	NSW Office of Environment & Heritage
PCT	Plant Community Type
PoM	Plan of Management
Proposal	The area to be directly affected by the proposal. That is, the footprint of the proposal, including the construction and operation of the CFAI.
PWIS	Pest and Weed Information System
REF	Review of Environmental Factors
Region	A biogeographical region that has been recognised and documented such as the Interim Biogeographical Regions of Australia (IBRA) (Thackway and Creswell 1995). The study area is located within the Murray Darling Depression Bioregion.

RFS	NSW Rural Fire Service
SEPP	State Environmental Planning Policy
SFAZ	Strategic Fire Advantage Zone
SIS	Salt Interception Scheme
SOP	Standard Operating Procedure
SOS	Saving our Species
Subject site	The area to be directly affected by the proposal; that is, the footprint of the proposal.
Study area	The study area includes the subject site and any additional areas that are likely to be affected by the proposal, either directly or indirectly.
TAP	NSW 2010 Threat Abatement Plan
TEC	Threatened ecological community (includes those communities listed as vulnerable, endangered or critically endangered).
Threatened biota	Those threatened species, endangered populations or endangered ecological communities considered known or likely to occur in the study area.
Threatened species	A species specified in the schedules of the BC Act, FM Act or the EPBC Act.
BC Act	NSW Biodiversity Conservation Act 2016

Declaration

This Review of Environmental Factors provides a true and fair review of the proposed activity in relation to its potential effects on the environment. It addresses to the fullest extent possible, all of the factors listed in Clause 228 of the Environmental Planning and Assessment Regulation 2000.

Signed: 

Name: Steve Sass

Delegation: Director/Principal Ecologist, EnviroKey Pty. Ltd.

Date: 13 July 2017

I have examined this REF and the certification and accept the REF on behalf of NSW Office of Environment & Heritage (OEH).

Signed ……

Name ……

Delegation ……

Date ……

Fees

OEH is the proponent for the proposal. No fees apply.

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1 INTRODUCTION

The NSW Government and Australian Wildlife Conservancy (AWC) have signed an historic agreement (Extinct Mammal Agreement) under which AWC is delivering scientific and land management services in the Mallee Cliffs National Park (NP). The Extinct Mammal Agreement (EMA) ("A project to reintroduce locally extinct mammals", Agreement number: OEH-677-2014) gives effect to a commitment under the NSW Government's Saving our Species Program. Central to the EMA is a requirement for AWC, on behalf of the NSW Government, to establish a large feral predator-free (fenced) area into which mammal species listed as extinct in NSW will be reintroduced.

The proposal represents one of the most significant threatened species projects in Australia as it will deliver a substantial:

- increase in the population of at least ten threatened mammal species, currently listed as extinct in NSW (Table 1); few proposals in Australia have delivered an ecological return on the scale anticipated by the EMA;
- benefit for other species, including species listed as threatened in NSW, for instance, Malleefowl and Western Pygmy-possum, as a result of the removal of feral animals and the restoration of ecosystem services (e.g. soil turnover by digging mammals).

Detailed assessment and planning for these reintroductions will occur as part of a Translocation Proposal that will be prepared, as required under the EMA.

Table 1: Population of locally extinct mammals proposed for reintroduction into Mallee Cliffs National Park and the likely increase to population size should this proposal proceed

Species	Population estimate (2012)	Proposed Mallee Cliffs feral predator-free fenced area: potential population estimate*	Increase
Western Quoll	13,500	90 inside fence, plus up to 350 outside fence	1-3%
Red-tailed Phascogale	<10,000	1,700	17%
Numbat	<1,000	270	27%
Western Barred Bandicoot	3,000	1,600	53%
Bilby	10,000	1,100	11%
Burrowing Bettong	14,500	2,900	20%
Brush-tailed Bettong	<18,000	1,800	10%
Bridled Nailtail Wallaby	2,300	2,150	93%
Greater Stick-nest Rat	4,500	1,800	40%
Mitchell's Hopping-mouse	>10,000	c. 1,000	c. 1%

*Note: Population estimates are based on best available data, using information on home range and/or density from areas of similar habitat and from other locations where feral predators are effectively controlled or absent, to the extent possible. Populations are expected to vary considerably with rainfall.

EnviroKey Pty. Ltd (EnviroKey) was engaged by AWC to prepare a Review of Environmental Factors (REF) for the proposed construction and operation of the conservation fencing and associated infrastructure (CFAI). The proposal is located about 23 km east of Buronga and

within the Wentworth Local Government Area (LGA). The regional setting showing the study area used for this REF is shown in Figure 1. A larger-scale representation of the approximate location of the proposal is in Figure 2. This is an approximate location due to the possibility of small shifts in the exact location of the CFAI to avoid any Malleefowl mounds, any significant trees, any areas of extreme erosion risk, or any other sensitive environmental constraints. However, the proposal would remain within the general vicinity of that detailed within the REF.

For this REF, the '*Proponents Guidelines for the Review of Environmental Factors'* prepared by the Department of Environment and Climate Change (now NSW Office of Environment and Heritage (OEH)) was followed given that the proposal is located within Mallee Cliffs NP and that OEH would be the proponent and determining authority (DECC 2008). The standard template for preparing REFs in lands reserved or acquired under the NSW *National Parks and Wildlife Act 1974* (NP&W Act) was also adopted in the preparation of this REF (DECCW 2011).

Accordingly, this REF will:

- undertake an analysis of the environmental, economic, physical and social implications of the proposal; and
- describe the environmental impacts associated with the proposal and develop environmental safeguards for each environmental component where deemed necessary.

This REF has been prepared in accordance with the requirements of Section 111 of the *Environmental Planning and Assessment Act* 1979 and Section 228 of the *Environmental Planning and Assessment Regulation 2000* specifying a "duty to consider environmental impact" and was prepared by suitably qualified and experienced personnel, details of which are provided in Appendix 1.

1.1 BRIEF DESCRIPTION OF THE PROPOSAL

The proposal would include the following components.

- The construction of a 37.2 km feral predator-proof fence enclosing an area of 9,570 ha in the Mallee Cliffs NP (Figure 1 and Figure 2). The conservation fence will require a 10 to 11 m-wide track to be cleared (up to 5.5 m wide on each side of the fence), resulting in the removal of about 40.9 ha of vegetation. No internal fences will be constructed within the fenced area other than temporary fencing (e.g. a temporary holding pen), if required, to facilitate the effective release of particular species, which would be specified in the approved Translocation Proposal. Any such temporary fencing would be installed and removed without material impact on the environment.
- Management of this area including the removal of feral animals and supporting the implementation of changes to fire management in relation to the area.
- The reintroduction of at least ten threatened mammal species: Bilby, Numbat, Western Barred Bandicoot, Bridled Nailtail Wallaby, Brush-tailed Bettong, Burrowing Bettong, Greater Stick-nest Rat, Mitchell's Hopping-mouse, Red-tailed Phascogale and Western Quoll, between March 2019 (earlier if possible) and April 2021.
- The establishment of an associated operations base (housing, infrastructure, services, etc.) in the Mallee Cliffs NP (Figure 4) outside the feral-free area, with a footprint of about 10.6 ha, which is predominantly an Asset Protection Zone (APZ). Most of the vegetation of the 10.6 ha would be modified rather than totally cleared. For the purposes of this REF and in line with OEH definitions of 'clearing', this will be assessed assuming total loss of vegetation over an area of 11 ha.

- Establishment of up to 54 km of tracks (comprising 11.10 km of proposed firetrail and 42.61 km of proposed minor tracks, Figure 3) and removal of about 23.7 ha of vegetation.
- The total impact area of this proposal is approximately 76 ha.

There is a possibility that an additional track will be required if the current main access road into the proposed operations base is not able to be used. If this alternative access is required (Figure 3), then it would be 6 m wide except for a section along the outside of the proposed fence, which would need to be 8 m wide in total (2.5 m wider than the planned track around the outside of the fence) to create a safe distance between large vehicles transporting construction materials and the fence. The additional area to be cleared if this alternative access was required would be 2.8 ha, which would increase the total impact area to about 78 ha.

1.2 PROPONENT'S DETAILS

The proponent for the proposal is the NSW OEH. Details of the proponent are provided in Table 2.

Table 2: Proponent's details

Item	Details
Proponent	NSW Office of Environment & Heritage (OEH)
Contact	Michael Wright, Executive Director Park Programs, NSW National Parks and Wildlife Service
Address	159-61 Goldburn Street, South Sydney, NSW 2000
Phone	+61 (0)2 9995 5000
Email	michael.wright@environment.nsw.gov.au

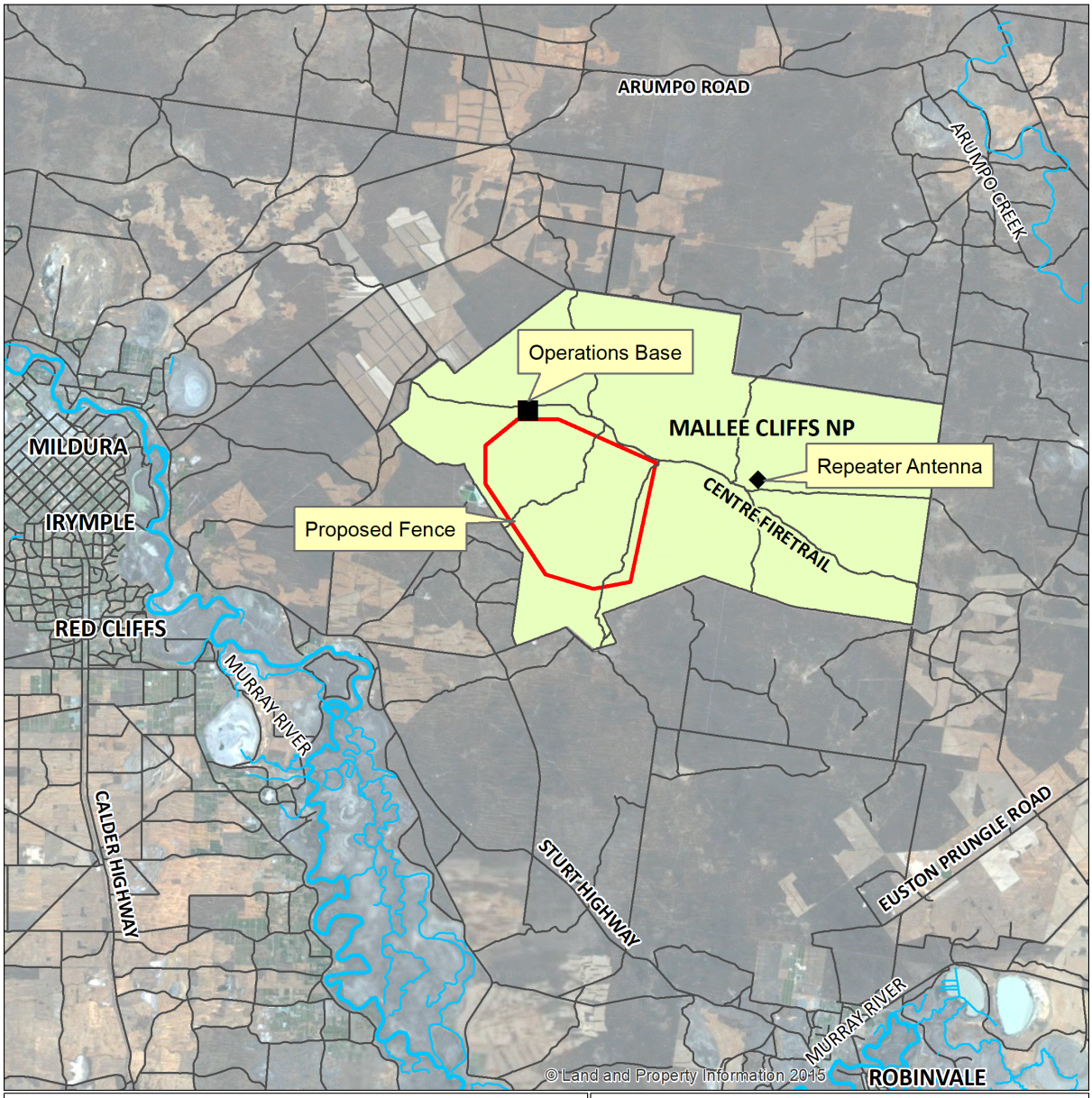

Figure 1: Regional setting of the study area applied to this REF

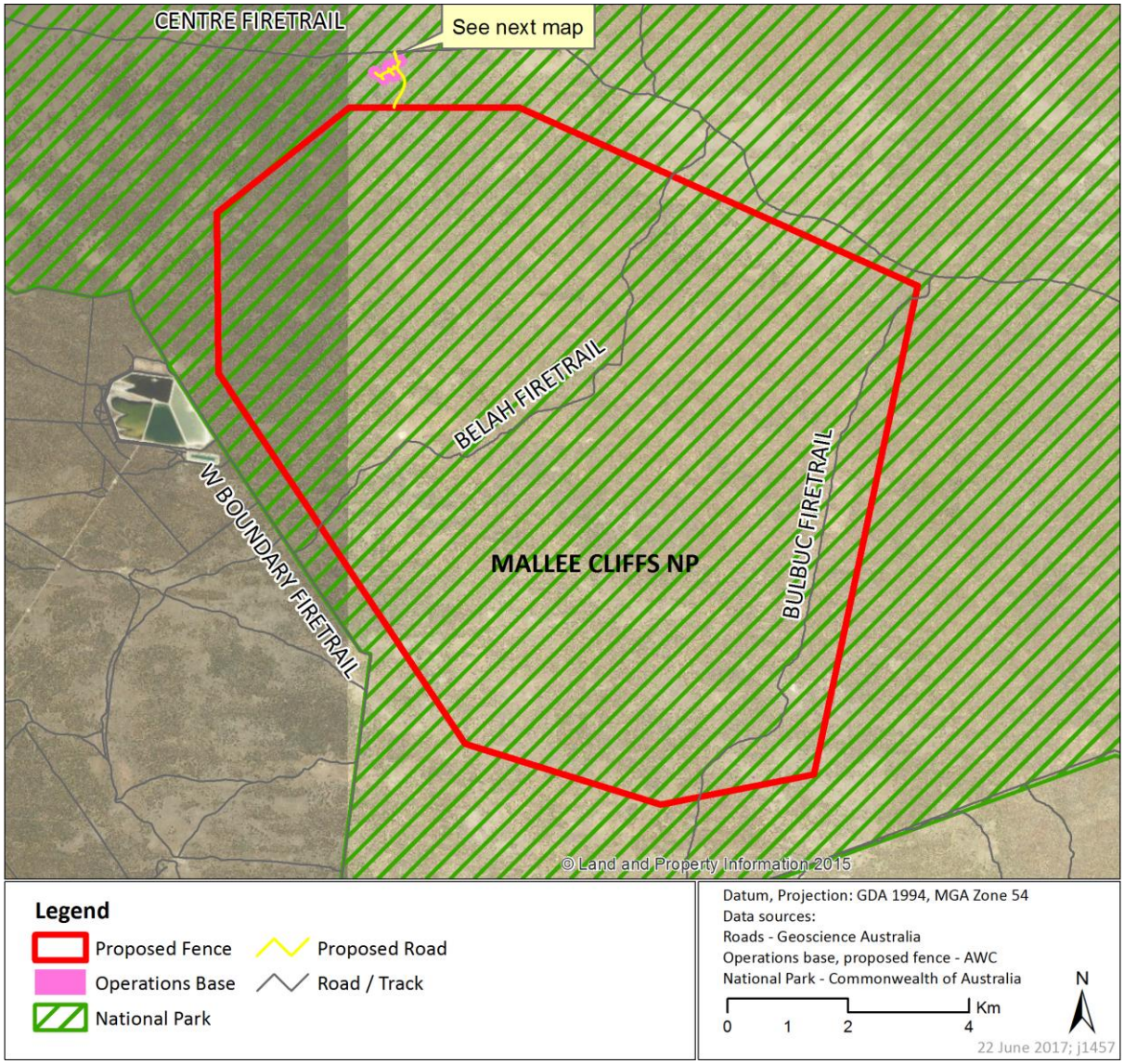

Figure 2: Location of the proposal: the conservation fence for the feral predator-free area and the operations base

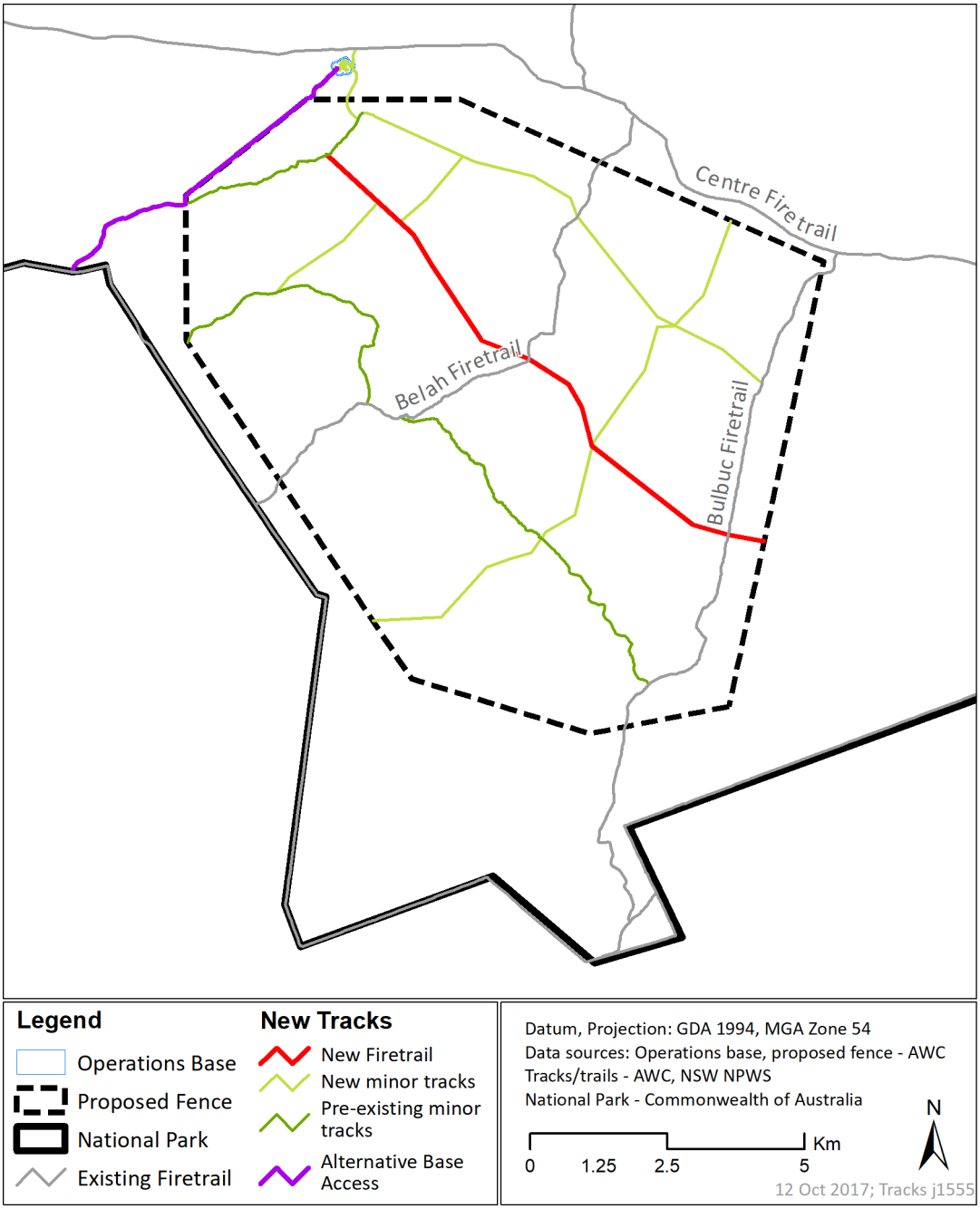

Figure 3: Locations of existing and proposed new management tracks, and the alternative access track (if required)

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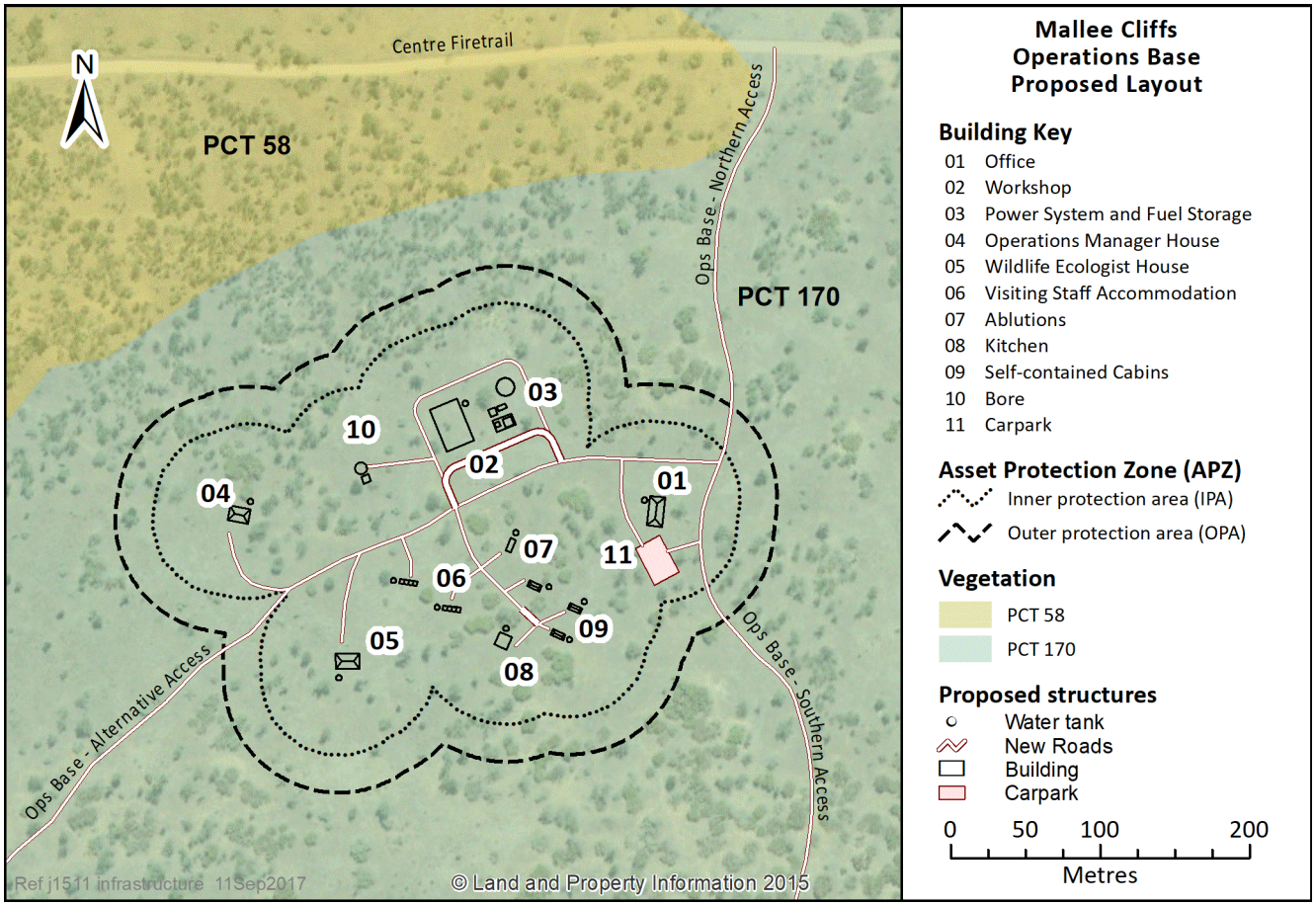


Figure 4: Layout of proposed operations base. NB: the vegetation boundaries in the map are taken from those of Morcom and Westbrooke (1990) for the area (see Section 5.8.4), and are incorrect in this location. The vegetation within the APZ is disturbed throughout but was originally Black Oak-Western Rosewood open woodland (PCT 58).

2 PERMISSIBILITY

2.1 LEGAL PERMISSIBILITY

The NSW Government and Australian Wildlife Conservancy (AWC) have signed an historic agreement (Extinct Mammal Agreement) under which AWC is delivering scientific and land management services in the Mallee Cliffs National Park. The Extinct Mammal Agreement (EMA) ("A project to reintroduce locally extinct mammals", Agreement number: OEH-677-2014) gives effect to a commitment under the NSW Government's Saving our Species policy. Central to the EMA is a requirement for AWC, on behalf of the NSW Government, to establish a large feral predator-free (fenced) area into which mammal species listed as extinct in NSW will be reintroduced.

2.1.1 NSW Biodiversity Conservation Act 2016 and National Parks and Wildlife Act 1974

On the 25 August 2017 the *Biodiversity Conservation Act 2016* (BC Act) commenced and plants and animals are now regulated under the BC act. Prior to this licensing was authorized under the provisions of the *National Parks and Wildlife Act 1974*.

The BC Act is administered by OEH and provides the basis for the legal protection of plants and animals in NSW. Unless a license is obtained under the BC Act, it is an offence to harm any animal or plant that is protected or is a threatened species or ecological community.

Activities in accordance with Part 5 Assessment of the *National Parks and Wildlife Act 1974* do not require a license under the NPW Act. The NPW Act also protects Aboriginal heritage values.

The proposal is broadly consistent with the objects of the BC and NPW Acts.

Objects of the BC Act (s.1.3)

The activity will contribute to:

(a) conservation of biodiversity and ecological integrity

(b) facilitate ecological sustainable development

(c) improve and share knowledge including local and Aboriginal knowledge, about the status and values of biodiversity and of ecosystem services and the effectiveness of conservation actions

Objects – Reserve management principles (s.30E)

The activity is consistent with the management principles of national parks under sections 30E of the NPW Act, particularly:

- the conservation of biodiversity and maintenance of ecosystem function
- the protection of ecological integrity
- provision for appropriate research and monitoring.

Relevant section of a plan of management

The proposal is broadly consistent with the Plan of Management (PoM) for Mallee Cliffs NP (NPWS 1998). However, the existing PoM would have to be amended to allow this proposal to proceed. To address this, the OEH produced the Mallee Cliffs National Park Draft Plan of

Management which was available for public review and comment until 28 August 2017. The review process is underway at the time of production of this REF.

Leasing, licensing and easement provisions

The proposal would not conflict with any of these provisions of the Act. Because OEH is the project proponent, no leases, licences or easements would be required.

Management powers and responsibilities of NPWS

The proposal is consistent with the management powers and responsibilities specified within the Act. For areas protected under the NP&W Act, Section 8 of the Act enables the Chief Executive of NPWS to:

- arrange for works connected to the management and maintenance of parks, and the preservation, protection and care of native fauna and flora
- undertake scientific research
- promote educational activities.

Section 12 of the NPW Act lists the powers and functions of NPWS. The most directly relevant to this project are:

- the conservation and protection of wildlife (including threatened species, populations and ecological communities, and their habitats)
- the identification, conservation, protection and prevention of damage to Aboriginal objects
- the identification and protection of buildings, places and objects of non-Aboriginal cultural values on reserved land
- the conduct of research monitoring
- the undertaking of public education.

2.1.2 NSW Environmental Planning and Assessment Act 1979

The NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) forms the legal and policy platform for development assessment and approval in NSW and aims to, inter alia, 'encourage the proper management, development and conservation of natural and artificial resources'.

The EP&A Act provides the framework for environmental planning in NSW and includes provisions to ensure that proposals which have the potential to significantly affect the environment are subject to detailed assessment.

The proposal will be determined by the OEH under Part 5 of the Act. The OEH, as the determining authority, must 'examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity' pursuant to Section 111 of the Act. Clause 228 of the *Environmental Planning & Assessment Regulation 2000* (EP&A Regulation) identifies matters that 'must be taken into account concerning the impact of an activity on the environment'.

Section 5A of the EP&A Act contains seven factors to be considered by determining authorities when considering the significance of impacts on threatened biota associated with activities under Part 5 of the Act (the '5-part test'). Should the 5-part test determine that a '*significant effect*' on any threatened biota listed under the BC Act is likely, then the authority must prepare a Species Impact Statement. Species which occur or have the potential to occur in the study area have been assessed using the 5-part test (Appendix 6). The proposal is *unlikely* to have a *significant effect* on any threatened biota listed under the BC Act.

2.1.3 NSW Wilderness Act 1987

The objectives of the NSW *Wilderness Act 1987 are*:

- to provide for the permanent protection of wilderness areas;
- to provide for the proper management of wilderness areas; and
- to promote the education of the public in the appreciation, protection and management of wilderness.

The proposal is not located within an area listed under the NSW *Wilderness Act 1987*.

2.1.4 NSW Biodiversity Conservation Act 2016

The NSW *Biodiversity Conservation Act 2016* (BC Act) provides legal protection for plants and animals of conservation significance. The BC Act aims to, inter alia, "maintain a healthy, productive and resilient environment….consistent with the principles of ecological sustainable development". It provides for:

- the listing of threatened plans and animals, populations and ecological communities, species extinct in the wild and key threatening processes;
- the preparation and implementation of strategies to achieve the long-term security of listed species and communities
- guidelines for the preparation of an Assessment of Significance.

The BC Act has been addressed in this REF by undertaking database searches and desktop analysis for any threatened species or communities previously recorded within the locality, and targeted field surveys. Key threatening processes relevant to the proposal have been identified as part of assessment of potential impacts. Assessments of significance for threatened species and ecological communities are provided in Appendix 6. The proposal is *unlikely* to have a *significant effect* on any threatened biota listed under the BC Act.

Drafting this REF coincided with the transition in legislation from the *Threatened Species Conservation Act 1995* (TSC Act) to the BC Act. Terminology and Assessment of Significance have been updated to be consistent with the new BC Act.

2.1.5 Commonwealth Environment Protection and Biodiversity Conservation Act 1999

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) enables the Australian Government to join with the states and territories in providing a national scheme of environment and heritage protection and biodiversity conservation to ensure that actions likely to cause a 'significant impact' on matters of national environmental significance (NES) undergo an assessment and approval process. Under the Act, an action includes a project, undertaking, development or activity.

An action that has, or is likely to have, a significant impact on a matter of NES may be undertaken only in accordance with the prior approval of the Australian Government Minister for the Environment (DOTE 2013).

The nine matters of NES that are protected under the EPBC Act are:

- Listed threatened species and ecological communities
- Listed migratory species
- Wetlands of international importance
- Commonwealth marine environment
- World heritage properties
- National heritage places

- The Great Barrier Reef Marine Park
- Nuclear actions
- A water resource, in relation to coal seam gas development and large coal mining development.

The Significant Impact Guidelines for the EPBC Act (DOTE 2013) set out criteria to assist in determining whether an action requires approval and in particular, whether a proposed action is likely to have a significant impact on a matter of NES.

If a proposed action is likely to have a significant impact on a matter of NES, referral of the proposal to the Department of the Environment and Energy is required to confirm whether the Commonwealth considers the proposal a 'controlled action' and therefore requires Minister approval under the EPBC Act.

All mammal species to be reintroduced, except Mitchell's Hopping-mouse, are listed under the EPBC Act. The likelihood that any additional threatened species or ecological communities or any migratory species occur in the vicinity of the proposal was assessed and results are tabulated in Appendix 7. The resulting list of species that are likely to occur within the vicinity of the proposal is in Table 3. Each species in Table 3 was assessed against the significant impact guidelines (Appendix 7). The proposal is *unlikely* to have a *significant impact* on any matter of NES in accordance with the Significant Impact Criteria (Appendix 7) (DOTE 2013). The assessments also showed that the activity would deliver substantial positive benefits for the species.

Table 3: Species listed as Critically Endangered, Endangered, Vulnerable or Migratory under the EPBC Act that are to be reintroduced or are likely to be within the vicinity of the proposed activity and that were assessed against the significant impact criteria (Appendix 7).

Species	EPBC category
Western Quoll (*Dasyurus geoffroii*)	Vulnerable
Red-tailed Phascogale (*Phascogale calura*)	Vulnerable
Numbat (*Myrmecobius fasciatus*)	Vulnerable
Western Barred Bandicoot (*Perameles bougainville bougainville*)	Endangered
Bilby (*Macrotis lagotis*)	Vulnerable
Burrowing Bettong (*Bettongia lesueur*)	Vulnerable
Brush-tailed Bettong (*Bettongia penicillata*)	Endangered
Bridled Nailtail Wallaby (*Onychogalea fraenata*)	Endangered
Greater Stick-nest Rat (*Leporillus conditor*)	Vulnerable
Fork-tailed Swift (*Apus pacificus*)	Migratory
Malleefowl (*Leipoa ocellata*)	Vulnerable
Yellow Swainson-pea *(Swainsona pyrophila)*	Vulnerable

2.1.6 NSW Fisheries Management Act 1994

The NSW *Fisheries Management Act 1994* (FM Act) aims to conserve fish stocks, key habitats, threatened species, populations and ecological communities of fish and marine vegetation. It also aims to promote viable commercial fishing, aquaculture industries and recreational fishing.

As a public authority, the OEH does not require a permit for dredging and reclamation works within 'water land' under Clause 200 (1) of the FM Act. Under this act, 'water land' means land submerged by water, whether permanently or intermittently or whether forming an artificial or natural body of water.

Under Clause 199 of the FM Act, a public authority must give the Minister written notice of any proposed dredging or reclamation work in 'water land' and must consider any matters concerning the proposed work that are raised by the Minister within 28 days after the giving of the notice (or such other period as is agreed between the Minister and the public authority).

No water land will be affected by this proposal.

2.1.7 NSW Heritage Act 1977

The NSW *Heritage Act 1977* defines 'environmental heritage' and can include places, buildings, works, relics, moveable objects and precincts. A property is a heritage item if it is:

- listed in the heritage schedule of the local council's Local Environmental Plan (LEP);
- listed on the State Heritage Register, a register of places and items of particular importance to the people of NSW; or
- listed in the National Heritage Database.

Heritage items are considered in this REF in Section 5.11. No heritage sites will be impacted by this proposal.

2.1.8 State Environmental Planning Policy No. 44 – Koala Habitat Protection

State Environmental Planning Policy (SEPP) No. 44 encourages the conservation and management of natural vegetation areas that provide habitat for Koalas to ensure that permanent free-living populations will be maintained over their present range across 107 local government areas (LGAs). Local councils listed under Schedule 1 of SEPP 44 cannot approve development in an area affected by the policy without an investigation of core Koala habitat. The policy provides the state-wide approach needed to enable appropriate development to continue, while ensuring there is ongoing protection of Koalas and their habitat. Wentworth LGA is listed within Schedule 1 of this SEPP. However, Part 1, Sec.5 confirms that SEPP44 does not apply on land dedicated or reserved under the NP&W Act. Therefore, SEPP44 does not apply to the proposal. Potential impacts on Koalas would nevertheless be considered throughout this REF if Koalas were likely to occur on Mallee Cliffs NP – however, there are no records from or near the park. The nearest records are from Mildura and Swan Hill.

2.1.9 Rural Fires Act and bushfire management plans

The CFAI will be part of the built infrastructure for the Mallee Cliffs NP, and a Strategic Fire Advantage Zone (SFAZ) and an Asset Protections Zone (APZ) for the conservation fence and the operations base are part of this proposal. Management of these zones mitigates the risk to the CFAI by incorporating strategic prescribed burns along a relatively narrow strip immediately adjacent to the fence, and near the operations base.

Vegetation within the operations base will be managed to comply with requirements for an Inner Protection Area and an Outer Protection Area consistent with the Rural Fires Act. Fire management is discussed in further detail in Section 4.3.8.

2.2 CONSISTENCY WITH OEH POLICY AND PROGRAMS

2.2.1 Mallee Cliffs NP Plan of Management

The NP&W Act requires that all activities on reserved land are consistent with an adopted plan of management (PoM) for the area. Under sections 81 and 81A of the NP&W Act, all operations in the Mallee Cliffs NP must be in accordance with the PoM.

The OEH released for public comment a new PoM and this is currently undergoing review (September 2017). This proposal is consistent with the proposed PoM, which provides expressly for the establishment of a feral predator-free area and the reintroduction of regionally extinct mammals.

This REF is consistent with the proposed PoM as it considers core environmental, cultural and recreational values in its assessment of potential direct and indirect impacts of the proposal.

2.2.2 Saving our Species

The proposal is consistent with the Saving our Species (SOS) program (OEH 2016). The key objectives of SOS are:

- to maximise the number of threatened species in NSW that can be secured in the wild for the next 100 years;
- to control key threats facing threatened plants and animals.

The EMA, together with this proposal, is a key partnership between the NSW Government and AWC under SOS to reintroduce extinct mammals into Mallee Cliffs NP. The proposal will also lead to the removal of feral cats, foxes, feral pigs, feral goats, feral rabbits and hares from within the proposed fenced area, thus benefiting other threatened species.

2.2.3 NSW permits, licences and approvals for activities related to wildlife

Under the NP&W Act and the BC Act, licences are required to 'harm (take), pick or possess' threatened species within NSW and to import threatened species into the state. Scientific licences and import permits (both administered by the NSW Department of Primary Industry) will be applied for in conjunction with the submission of the Translocation Proposal for species to be reintroduced to the proposed feral predator-free area.

Additional licences, permits or approvals that may be required under the EPBC Act and under legislation in operation in any of the other Australian states that may be involved in the wildlife translocations are outlined in Section 2.3.3.

2.2.4 Other policies

Other NSW park management policies and procedures may be applicable to the proposed activity and will be complied with in delivering the proposal. Policies which may be relevant include:

- NPWS Cultural Heritage Conservation Policy, and any other relevant cultural heritage policies
- Environmental Integrity Policy
- Erosion Policy Statement
- Weeds Policy Statement

- Use of raw materials policy statement
- Various feral animal policies
- Fire management manual
- Landscape/scenic quality policy statement
- Sustainability assessment criteria
- Rabbits Policy statement
- Roads Policy
- Soils Policy
- Translocation of threatened fauna policy.

2.3 OTHER RELEVANT LEGISLATION, POLICIES OR PLANS

2.3.1 Ecologically Sustainable Development

Ecologically sustainable development (ESD) involves the effective integration of social, economic and environmental considerations in decision-making processes. In 1992, the Commonwealth and all state and territory governments endorsed the *National Strategy for Ecologically Sustainable Development*. In NSW, the concept has been incorporated in legislation such as the EP&A Act and Regulation.

For the purposes of the EP&A Act and other NSW legislation, the Intergovernmental Agreement on the Environment (1992) and the *Protection of the Environment Administration Act* 1991 outline the following principles which can be used to achieve ESD.

> The precautionary principle: that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions can be guided by:
>
> > (i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and
> >
> > (ii) an assessment of the risk-weighted consequences of various options.
>
> Inter-generational equity: that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.
>
> Conservation of biological diversity and ecological integrity: that conservation of biological diversity and ecological integrity should be a fundamental consideration.

The aims, structure and content of this REF are guided by these principles. The precautionary principle has been adopted in the assessment of impact; all potential impacts have been considered and mitigated where a risk is present. Where uncertainty exists, measures have been suggested to address it.

2.3.2 Wentworth Local Environmental Plan 2011

The proposal is located in the Wentworth LGA and is subject to the Wentworth Local Environmental Plan 2011 (LEP). The site is zoned as E1 National Parks and Nature Reserves. Uses authorised by the NP&W Act are permitted without council consent.

The aims of the Wentworth LEP include but are not limited to:

- to encourage and manage ecologically sustainable development within Wentworth;

- to encourage the retention and enhancement of land that supports the primary economic activities within Wentworth for productive agriculture and other primary production purposes;
- to conserve and protect items of European and Aboriginal cultural heritage;
- to conserve and protect areas of environmental significance, particularly conservation parks, reserves and the Murray and Darling River systems.

The proposal is consistent with the aims of the LEP.

2.3.3 Permits, licences and approvals from non-NSW administrations

The need for approval from the Commonwealth Government to take and liberate wildlife under the EPBC Act will be discussed with the relevant authorities and approval applied for if required.

The threatened species to be reintroduced are likely to be sourced from South Australia, Victoria, Queensland, Western Australia and the Northern Territory, and each jurisdiction administers a system of export permits. Relevant ones will be applied for in conjunction with the submission of the Translocation Proposal.

3 CONSULTATION

AWC is committed to discussing the proposal with all relevant stakeholders and government agencies and has introduced the proposal to them. This section provides commentary on discussion between AWC and the identified stakeholders and government agencies and responses if relevant to this REF (Table 4).

Table 4: Details of stakeholder and government agency consultation

Organisation	Date	Attendees or contacts	Synopsis
Wentworth Shire Council	28th February 2017	Director of Planning and General Manager	AWC emailed information regarding the Mallee Cliffs EMA project and this proposal – including an introduction, and copies of Wildlife Matters. AWC have engaged with the Wentworth Shire council for many years through ongoing operations at Scotia Wildlife Sanctuary.
Dareton Local Aboriginal Land Council	10th April 2017	CEO	An email providing an overview of the EMA project and this proposal, AWC contact information and Wildlife Matters newsletter was provided. An invitation to participate in the Indigenous Heritage Survey was given.
Kerribee Station (neighbouring property to Mallee Cliffs NP)	15th November 2016	Jim Maynard	AWC was introduced by NPWS staff; AWC provided an overview of the EMA project and this proposal, and AWC contact details. AWC has subsequently regularly contacted neighbours to provide updates.
Gulthul Station (neighbouring property to Mallee Cliffs NP)	15th November 2016	Steve Leslie	AWC was introduced by NPWS staff; AWC provided an overview of the EMA project and this proposal, and AWC contact details. AWC has subsequently regularly contacted neighbours to provide updates. AWC has been using accommodation provided by Gulthul Station for staff undertaking ecological surveys.
Trentham Cliffs Station (neighbouring property to Mallee Cliffs NP)	15th November 2016	Ian & Daniel Linklater	AWC was introduced by NPWS staff; AWC provided an overview of the EMA project and this proposal, and AWC contact details. AWC has subsequently regularly contacted neighbours to provide updates. AWC will work with Trentham Cliffs station on access, and use of storage and laydown areas as required.
Birdlife Mildura	30 April 2017		AWC has engaged with Birdlife Mildura to assist with ongoing bird surveys across Mallee Cliffs NP.

AWC will maintain engagement with a range of stakeholders throughout the proposed activity including during the public engagement period.

4 THE PROPOSAL

4.1 ANALYSIS OF THE OPTIONS

4.1.1 Option 1: Do nothing

The 'do-nothing' option is an option that OEH is legally obliged to consider under the EP&A Act. In a do-nothing case, the EMA would not be implemented and the CFAI would not be constructed or operated.

Advantages

- No capital expense
- No negative impacts to native vegetation and habitat

Disadvantages

- Feral predators will continue to have a major negative impact on biodiversity. Across Australia, small to medium-sized ground-active mammals and ground-active birds such as the Malleefowl are threatened by feral predators (Benshemesh 2007; Woinarski et al. 2014). Data from semi-annual trapping surveys conducted in Mallee Cliffs NP from 2001-2014 show a 10-fold decline in the mean abundance of Western Pygmy-possums between 2001-2006 and 2008-2014 (NPWS unpublished data). Data from semi-annual aerial surveys of Malleefowl mounds in Mallee Cliffs NP show a decline in the number of active mounds over the past 5-10 years (NPWS unpublished data). As a consequence, under the do nothing option, threatened species in the project area such as Malleefowl and Western Pygmy-possum can be expected to continue to decline or be maintained at low densities by feral predators.
- Feral herbivores will continue to have a major negative impact on biodiversity. As a consequence, threatened species adversely affected by feral herbivores in the project area can be expected to continue to decline or be maintained at low densities by feral herbivores.
- Lost opportunity to reintroduce extinct mammals into NSW national parks estate. Mallee Cliffs NP is an important site in this context given the diversity of its pre-European mammal fauna (Krefft 1866).
- Lost opportunity to restore ecosystem processes provided by the regionally extinct mammals.
- Lost opportunity for a significant economic benefit for the region.
- Lost opportunity for increased park visitation by members of the community who wish to see Bilbies, Bettongs and other regionally extinct mammals in the wild.
- Lost opportunity to advance scientific knowledge in relation to key threatening processes (feral animals) and biodiversity.
- Significant government/community/stakeholder support for the project would not be realised.
- NSW Government commitment to Saving our Species policy not delivered and the terms of the EMA not implemented.

4.1.2 Option 2: Reintroduce extinct mammals without the conservation fence

Option 2 would see the reintroduction of mammals that are listed as extinct in NSW, primarily due to impacts from feral predators and competition with introduced herbivores, in the absence of conservation fencing. A nearby operations base would not be required.

In relation to this option, it is important to note that it is highly likely any proposed mammal reintroductions in Mallee Cliffs NP will fail in the absence of conservation fencing. This is explicitly recognised in the Saving our Species policy. Outside of south-western Australia, there have been no successful (established over the long term) mainland reintroductions of the relevant species in the absence of feral-proof fencing. There are several examples of failed attempts to reintroduce the candidate mammal species in the absence of a fence (e.g. Western Quoll and Numbat: several locations in Western Australia; Western Barred Bandicoot: Heirisson Prong WA; Brush-tailed Bettong: Francois Peron National Park WA, Yathong Nature Reserve, NSW and several locations in Western Australia and South Australia; Bridled Nailtail Wallaby: Idalia National Park, Qld) or where a fence has proven ineffective, for example due to poor maintenance (e.g. Bilby: Currawinya National Park, Qld). The major factor driving the failure of mammalian reintroductions in Australia is the presence of feral cats and foxes (Woinarski et al. 2014).

Advantages

- Lower capital expense as the fence would not be constructed
- No negative impacts to native vegetation and habitat as a result of fencing/infrastructure establishment
- Potentially some scientific learnings if the fate of the reintroduced mammals is tracked in a rigorous manner
- Limited economic benefits for the region (significantly less than Option 3 given the reduction in capital investment and the elimination of long term visitor opportunities linked to reintroduced mammals)
- Potentially some government/community/stakeholder support for the project would be realised. However, this will be compromised by the likely failure of the reintroductions.

Disadvantages

- As indicated above, it is highly likely the mammal reintroductions will fail
- Poor use of financial resources as there will be no ecological return on the investment – i.e. it will be largely wasted
- Lost opportunity for significant economic benefit for the region
- NSW Government commitment to Saving our Species policy not delivered and the terms of the EMA not implemented.

4.1.3 Option 3: Reintroduce extinct mammals with conservation fence and associated infrastructure

Option 3 fulfils the agreement made between the NSW Government and AWC to deliver the Extinct Mammal Agreement (“A project to reintroduce locally extinct mammals”, Agreement number: OEH-677-2014). It requires the construction of a conservation fence to exclude feral predators, the removal of feral predators and herbivores from inside the fence, and subsequent effective maintenance of the fence. In turn, these actions require the development of a nearby operations base and new tracks inside the fenced area. The proposed sites for the fence, operations base and new tracks are the result of considering ways in which advantages could be optimised and disadvantages minimised. Factors influencing site and design selections are described in detail in Section 4.3.1.

Advantages

- High likelihood of success in reintroducing mammal species which are listed as extinct in NSW and for which predation by foxes and feral cats is the most significant

threatening process. The effectiveness of conservation fencing has been recognized in the Mammal Action Plan (Woinarski et al. 2014), in the Australian Government's Threatened Species Strategy (www.environment.gov.au/biodiversity/threatened/publications/threatened-species-strategy) and in a report of a recent Federal Senate inquiry (www.aph.gov.au/ParliamentaryBusiness/Committee/Senate/EnvironmentandCommunications/Completedinquiries/2010-13/threatenedspecies/report). AWC has successfully delivered conservation fencing and associated reintroductions of threatened mammals at Scotia Wildlife Sanctuary, Karakamia Wildlife Sanctuary, Mt Gibson Wildlife Sanctuary and Yookamurra Wildlife Sanctuary.

- Substantial increase in the population of at least ten threatened mammal species, currently listed as extinct in NSW (Table 1).
- Substantial benefits for other species, including many species listed as threatened in NSW, as a result of the removal of feral animals and the restoration of ecosystem services including, but not limited to, Malleefowl and Western Pygmy-possum.
- Significant increase in scientific knowledge as a result of the proposal.
- Restoration of ecosystem processes such as digging and turnover of soil by small mammals and reintroduction of native predators.
- Key significant government/community/stakeholder support for the project would be realised.
- Opportunity for significant economic benefit for the region through the capital investment in establishment of the project, the ongoing investment in delivery of the project and the establishment of an additional visitor attraction in the region.
- Opportunity for increased park visitation

Disadvantages

- Higher capital expense than Options 1 or 2. This needs to be considered in the light of the substantial ecological and social returns generated by that investment.
- There are limited negative impacts to native vegetation and habitat as a result of conservation fencing and associated infrastructure construction. However, these do not represent a significant impact on the environment.
- There will be changes to the environment resulting from reintroduction of mammals, which potentially include a reduced abundance of particular plants or animals eaten by reintroduced mammals, but such changes are part of the restoration of the ecological processes that have operated at the proposal site in the past, except for the last hundred years. The activities of native mammals do not represent a significant negative impact on the environment, rather, they are an integral part of the environment.
- Populations of native mammals reintroduced to a large fenced area may, over decades, require management, including genetic management and management of population size. Reintroduction to a fenced area therefore requires robust monitoring and potentially more intensive management than other options less likely to result in successful reintroduction of threatened mammals.

4.1.4 Preferred option

After careful analysis of each option the OEH, as the proponent, has determined that the preferred option is Option 3. It delivers a significant environmental benefit through the reintroduction of regionally extinct mammals. It also delivers other substantial benefits to the local community. It gives effect to a commitment under the NSW Government's Saving our Species policy and the Extinct Mammal Agreement as detailed in Agreement Number OEH-677-2014: A project to reintroduce locally extinct mammals.

Option 3 meets the objectives of the proposal and maintains core environmental values identified within the study area by this REF.

For the purpose of this REF, Option 3 is the preferred option for the proposal.

4.2 OBJECTIVES OF THE PROPOSAL

The NSW Government and AWC have signed the Extinct Mammal Agreement under which AWC is required to deliver the Project. The Extinct Mammal Agreement ("A project to reintroduce locally extinct mammals", Agreement number: OEH-677-2014) gives effect to a commitment under the NSW Government's *Saving our Species* policy.

The Saving our Species program aims to maximise the number of threatened species that can be secured in the wild for 100 years.

The objective for this proposal as set out in the EMA is:

> To maximise biodiversity outcomes in each of the parks and increase community engagement with threatened species through the successful reintroduction of mammals formerly extinct in NSW and associated management activities.

In the Initial Period of 10 years commencing 1 May 2016, the following desired outcomes are identified to help meet the objective:

1. Viable Populations of reintroduced mammals are established inside the fenced area, or are on track to becoming established, and progress has been made towards enabling establishment of populations of reintroduced mammals outside the fenced area.
2. Successful reintroduction of locally extinct mammals is leading to improved ecosystem health within the fenced area.
3. Reintroduction of locally extinct mammals leads to community engagement in threatened species and park management, and increased social benefit.
4. Increased knowledge leads to improved conservation outcomes.
5. Delivery of agreed park management services meets Government and public expectations.

4.3 DESCRIPTION OF PROPOSAL

The proposal comprises the following.

- The construction of a 37.2 km feral predator-proof fence enclosing an area of 9,570 ha in the Mallee Cliffs NP (Figure 1 and Figure 2). The conservation fence will require a 10 to 11 m-wide track to be cleared (up to 5.5 m wide on each side of the fence), resulting in the removal of about 40.9 ha of vegetation. No internal fences will be constructed within the fenced area other than temporary fencing (e.g. a temporary holding pen), if required, to facilitate the effective release of particular species, which would be specified in the approved Translocation Proposal. Any such temporary fencing would be installed and removed without material impact on the environment.
- Management of this area including the removal of feral animals and the implementation of some changes to fire management in relation to the area.
- The reintroduction of at least ten threatened mammal species: Bilby, Numbat, Western Barred Bandicoot, Bridled Nailtail Wallaby, Brush-tailed Bettong, Burrowing Bettong, Greater Stick-nest Rat, Mitchell's Hopping-mouse, Red-tailed Phascogale and Western Quoll, between March 2019 (earlier if possible) and April 2021.
- The establishment of an associated operations base (housing, infrastructure, services, etc.) in the Mallee Cliffs NP (Figure 4) outside the feral-free area, with a

footprint of about 10.6 ha, which is predominantly an Asset Protection Zone (AZP). Most of the vegetation of the 10.6 ha would be modified rather than totally cleared. For the purposes of this REF and in line with OEH definitions of 'clearing', this will be assessed assuming total loss of vegetation over an area of 11 ha. Core elements of the operations base are set out in Appendix 3 and in Section 4.3.3 below. Users of the operations base will include representatives of AWC and NSW including partners who are engaged in project delivery. Examples include resident AWC staff; NSW Government staff; contractors; volunteers involved in activities such as bird surveys; external researchers such as university students and, from time to time, guests involved in promoting awareness and outreach (e.g. representatives of media, Federal and local government, local community organisations, representatives of other conservation projects and participants in the philanthropic sector relevant to conservation). The operations base will not be used for tourism or general visitation by the public. Facilities for visitors, including the development of a campground, will be proposed following the reintroduction of native species. Key elements of the operations base include:

  - living quarters:
    - a 3-bedroom house for the Operations Manager
    - a 2-bedroom house for the Wildlife Ecologist
    - 3 self-contained cabins for Field Ecologists and Land Management Officers
    - block accommodation with 8 single rooms for visiting personnel
    - communal living area (including kitchen and laundry)
    - communal ablutions block.
  - workplace facilities:
    - office for up to 8 people
    - large workshop
    - power system with solar, batteries and 20 kVA diesel generator
    - rainwater storage
    - groundwater bore, if required
    - chemical and general storage.
- Establishment of up to 54 km of tracks (comprising 11.10 km of proposed firetrail and 42.61 km of proposed minor tracks) resulting in the removal of about 23.7 ha of vegetation.
- Establishment of a repeater antenna with a footprint of approximately 3 m^2 about 17 km ESE of the operations base, on a disturbed site that provides good coverage of the NP. The proposed site is at or 142°41'2.5"E, 34°13'6.5"S (Figure 1).
- The total impact area of this proposal is approximately 76 ha.

There is a possibility that an additional track will be required if the current main access road into the proposed operations base is not usable (that is, the access via Dansons Road to the Centre Firetrail). If this alternative access is required (Figure 3), then it would be 6 m wide except for a section along the outside of the proposed fence, where the standard fenceline track would be increased from 5.5 m to 8 m wide to create a safe distance between large vehicles transporting construction materials and the fence. The additional area to be cleared if this alternative access was required would be 2.8 ha, which would increase the total impact area to about 78 ha.

A summary of the proposal features is in Table 5.

Table 5: Summary of proposal and description

Item	Description
Feral predator-proof fence	37.2 km in length, and 1.8 m high. About 41 ha of vegetation would be removed.

Item	Description
Operations base	Housing, infrastructure, office, services. Details of these are provided in Appendix 3. About 11 ha of vegetation would be removed or modified to create an Asset Protection Zone (APZ).
Management tracks	Establishment of approximately 54 km of tracks (comprising 11.10 km of proposed firetrails and 42.61 km of proposed minor tracks) and removal of up to 24 ha of vegetation. (If the alternative access track is required, an additional 2.8 ha of vegetation would be removed.)

4.3.1 Justification of the fence, operations base and new track locations

The EMA project requires the reintroduction of mammals into a feral predator-free fenced area. For the fenced area to remain feral predator-free, it is essential that the fence is patrolled frequently (every 2-3 days) and for any damage to be repaired rapidly. (Other fenced areas have suffered significant losses of native species as a result of inadequate maintenance and patrol regimes, for example, Currawinya NP, Qld.) This intense inspection regime makes a nearby operations base a necessity. New tracks will be required if feral animal control, fire management and science activities are to be effective within the fenced area. In particular, a new east-west firetrail is needed to join the two existing north-south ones.

AWC have carried out extensive analysis of the potential locations of the conservation fence, the new tracks and the operations base. Avoiding or mitigating adverse impacts influenced site selections. The current proposed location of the conservation fence has been determined after consideration of the following factors.

- The proposed fenceline has been purposely designed taking into consideration the local conditions including vegetation, terrain, rainfall, etc. The fenceline will be between 10 and 11 m wide allowing for a 5 to 5.5 m wide access track on each side of the fence. This maximum width will allow for safe vehicle access on each side of the fence, provides a buffer from any potential tree and branch falls, and acts as a fire break in the event of wildfire.
- Representation and extent of vegetation communities: Reintroduction success for regionally extinct species is likely to be dependent, in part, on the availability of suitable habitat. Since all of the species proposed for reintroduction have been extinct in NSW for more than 100 years, the details of the habitat requirements for each species are poorly known. The previous ranges of each regionally-extinct species are known to have included the project area so, given the uncertainty about local habitat requirements, the approach taken has been to ensure that all of the main vegetation types in the Mallee Cliffs NP are well represented inside the conservation fence. In addition, the habitat preferences of some currently-extant threatened species (e.g. the Malleefowl, Gilbert's Whistler, Red-lored Whistler, and a number of reptiles including the Mallee Worm-lizard) are known to include Mallee with spinifex so this vegetation type was given special consideration. In addition, the location of the proposed fence is designed to ensure the feral predator-free area is of sufficient size to support viable populations of reintroduced species (see Table 1).
- Threatened vegetation communities and threatened flora: The fence has been sited to avoid listed communities and listed plants, where they have been found to occur.
- The fence has been sited to avoid Malleefowl mounds.
- Modified and disturbed vegetation communities: The fence has been located to coincide as far as possible with the distribution of the disturbed Plant Community

Type 166 (i.e. Herbland/open-herbland; Morcom and Westbrooke 1990). This vegetation type is a derived community considered to have developed from chenopod shrublands (i.e. PCT 166) due to heavy grazing over the past 100 years. It is associated with clay-rich and texture-contrast soils and now consists largely of exotic annual herbs and grasses (Morcom and Westbrooke 1990). The fence alignment is also sited to minimise impact on PCTs 171/172 (i.e. mallee woodlands with a dense spinifex understorey), passing instead through the more open mallee woodlands (PCT 170) and Black Oak woodlands (PCT 58) (Figure 5).

- Existing road and firetrail network: The fenced area has been sited to avoid restricting access on important roads and firetrails, especially Centre Firetrail and the park boundary roads.
- Watercourses: the fence has been sited to avoid impacts on waterways.
- Aboriginal and other cultural sites: the fence has been sited to avoid impacting heritage sites.
- Size: The fence location addresses the above issues/constraints while being of sufficient size to support viable populations of reintroduced species (see Table 1).
- Area to perimeter ratio to minimise clearing for the fence: While a circular fenced area would have the shortest perimeter, it would be impracticable in terms of the existing road network and would also compromise the structural strength of the fence. Various options were assessed before the proposed location was selected: for instance, square or rectangular designs would not fit well with the existing road network, and would have required more clearing for new access tracks.

The initial location proposed for the conservation fence was in the south-east corner of the Mallee Cliffs NP, whereas the current proposal is the south-west corner of the park. The current fence proposal includes a more even distribution of the main vegetation types in the Mallee Cliffs NP, and it would include a larger amount of the Mallee with spinifex vegetation type. The proportion of the disturbed/derived Herbland/open-herbland vegetation community would be reduced and most of it would be close to the route of the proposed fence, so that impacts of clearing for the fence on native vegetation would be reduced.

The proposed route of the fence is offset from existing roads for the following reasons.

- General: Achieving and maintaining fence integrity is paramount to its success. Corner strain assemblies are weak points in terms of structural strength and are vulnerable to predator incursion. In optimising the fenceline route, a balance between minimising the number of corners while avoiding areas of high conservation value has been sought, amongst other factors.
- The northern fenceline section: The section was offset from the Centre Firetrail for the following reasons.
  - The Centre Firetrail is not straight, which means that if the fenceline were to follow it, either more corner assemblies (weak points) or extra clearing would be required.
  - Placing the fenceline along the main access track through the park would create risks to both fence integrity and to through-traffic from vehicle collision.
  - Unmanaged public access to the fence is a security risk and this risk would be particularly high once public access to the park was restored if the fence was along a main access track.
  - Because of the two previous points, if the fence followed the Centre Firetrail, an additional management track would have to be cleared to maintain general-use east-west access through the park.
  - The proposed fenceline makes use of the open-herblands located to the south of the Centre Firetrail, while maximising the area of desirable Mallee habitat within the fence relative to the available length of fencing. Extending the fenceline north

to follow the Centre Firetrail would increase the required perimeter and also increase the area of low conservation value 'open-herbland' within the fence, which is already well represented.

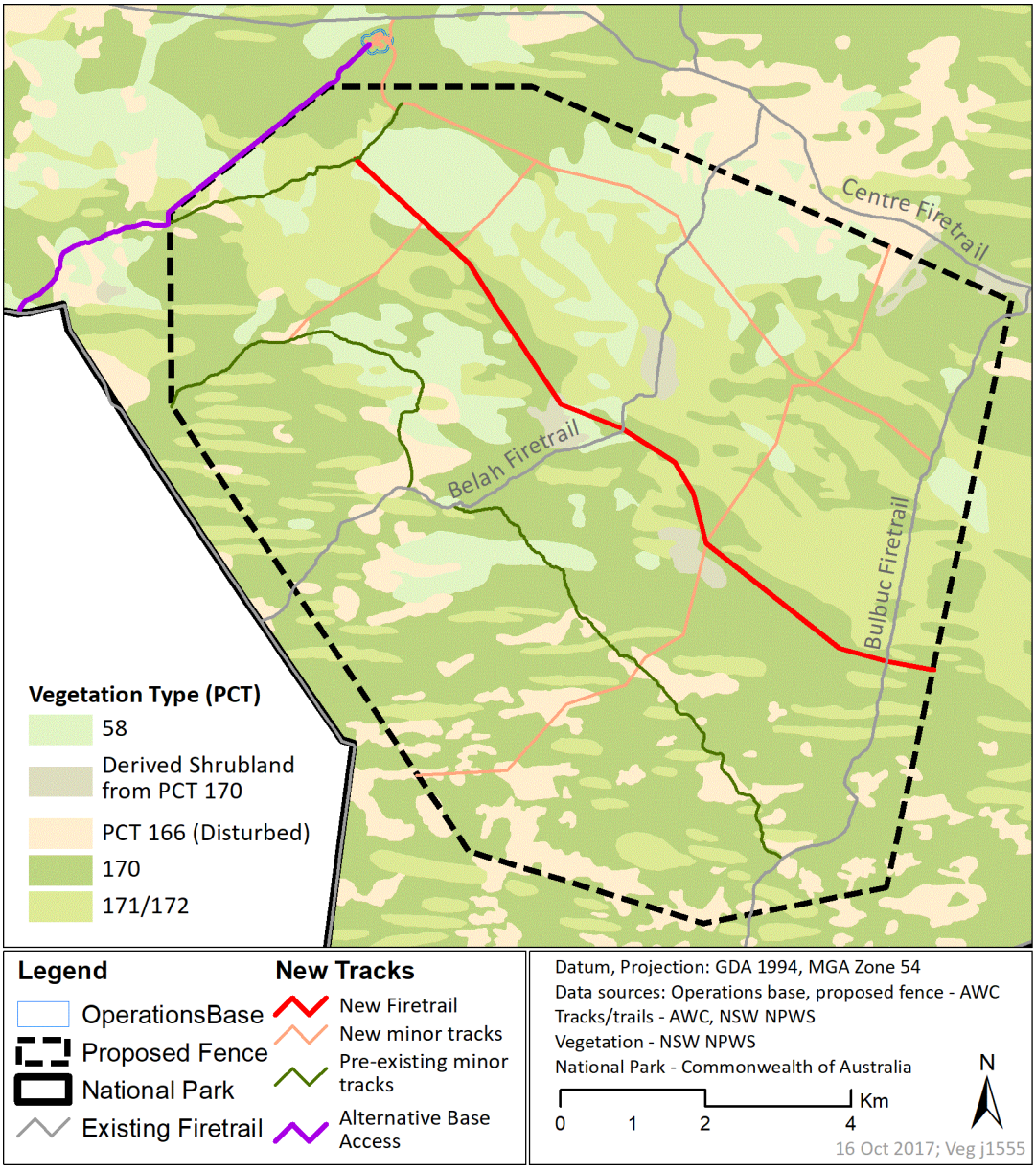


Figure 5: Locations of the proposed fence, the existing and new management tracks, and the alternative access road (if required), in relation to vegetation types (see Section 5.8.4 for explanation of vegetation type codes)

- <u>The eastern fenceline section:</u> The section was offset from Bulbuc Firetrail for the following reasons.
  - Siting the fence east of the firetrail meant that more Mallee with spinifex habitat was inside the fence and this increases the benefits of the conservation fence to extant species which depend of this system and potentially increases the success of the translocations of the 'Mallee Cliffs Species'.
  - The current proposed fenceline bisects a high-value area of Mallee with spinifex at its most patchy point, minimising clearing of this community in favour of

communities of low-conservation priority such as the derived dodonaea shrubland.
    - Placing the fenceline to the east of Bulbuc Firetrail creates an additional firebreak to protect the fenced area and translocated species should any wildfire from the south-east threaten the fence.
    - As Bulbuc Firetrail is not currently straight, following this road would require additional clearing, which would affect high conservation value communities occurring alongside this trail.
    - As Bulbuc Firetrail is only one of two existing primary access roads running through the proposed fence area, using this road as a fenceline clearing would require the additional clearing of another primary road to maintain access for fire and management vehicles.
- The southern and south-western fenceline sections: These sections were offset from the southern park boundary track for the following reasons.
    - The attempt to balance competing demands of maximising the area of Mallee with spinifex habitat and minimising the fence perimeter-to-area ratio limited the extent to which the fenceline could be moved to the south.
    - Due to concerns over potential salinity issues associated with proximity to the Salt Interception Scheme (SIS), the fence was placed at what was considered a safe distance from it.
    - The choice of fenceline location in this area was influenced by the discovery of an active Malleefowl mound, which determined the current alignment. The proposed fenceline buffers this mound by about 200 m. Further re-alignments of this boundary may have negative impacts on this and other mounds.
    - Offsetting the fenceline to the north of the southern boundary track creates an additional firebreak to protect the fence and translocated species should a wildfire approach from the south.
    - The potential to use the existing southern boundary track as a fenceline clearing would be limited by the adjoining SIS fence, which poses a safety risk during fire events and also limits the potential width of the road. Widening the road would result in additional clearing. Also, using this road as a fenceline would require the additional clearing of a major track to maintain perimeter access at an adequate distance from the fence to ensure and maintain fence integrity.

Considerations that went into deciding the location of the operations base are described below.

- The footprint should be located predominantly within an area that has received considerable earlier disturbance.
- The footprint should be located primarily in one of the most common and widespread vegetation types in the Park. Most of the proposed site is derived from PCT 58, but tree cover is now very low and shrubs are sparse. (This site has been mapped as PCT 170 ('Chenopod sandplain mallee woodland/shrubland', Morcom and Westbrooke 1990) but this is in error (see Appendix 3, Figure 39).)
- The operations base should be located near to, but outside, of the proposed conservation fence.
- The base should have several exit options for personnel in case of an emergency such as a wildfire.
- The current site was selected, following consultation with NPWS staff, on the basis of providing ready access to the fenced area and aesthetics for livability, whilst ensuring that the facilities were located off a main park thoroughfare thereby assisting with security and dust impact on staff and buildings.

- The scale of the operations base has been determined on the basis of mitigating risk as far as is practicable for bushfire threat by ensuring that buildings have enough distance between them to limit the risk of fire transferring from one building to another. In addition, providing space between accommodation buildings, the accommodation precinct and the operational areas such as the office and workshop ensures that noise impact will be minimised and privacy not compromised.

Alternative options considered included two disturbed sites further east and close to the Centre Firetrail. The proposed site was selected primarily based on lower bushfire risk as well as less exposure to wind and greater offset from the main Centre Firetrail thoroughfare.

Considerations that went into planning the track network are described below.

- The network was designed to minimise disturbance while providing adequate access for feral animal control, suitable release sites for reintroductions, monitoring outcomes of reintroductions, ecological health monitoring and fire management activities.
- New track routes have been selected to:
    - maximise the use of the many existing vehicle tracks, rather than clearing less disturbed land;
    - minimise disturbance to sensitive Mallee with spinifex vegetation communities (Figure 5);
    - avoid Malleefowl mounds and threatened plants;
    - use derived and disturbed vegetation in preference to less disturbed vegetation, where feasible.

A repeater antenna with a footprint of approximately 3 m^2 will be erected about 17 km ESE of the operations base, on a disturbed site that provides good coverage of the NP. The proposed site is at 142°41'2.5"E, 34°13'6.5"S (Figure 1). It will be set to a private channel and will provide staff working across the NP with a means of communication for any emergency, for scheduled safety check-ins, and for general task-related purposes. The antenna will be 20 m tall and have a small solar package and housing for the radio repeater.

4.3.2 Construction of the fence

The conservation fence is specially designed to prevent incursion of feral animals into the enclosure. The proposed fence design is a continued evolution of that constructed at AWC sanctuaries, and specifically based on that successfully implemented at Mt Gibson Wildlife Sanctuary in Western Australia. Early versions of the fence design were subject to breakages through impact by macropods. As such, the top two sections of netting that would be installed on the fence will overlap (as opposed to being 'butt-joined') to improve the strength across the join (see diagram in Appendix 3). There would be a second overlapping section extending up from the base (the area most subject to macropod impact).

The fence would be 1.8 m high, with a floppy top and two hot (electric) wires. In addition, the fence has two 'skirts' that lay flat on the ground on the inside and outside of the fence, extending 450 mm and 300 mm respectively. The bulk of the fence is constructed from netting, with 30 mm aperture on the lower section and 40 mm on the upper section. The smaller holes on the lower section are designed to prevent small rabbits entering the fenced area (see diagram in Appendix 3).

Up to eight gates will be included at strategic points (such as existing firetrails) to provide people within the proposed feral-free fenced area several options for exits in an emergency (such as a wildfire).

Upon completion of the fenceline clearing, strainer assemblies will be installed at corners. Strainers will consist of posts and rails and be designed as bases for wire tensioning. A

single plain wire will be installed at ground level to provide a sight line for the installation of pickets and intermediate posts.

Intermediate posts (posts 1.8 m above ground level, 80 mm nominal bore) will be spaced every 400 m, or where extra strength or support is required. Intermediate posts will be concreted into the ground.

Pickets (1.8 m above ground level) will be spaced every 5 m. Pickets will be installed mechanically, using a post knocker that will ram them to a depth of 600 mm. Following installation of posts and pickets, 6 horizontal plain support wires (2.5 mm diameter) will be strung, spanning the height of the fence (making a total of 7 horizontal plain wires, including the sighter wire). The plain wires will be tensioned back to the strainers, and tied off to the pickets using tie-wire.

Hot wire 'stand-offs' will then be installed. The stand-offs are 160 mm long rods that support the electric wires, and keep them clear from the body of the fence to prevent shorting out. The stand-offs will be bolted to the pickets at 1,000 mm and 1,300 mm above ground level. Insulators will be fitted later in the construction process.

Netting will then be installed. Three rolls of netting are used:

- 1,800 mm wide roll for the upper vertical section, including the 600 mm floppy top (40 mm aperture);
- 1,200 mm wide roll for the lower vertical section and external skirt (30 mm aperture);
- 900 mm wide roll for the lower section and internal skirt (30 mm aperture).

All netting will be 1.4 mm gauge.

Netting is connected to the plain support wires using 'c-clips' that are installed using pneumatic guns. At this point, lengths of 3.15 mm plain wire will be threaded in the netting that forms the floppy top to help hold its shape so that it is effective in excluding any feral animals that climb the fence. These will be installed at every picket, and two between pickets.

Electric wires will then be installed, threaded through insulators on the stand-offs, and connected to a solar-powered electric fence energiser. Two energisers will be installed at diagonally opposite sections of the fence to ensure consistent voltage is maintained around the perimeter.

The final items for installation will be gates – the proposed gates are sliding gates that will roll on tracks set into a concrete plinth. The gates will have a fixed-angle top to prevent feral incursions. All gates will be padlocked (keyed alike).

There will be minor variations in the fence design through construction to accommodate local variances in terrain (such as distance between posts and pickets).

A diagram illustrating the design for the fence is provided in Appendix 3.

4.3.3 Establishment of an operations base (housing, infrastructure, services etc.)

The proposal includes the establishment of an operations base (housing, infrastructure, services, etc.) in Mallee Cliffs NP to be constructed in accordance with the OEH Construction Assessment Procedures and the NPWS Facilities Manual and associated policies. Notably, building will primarily be modular construction (constructed offsite), and transported in and installed upon footings. All buildings will be externally clad in colourbond of shades that will be sympathetic to the natural setting. All buildings will be insulated, including floor insulation in visiting personnel accommodation.

The location of the operations base is shown in Figure 2 and the lay-out of the components is shown in Figure 4. A description of the components is provided in Appendix 3. Key elements of the base include:

- living quarters:
  - a 3-bedroom house for the Operations Manager
  - a 2-bedroom house for the Wildlife Ecologist
  - 3 self-contained cabins for the Field Ecologists and Land Management Officers
  - block accommodation with 8 single rooms for visiting personnel
  - communal living area (including kitchen and laundry)
  - communal ablutions block
- workplace facilities:
  - office for up to 8 people
  - large workshop
  - power system with solar, batteries and 20 kVA diesel generator
  - rainwater storage
  - groundwater bore, if required
  - chemical and general storage.

All buildings will be constructed in accordance with the requirements specified in the EMA: i.e. in accordance with relevant NPWS strategies (NPWS Construction Assessment Procedures, NPWS facilities manual) and the Building Code of Australia.

The footprint of the operations base is up to 11 ha, including a 75 m Asset Protection Zone (APZ). The operations base is located outside the feral predator-free area. The impacts to this 11 ha area include:

- complete removal of vegetation from approximately 1.3 ha to allow for the construction of buildings and access tracks;
- modification of vegetation in the Inner Protection Area, being the area within a 50 m radius around the operations base (6.2 ha):
  - tree canopy cover will be maintained below 10%; this will be a random sample of the trees present in this zone; and
  - shrub levels and ground cover will be maintained on the same basis and to the same extent;
- in the Outer Protection Area, being the area between the Inner Protection Zone and the boundary of the 75 m radius APZ (3.1 ha):
  - tree canopy cover will be maintained below 30%; this will also be a random sample of the trees present in this zone; and
  - shrub levels and groundcover will be reduced on the same basis and to the same extent.

The site currently has low tree and shrub cover resulting from previous disturbance of the area (see aerial image below layout diagram in Figure 4 and photographs in Figure 39 of Appendix 3). Therefore, maintaining tree and shrub cover at required levels will require little change.

The operations base will serve as both an accommodation base for AWC ecological and operational staff and visiting personnel, as well as provide the necessary associated office facilities to support the proposal and the EMA project. In addition, a workshop area will be installed and legislatively-compliant chemical and hydrocarbon storage facilities established.

The operations base will be self-supporting, using rainfall capture (supplemented by bore water if required), solar power generation supplemented with diesel generation, and gas for water and accommodation heating as well as all cooking.

4.3.4 New tracks and maintenance of existing track network

There are currently two maintained firetrails within the proposed feral predator-free fenced area. These trails, Belah Firetrail and Bulbuc Firetrail, run in parallel north to south through the centre and the east of the proposed conservation fenced area, respectively (Figure 3). These trails are maintained to the standard required by the Rural Fire Service (RFS) to support fire response vehicles.

In addition to the existing track network, new tracks are necessary to facilitate land management (particularly feral animal eradication and ongoing control), fire management and science activities within the fenced area. All proposed new track locations have been selected to minimise impacts to sensitive Mallee with spinifex vegetation communities (Figure 5), to avoid Malleefowl mounds and threatened plants, and to make as much use of existing cleared areas and previously existing tracks as possible.

The new tracks are essential to protect the Government's substantial financial investment in Mallee Cliffs and to ensure the objectives of the program are achieved. Any failure to establish and maintain these new tracks would represent a massive risk to the establishment and survival of 10 nationally threatened species. Millions of dollars of public and private funds could be wasted.

- The new tracks are required to enable effective and efficient **feral animal control**. The feral predator-free area at Mallee Cliffs will be the largest feral predator-free area on mainland Australia – i.e., removing feral predators initially from this area, and then dealing with any incursions, represents a challenge never before attempted on the mainland. The proposed network of tracks is an essential part of meeting this challenge – it provides a basis on which to track and monitor feral animal activity by providing sufficient access throughout the area; it facilitates detailed monitoring via a camera trap array and sandplots (noting the utilisation of tracks by feral cats and foxes). In addition, the tracks will allow the deployment of feral animal control measures in a very targeted way, which is essential to success given the overall size of the fenced area.
- The new tracks are also required to ensure effective **fire management** and to assist in responding to any threat from wildfire. The tracks are required to deliver controlled (prescribed) burns at an appropriate scale. They also confer a vital advantage in responding to any wildfire through greater access and strategic back-burning. In particular, the new tracks are required to help ensure that the entire feral predator-free area is not burnt in a single wildfire event: the new tracks dramatically reduce this risk.
- The new tracks will ensure delivery of a **world-class ecological health monitoring framework** by facilitating access across the fenced area for monitoring (including live animal trapping) in a way that would otherwise be impracticable. The results obtained by this monitoring are essential to ensure the ongoing viability of the threatened mammals. The results will also provide invaluable information for land management and threatened species conservation more broadly. Accordingly, failure to establish the new tracks would significantly limit the ability of the Government to capture one of the key benefits of the project – scientific knowledge.

The essential need for the new tracks needs to be considered in the context of the area to be disturbed – the vast majority of the area to be disturbed is already heavily degraded by weeds and utilises a network of pre-existing minor tracks (i.e., the areas have already been disturbed). The potential environmental impact of the new tracks is therefore very limited. All sensitive areas have been avoided.

The additional tracks include:

- An additional firetrail perpendicular to the existing firetrails through the centre of the proposed fenced area (see red track in Figure 3). This firetrail will consist of a cleared and graded track 6 m in width. This width complies with the RFS guidelines and the NPWS fire management strategy for a firetrail to support access by category 3 and 4 fire tankers. This additional firetrail will improve access within the Mallee Cliffs NP and will be engineered to carry a higher traffic capacity, which will reduce traffic loads on minor tracks.
- The establishment of a network of minor tracks within the proposed fenced area (Figure 3Figure 5). Part of this network will make use of pre-existing minor tracks (see dark green tracks, Figure 3). All minor tracks will be cleared roads to 4 m in width and maintained to support access by light four-wheel drive vehicles (such as standard Toyota Landcruisers, all-terrain vehicles, etc.).
- AWC has identified an alternate access route to the Mallee Cliffs Operations base and fenced area. The traditional access to Mallee Cliffs NP via Dansons Road is not currently available. If this access cannot be regained, an alternate access road to Mallee Cliffs will be required.

All tracks have had a flora and vegetation survey completed, and all tracks will avoid non-permanent water sources such as clay pans to minimise any potential risk to indigenous heritage sites. AWC notes that whilst no indigenous heritage sites were identified, the likely sites of indigenous heritage would be adjacent to non-permanent water sources.

4.3.5 Eradication of feral predators and herbivores from proposed feral-free fenced area

The eradication within the proposed fenced area will be delivered through intensive feral animal control programs informed by a comprehensive monitoring program. The feral animals known to be in the area are: cats, foxes, wild dogs, goats, pigs, rabbits and hares.

All feral animal control will be conducted in accordance with standard operating procedures (SOPs) developed by the Invasive Animal CRC; with the NPWS Vertebrate Pest Control Manual; and with OEH SOPs. Shooting (opportunistic or planned) will be conducted in accordance with approved shoot plans and carried out by authorised personnel.

Phase 1

A monitoring program will be implemented, consisting of remote camera traps (up to 60) deployed in an array throughout the proposed fenced area, and sand plots on tracks. Eradication effort and impact will be logged and, together with the data from the monitoring program, the results will be used to refine the eradication program.

All water storage tanks within the fenced area have been closed, and these will be checked regularly to ensure they remain so. Before the gates of the fenced area are closed, fodder may be provided in strategic locations outside the fence to attract as many animals away from the fence as possible.

The initial program to be implemented will be the control of rabbits. Rabbits are a food source for cats and foxes. Removal of this food source will ensure that feral predators are more likely to be interested in baits and attractants. AWC uses an array of techniques to eradicate rabbits. AWC will assess the best practice to achieve the required outcome with minimal impact to the local environment. Immediately prior to the fence being closed, rabbit baiting will commence – using Pindone and/or 1080 treated oats and carrots. Rabbit haemorrhagic disease (and subsequent variations of rabbit biological control agents) will be used where conditions at the time of eradication permit. Should warren use be determined to be an issue in reducing rabbit numbers, methods including the use of Phostoxin or warren

ripping will be applied. Any warren ripping would be restricted to a single tyne style. Warrens within the conservation fence area will be preserved where possible, as the Burrowing Bettongs to be reintroduced may adopt any existing warrens. Control of rabbits will be conducted until the rabbit numbers are at ecologically insignificant numbers, where ecologically insignificant means that numbers are so low that AWC believes their impacts are unlikely to be significant. AWC has achieved this at other sanctuaries, evidenced by successful mammal reintroductions into feral predator-free fenced areas, even though experience has shown it is rarely possible to completely eradicate rabbits. AWC has developed a draft Ecological Health Monitoring Framework (EHMF, see Appendix 12) which will provide an ongoing means of assessing rabbit activity (number of records per monitoring site) and occupancy (proportion of sites with records) which are indicators of rabbit density.

Phase 2

Once the fence is at 'lock-up' stage, intensive control of feral predators and herbivores will be conducted. The tactical deployment of eradication effort and tools will be modified in response to the information generated by the monitoring program. Typically, the eradication tools will include:

- ongoing regular spotlighting patrols: these patrols will be used for opportunistic shooting of feral herbivores and predators;
- deployment of soft-jaw traps for feral cats, foxes and rabbits;
- deployment of cage traps, using a variety of attractants to bring feral animals into the traps;
- deployment of Canid Pest Ejectors (CPEs) throughout the fenced area, using a variety of attractants;
- pending activity records of feral herbivores, water and fodder points may be established inside the fenced area to attract feral herbivores to allow more efficient removal;
- traps – using 1080 treated grains or manufactured baits – will be deployed for feral pigs, pending numbers recorded through the activity monitoring;
- use of cat-detection dogs;
- use of cat trackers;
- deployment of Eradicat (subject to permit approval).

Shooting (opportunistic or planned) will be conducted under shoot plans approved by NPWS and carried out by authorised personnel. Feral animal control programs will be consistent with the NPWS Vertebrate Pest Control Manual, Invasive Animal CRC SOPs and OEH standard operating procedures.

Verification of Feral Predator-Free Status

The proposed fenced area will be monitored using remote camera arrays (at least 1 camera per 150 ha) and sand plots. Verification of feral predator-free status will be determined through assessing activity of feral animals over time. Where there has been no activity detected on camera or on sand plots for 2-3 months, an 'interim feral-free status' will be declared. To ensure all feral predators have been removed, intensive monitoring will continue for a further 2-3 months post 'interim feral-free status', after which the area will be declared 'feral predator-free'. Subject to the results of the monitoring, initial reintroductions may be conducted before the conclusion of the 4-6 month monitoring period, with released animals monitored intensively for survival.

Once declared feral-free, regular monitoring for the presence of feral predators and herbivores will continue inside the fence (using remote camera traps and sand plots on tracks) to ensure any incursions are detected.

The objective in relation to rabbit control is to reduce rabbit numbers to ecologically insignificant levels that do not impede the reintroductions, i.e. the proposal does not require complete eradication of rabbits although that will be achieved if feasible.

4.3.6 Removal of large macropods and Emus from fenced area

Large macropods (Red Kangaroo, Eastern Grey Kangaroo, Western Grey Kangaroo and possibly Common Wallaroo) and Emus within the fenced area would be a potential risk to the fence and could reduce the prospect of success for the reintroductions by impacting on vegetation (i.e. removing cover and food for reintroduced mammals). Accordingly, AWC will aim to remove large macropods and Emus from within the proposed fenced area through non-lethal measures. Lethal measures will only be considered should populations over a threshold persist. It is estimated that the total number of macropods to be removed are as follows:

- Red Kangaroo: about 375 individuals
- Eastern Grey Kangaroo: about 125 individuals
- Western Grey Kangaroo: about 725 individuals
- Common Wallaroo: not detected
- Emu: about 10 to 20 individuals.

Phase 1

All water storage tanks within the fenced area have been closed, and these will be checked regularly to ensure they remain so. Whilst not specifically targeted at the removal of macropods and Emus, the increase in the level of activity in the area during the fence building would encourage some macropods and Emus to relocate.

Phase 2

Upon completion of the fence, traps (in the form of small compounds) would be established just inside the gates using water and fodder as attractants. The aim will be to draw the animals into a compound near a gate in the fence, then release the macropods outside the fenced area. This method has proved successful at other feral predator-free fenced area projects delivered by AWC, such as Mt Gibson in Western Australia where macropods and Emus were removed from across nearly 8,000 ha.

Phase 3

If any macropods remain in the fenced area after Phase 2, AWC will anaesthetise remaining animals by darting with non-lethal drugs. Anaesthetised animals will be relocated outside the fenced area.

Phase 4

AWC expects to remove all large macropods using non-lethal measures. However, if any remaining macropods cannot be removed using non-lethal measures, AWC will consider seeking a permit to remove remaining macropods under a Landholder's licence. Any such activity will then be implemented in accordance with the '*National code of practice for the humane shooting of kangaroos and wallabies for non-commercial purposes*'. Should an 'Application to harm' permit not be granted, AWC will attempt to manage populations through the continued usage of non-lethal drugs and trapping using methods detailed above.

4.3.7 Changes in feral predator control

AWC feral predator control priorities

The red fox (*Vulpes vulpes*) and feral cat (*Felis catus*) have contributed to declines and extinctions in a wide range of native fauna, and are the primary causes of decline in small and medium-sized ground-dwelling mammals, semi-arboreal mammals and ground-nesting birds (Woinarski et al. 2014). Foxes and cats are now widespread across the continent and occur in the proposal area. The impacts of red foxes on native fauna can be reduced, to an extent, through coordinated and intensive control methods including, baiting, trapping and poisoning, although permanent eradication of foxes at a landscape scale is not possible. There are currently no effective measures for ongoing landscape control of feral cats.

Predation by the red fox was the first *key threatening process* listed under the BC Act. As such, elimination of the red fox was listed as a priority in the NSW 2010 Threat Abatement Plan (TAP). Mallee Cliffs is listed in the TAP as a priority national park for fox control due to the risk of fox predation on threatened species, including Malleefowl, Chestnut Quail-thrush and Southern Scrub-robin. This listing requires that fox control must continue within Mallee Cliffs NP.

The main priority for AWC predator control is to eradicate/reduce feral predators within the Mallee Cliffs NP with the dual purpose of:

- reducing predation pressures on the native fauna currently inhabiting the EMA project area; and
- eradicating cats and foxes from the proposed feral predator-free fenced area prior to release of reintroduced mammals.

AWC aims to do this through developing and implementing an integrated strategy for feral cat and fox control. The feral cat control strategy will be new (there is no existing feral cat control strategy) while the fox strategy will be a modified version of the fox strategy employed to date by NPWS. The strategy will include comprehensive monitoring programs to measure cat and fox activity (number of records per monitoring site) and occupancy (proportion of sites with records).

Plans for controlling other exotic animals such as pigs, goats and rabbits will be developed and implemented in parallel.

NPWS history of predator control in Mallee Cliffs NP

Fox control measures in Mallee Cliffs NP have consisted of a combination of buried ground baits and CPEs.

Permanent ground bait stations were set at 115 sites at 1.5 km intervals along the main road and firetrail network in the Mallee Cliffs NP (Table 6, Figure 6). Baits are buried in the ground to a minimum depth of 10 cm, the locations of which are indicated by a star picket with a green cattle ear-tag on top. Baits are set four times a year in February, May, August and November. The baits are checked and replaced for three consecutive days during each baiting session, then removed and disposed of. Previously, fox bait take was recorded and entered into the Pest and Weed Information System (PWIS) to indicate the likely effectiveness of the baiting program. This monitoring method was replaced by the use of camera traps just before AWC began pest management as part of the EMA project.

Also, 112 permanent CPE stations were set at 1.5 km intervals along the road and firetrail network in the Mallee Cliffs NP, alternating with the placement of buried baits (Table 6, Figure 6). Ejectors had a dried meat lure with a 1080 capsule. Since 2013, the CPEs have been set continually. Ejector activation was checked and the ejectors reset every six to eight weeks. Both the number of ejectors triggered and the number not triggered were entered into the PWIS to determine the likely effectiveness of the CPE program.

Table 6: Predator control methods and effort implemented historically on Mallee Cliffs NP by National Parks and Wildlife Service (NPWS) and the proposed minimum effort to be implemented by Australian Wildlife Conservancy (AWC)

	Fox control				Cat control	
	Length of baiting run	CPE stations	Ground bait stations	Planned and opportunistic shooting	Cage trapping	Planned and opportunistic shooting
NPWS	179.6 km	112	115	None	None	None
AWC	219.2 km	139	142	Yes	>200	Yes

Assessment of predator abundance

The densities of cats and foxes in Mallee Cliffs NP have yet to be robustly quantified. In late 2016 and early 2017, AWC conducted initial surveys to assess the baseline abundance of cats and foxes in the EMA project area.

Activities of cats and foxes (i.e. number of records per site) were recorded using an intensive camera trap survey. In late 2016, motion cameras were deployed at 1.5 km intervals along roads (n=66) and at each of 50 fauna monitoring sites (that is, 116 camera trap sites in total, see Section 5.8.2 for site details). In the early 2017 survey, there were four additional fauna monitoring sites and so there were 62 cameras along roads and 54 at fauna monitoring sites. Cameras were programmed to take three images per trigger, with a five-minute delay between triggers. Each camera was attached to a star picket or other suitable structure at 50 cm above ground level; a lure tube containing a chicken neck was placed in front of the camera to attract predators.

Both species were frequently detected. In the 2017 survey, in the 62 cameras along roads, foxes were detected in 53 and cats in 16. Spotlighting surveys conducted by AWC in 2016 estimated cat density at 0.3 individuals/km^2 and fox density at 1.1 individuals/km^2. However, spotlighting generally underestimates densities of foxes and cats, often by a large margin (Read and Eldridge 2010; McGregor et al. 2015). That is, the spotlight data place a lower bound on likely densities.

The results from the baseline survey indicated that despite previous baiting efforts a high number of both cats and foxes remains throughout Mallee Cliffs NP.

AWC proposed predator control

The results of the baseline survey of cats and foxes throughout the project area indicated that the previous fox strategy needs to be modified and that specific measures are required to target feral cats. Once the proposed fenced area is declared feral-predator free (Section 4.3.4), programmed control activities inside the fence will end. However, regular monitoring for the presence of feral predators and herbivores will continue inside the fence (using remote camera traps and sand plots on tracks) to ensure any incursions are detected. If a feral predator incursion was detected, intensive control measures would be reinstated until the area was again declared feral predator-free.

All feral animal control will be conducted in accordance with standard operating procedures (SOPs) developed by the Invasive Animal CRC; with the NPWS Vertebrate Pest Control Manual; and with OEH SOPs. Shooting (opportunistic or planned) will be conducted under shoot plans approved by NPWS and carried out by authorised personnel.

Red foxes

The NPWS baiting run through Mallee Cliffs has been extended to include the perimeter of the entire Mallee Cliffs NP and additional roads within the proposed feral predator-free fenced area (Figure 6). This will create an intensively baited core area (fenced area) with a buffer throughout the remainder of the Mallee Cliffs NP. This extended effort is vital not only for the viability of the reintroduced mammals but for protecting the native fauna currently subject to fox predation within Mallee Cliffs NP.

In addition to extending the length of the baiting run, the number of bait stations will be increased and will consist of a combination of buried ground baits and CPEs. Foxes rapidly fill home ranges vacated in areas where control operations succeed in killing resident individuals (Newsome et al. 2014). The oral delivery of baits using CPEs reduces the risk of impacts on non-target species and eliminates caching of baits. CPEs have low rates of decomposition remaining viable for an extended period of time (Marks et al. 2017), ensuring consistent bait exposure throughout the year. By extending the baiting run to cover the entire perimeter of the Mallee Cliffs NP, AWC aims to reduce immigration of foxes.

The CPEs will be augmented by ground baiting to intensify the control effort during times of seasonal fox increases. They will be deployed during autumn when juveniles disperse (Thomson et al. 2000) and spring when vixens increase foraging (Towerton et al. 2016). To reduce the risk to non-target species, ground baits will be buried a minimum of 10 cm below ground level. Research has shown that burying baits underground with no dirt mound above reduces bait take by non-target animals (Glen and Dickman 2003). Star pickets with colour-coded, numbered cattle tags will be used to indicate locations of both types of bait stations.

All 1080 baiting would be undertaken in accordance with the requirements of the relevant Pesticide Control Order (Pesticide Control (1080 Ejector Capsules) Order 2015 or Pesticide Control (1080 Bait Products) Order 2017). Baiting strategies will be designed with reference to the current Vertebrate Pest Control Manual and will take into consideration risk management for non-target species and OEH SOPs.

In addition to deploying CPEs, traps (soft jaw and cage traps) will be used.

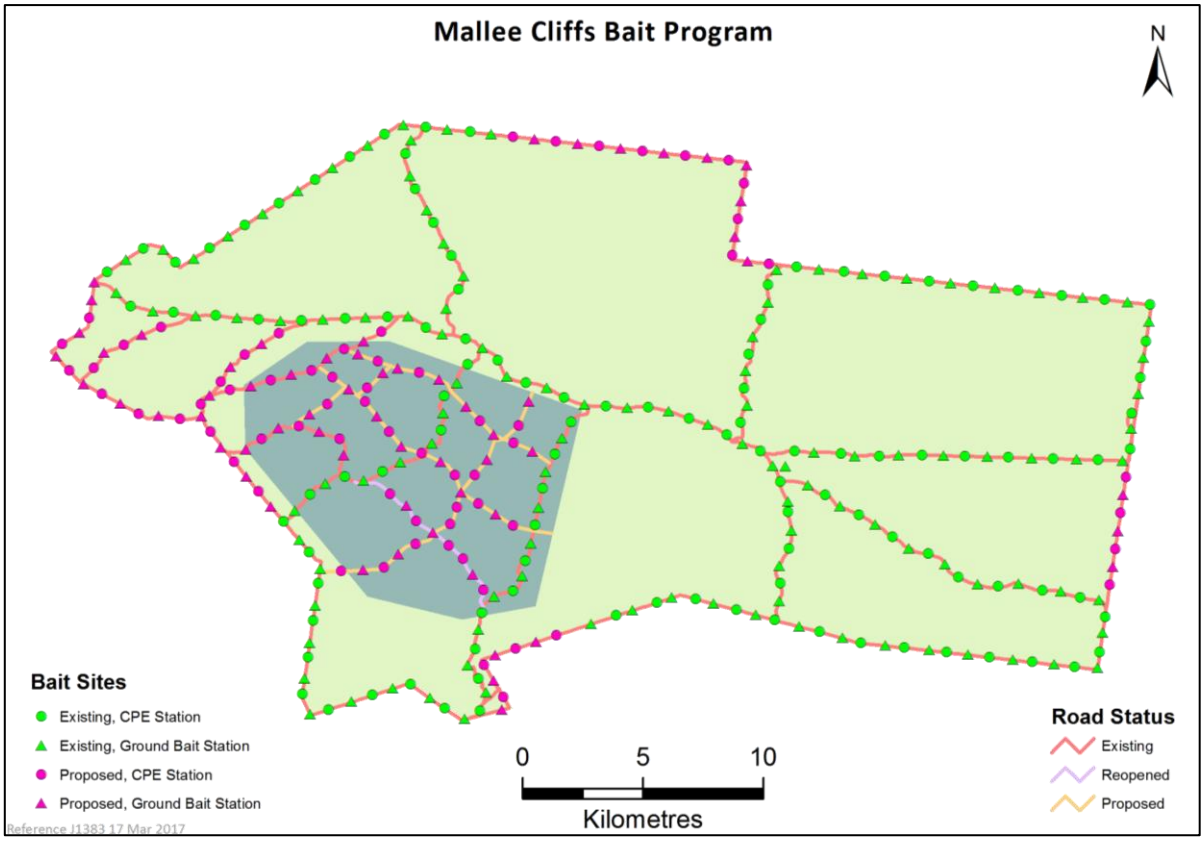


Figure 6: The modified AWC baiting run in the Mallee Cliffs NP. The original NPWS baiting run (green) will be extended (pink) to ensure the entire perimeter is treated

Feral cats

AWC would implement feral cat control using a combination of opportunistic shooting, coordinated shooting and trapping and, possibly, the deployment of Eradicat (subject to permit approval).

Baseline camera surveys resulted in a higher number of cats captured on road-based cameras than on cameras away from roads, so trapping would be conducted along the road network in the Mallee Cliffs NP. Cage traps will be placed along the roads approximately 700 m apart and deployed biannually in autumn and spring for a two-week period with a variety of lures used. Traps will be checked daily within an hour of sunrise and trained staff would euthanase captured cats. Shooting will be conducted on site by licensed employees.

AWC will also consider the use of cat-detection dogs or cat-trackers within the proposed feral-free fenced area as an aid to the eradication of cats within it.

4.3.8 Strategic fire management to protect infrastructure

The protection of life and property, including assets, is a legislative requirement and the primary fire management objective of the OEH. OEH's asset protection obligations extend to all assets and activities on-park as well as off-park.

The OEH has a responsibility for assets owned by the OEH, or assets on land owned by the OEH and leased to a third party. The OEH also has a role in managing the risk to assets off-park if they are threatened by fire emanating from a park.

The OEH has overall responsibility for the delivery of fire management across the Mallee Cliffs NP. AWC has a role in assisting in the design and delivery of fire management. Fire management will accord with the NPWS Fire Management Manual.

Fire is an integral component in the ecology of Mallee systems. The Mallee regions of north-western Victoria, eastern South Australia and south-western New South Wales have experienced several major large-scale wildfires over the past few decades. These fires have homogenised the habitat age in many Mallee reserves; recent fires in South Australia and Victoria have led to declines in occurrences of iconic species such as the Mallee Emu-wren and the Black-eared Miner. In this regard, Mallee Cliffs is a major ecological asset in the region as it has remained largely unburnt following major fires in 1975.

Large areas of long-unburnt Mallee are important habitat for the endangered Malleefowl and are associated with higher bird species richness and abundance than younger successional stages and smaller unburnt areas (Berry et al. 2015). However, a number of species such as the Desert Skink are associated with early successional stages and will decline as time-since-fire increases (Nimmo et al. 2013). Furthermore, the occurrence of fire outside of certain fire intervals may see a decline in plant species diversity and may have flow-on consequences for ecological health across the reserve. Achieving desirable levels of fuel reduction, fire containment and suppression to limit the extent of large conflagrations is a key objective of fire management planning at Mallee Cliffs.

NPWS history of fire management in the Mallee Cliffs NP

At present, the area of the proposal does not support any infrastructure identified for fire protection. The proposal area does not possess any designated Asset Protection Zones (APZs) or Strategic Fire Advantage Zones (SFAZs). Current NPWS fire plans for the park focus on fuel reduction and ecological burns, principally to protect (i.e. exclude fire from) older-aged Mallee with spinifex that appears to be preferred habitat for Malleefowl and a number of other threatened species. Such burns have been restricted in space and time to relatively few, strategically-located, small-area burns mainly within the southern part of the park.

To protect the infrastructure associated with the proposal, existing NPWS fire management plans for the Mallee Cliffs NP would require to be reviewed.

To reduce the risk of wildfire affecting infrastructure, AWC proposes that a range of fuel management approaches be implemented using both prescribed burning and mechanical fuel alteration within two types of fire management zones:

- the establishment of a long-term 75 m APZ around the operations base (Figure 7) to reduce fuel loads and thus minimise fire risk to the people stationed there;
- to reduce the risk of fire to the integrity of the feral predator-proof fence, a 200 m wide SFAZ would be established around the fence perimeter (Figure 7).

These fire management measures need to be considered in the context of broader regional fire management strategies implemented by OEH and other landholders, which collectively influence the level of bushfire risk across the region and the effectiveness of any site-based measures.

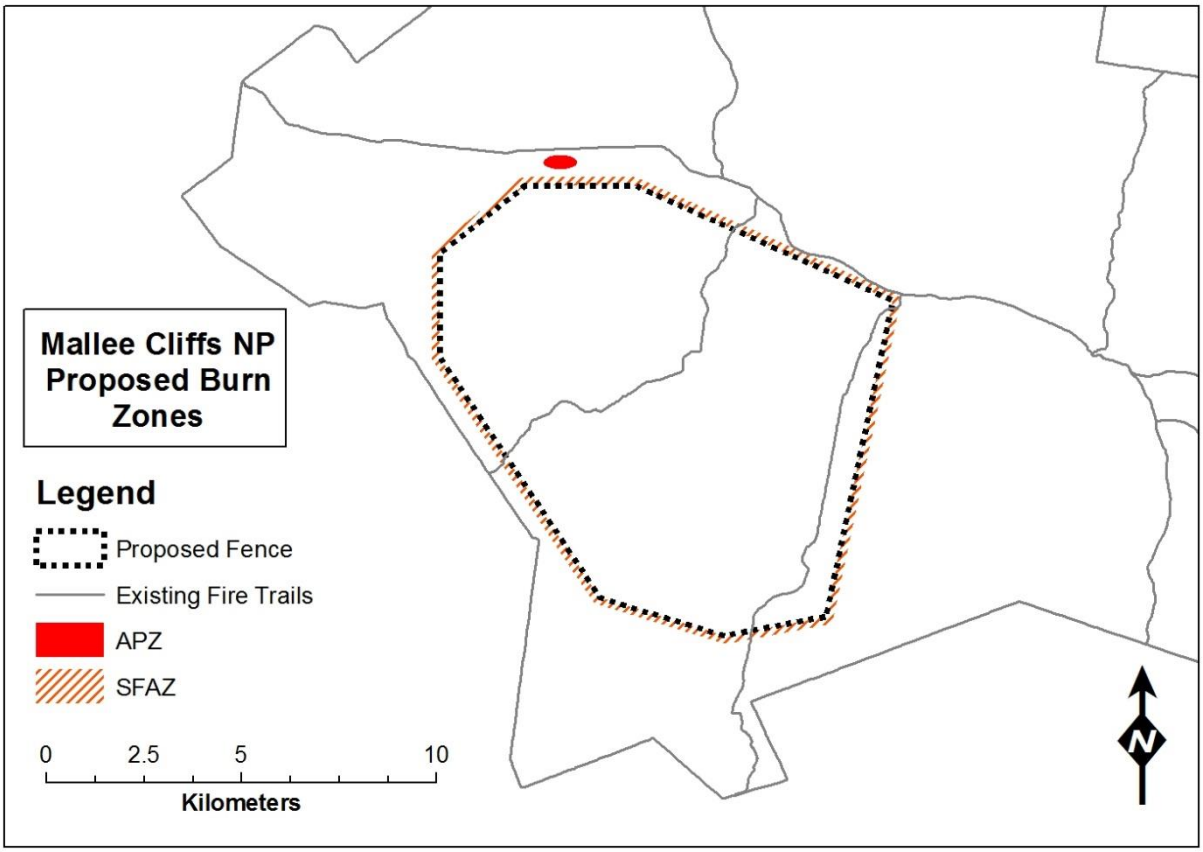


Figure 7: Locations of proposed fire management zones around the feral predator-free fence and the operations base

Asset Protection Zones

The primary purpose of an APZ is to protect life and built assets. The suppression objectives of an APZ are to enable the safe use of direct attack suppression strategies within the zone and to minimise bushfire impacts on undefended assets.

It is proposed that a 75 m APZ be maintained around each building within the proposed operations base. This APZ will comprise an 'inner area' of 50 m (see the RFS document 'Planning for Bushfire Protection') and an 'outer area' of 25 m. These distances are consistent with those recommended in the RFS guidelines.

Fuel reduction within the APZ will be conducted by AWC using mechanical approaches with prescribed burns restricted to the 'outer zone'. The entire extent of the APZ will be managed to minimise surface fuel cover including reducing the cover of woody debris and shrubs. Canopy cover in the inner zone will be maintained below 10% and in the outer zone below 30%. Fuel loads will be managed on a yearly cycle.

Strategic Fire Advantage Zones

The purpose of SFAZs is to provide strategic areas of fire protection advantage which will reduce the speed and intensity of bushfires and aid fire-fighting and containment efforts. In particular, SFAZs aid direct containment efforts during bushfires and also provide designated areas where indirect attack methods such as back-burning can be conducted.

Reduction of fuels within the SFAZ can be achieved using both prescribed burning to reduce surface fuel loads and continuity, and the mechanical removal of ground debris, shrubs and sub-canopy trees to interrupt fuel continuity.

AWC propose the establishment of an SFAZ around the outside perimeter of the feral predator-proof fence. Fuel reduction within the SFAZ will aim to reduce the overall fuel hazard to below the rating of 'high' (the target for an SFAZ) with the intention of reducing the risk of crown fire within the zone and to reduce the potential of spot-fire ignition from the zone. Fuel reduction burns will be conducted, under the management of OEH, within this SFAZ to maintain the fuel hazard to below 'high'. Additional mechanical fuel treatments would be applied by AWC on shorter rotations to further disrupt ground fuel continuity. Canopy cover in the SFAZ may need to be reduced to achieve low crown connectivity.

4.3.9 Post-approval monitoring

AWC has developed a detailed draft Ecological Health Monitoring Framework (EHMF) for Mallee Cliffs NP (Appendix 12). Under this draft EHMF, AWC ecologists will undertake regular biological surveys to measure a suite of indicators at sites both inside and outside the feral predator-proof fence. Indicators are selected to monitor trends in:

- biodiversity indicators (species such as Malleefowl, etc.);
- threat indicators; and
- indicators related to ecological processes.

The objectives of this monitoring program include to: (a) track the ecological health of Mallee Cliffs NP over time; (b) monitor the success of endangered mammal reintroductions; and (c) measure the changes in ecological health that occur as a result of the removal of feral animals and the reintroduction of threatened mammals. The last will allow AWC to evaluate the outcomes of the reintroduction project for extant species and ecosystems at sites both inside and outside the fence.

The total **annual** survey effort under the draft EHMF, prior to the release of regionally extinct mammals, in Mallee Cliffs NP would be as follows:

- 1,856 pitfall trap nights: 58 sites, 8 traps per site, 4 nights
- 4,640 Elliot trap nights: 58 sites, 20 traps per site, 4 nights
- 2,784 funnel trap nights: 58 sites, 12 traps per site, 4 nights
- 928 cage trap nights: 58 sites, 4 traps per site, 4 nights
- 3,360 camera trap nights: 120 sites (58 off-road, 62 on-road), 14 nights, twice yearly
- 48 nest-box sites (24 sites, 2 boxes per site)
- 174 bird surveys (standard 2 ha, 20 minute; and Songmeter) (58 sites, 3 replicates)
- 160 bat survey nights (Songmeter) (20 sites, 4 nights), twice yearly
- 160 vehicle spotlight surveys (8 transects of 10 km, 2 repeats)
- 58 surveys of habitat and ecological processes
- 32 vegetation surveys (16 inside fence, 16 outside fence)
- Other surveys will include targeted searches for frogs, Malleefowl and threatened plants, and potentially camera grids for estimating density of feral predators.

Once animals are reintroduced to the feral predator-free area, the level of effort will increase substantially to monitor their survival, population dynamics and other relevant metrics: these additional survey requirements will be identified as part of the Translocation Proposal process.

The details of the draft EHMF may be modified once reviewed by the OEH, but the draft plans for the EMA projects at Mallee Cliffs NP and the Pilliga involve the most extensive and comprehensive long-term biodiversity monitoring programs ever carried out in a NSW national park (a literature review has failed to identify any other biological monitoring program in a NSW NP that is as extensive and comprehensive). The Mallee Cliffs EHMF

will provide a scientifically rigorous mechanism for monitoring the impacts of the project and identifying any adjustments that are required to project delivery over time.

A stratified, random, spatially-blocked sampling design was selected as the primary approach to locating biodiversity monitoring sites as part of the draft EHMF. To achieve the objective of broad geographical sampling within the park, we grouped our survey sites into four sets of 14 replicates in each of which five replicates were located inside the proposed conservation fence and nine outside of the fence (total 56 sites). Each set of replicates sampled the four main vegetation types present in the park. Two additional sites were located within an extensive block of Mallee with spinifex habitat, bringing the total to 58 survey sites in the Mallee Cliffs NP (Figure 8). Sites were separated by a minimum of 2 km to ensure spatial independence for most species.

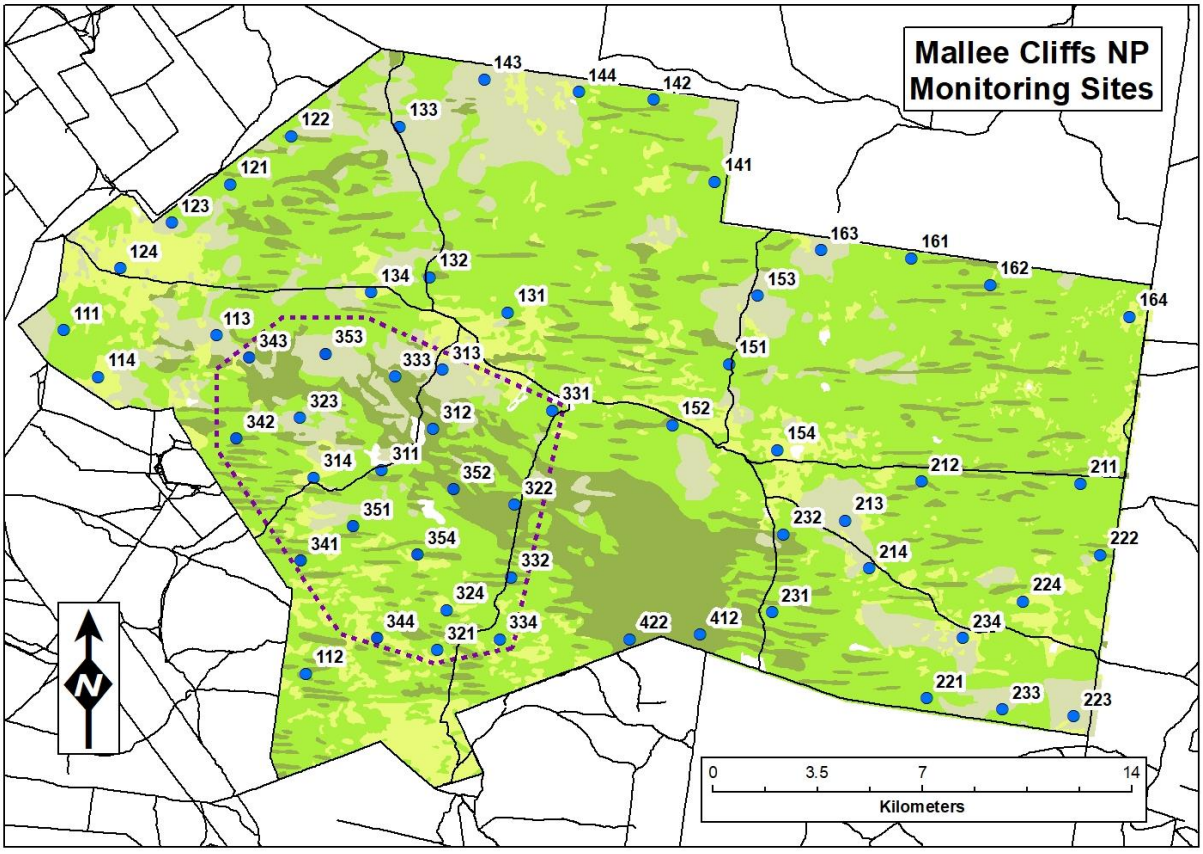


Figure 8: Distribution of the 58 biodiversity monitoring sites in Mallee Cliffs National Park.

4.4 REINTRODUCTION OF TEN THREATENED MAMMAL SPECIES

The reintroduction of ten threatened mammal species will occur between March 2019 (earlier if possible) and April 2021.

Detailed assessment and planning for these translocations will occur as part of the Translocation Proposal, as required under the Extinct Mammals Agreement. This REF will address the general impacts associated with reintroducing the threatened mammals (including impacts on resident species and vegetation).

The Translocation Proposal will require approval by the OEH and would include the detail of any licensing required for the reintroductions.

This section provides a summary of the mammals to be reintroduced as part of the proposal.

4.4.1 Western Quoll

Conservation status

NSW: Presumed Extinct; EPBC: Vulnerable

Distribution

Pre-European: All of southern and central Australia, from WA through to the western slopes of the Great Dividing Range (Figure 9). Around 70% of the continent. Last record from NSW was in 1857, when it was collected in the Blandowski expedition to the Murray River – the base camp for the expedition was at Gol, near Mildura (Krefft 1866).

Current: remnant populations restricted to south-west WA (Figure 9). There is currently an attempt to reintroduce Western Quolls to the Flinders Ranges, SA. The Western Quoll persisted in central Australia to the mid 20th century (Burbidge et al. 1988).

Ecology (overview)

- Size: 0.9-1.3 kg
- Diet: small vertebrates, invertebrates, carrion, fruit
- Breeding: annual, 2-6 young
- Average lifespan in wild: up to 3 years
- Nocturnal
- Terrestrial / arboreal
- Dens in hollow trees, rocky areas, burrows

As a mid-sized native predator, the Western Quoll may play a role in the regulation of populations of prey species.

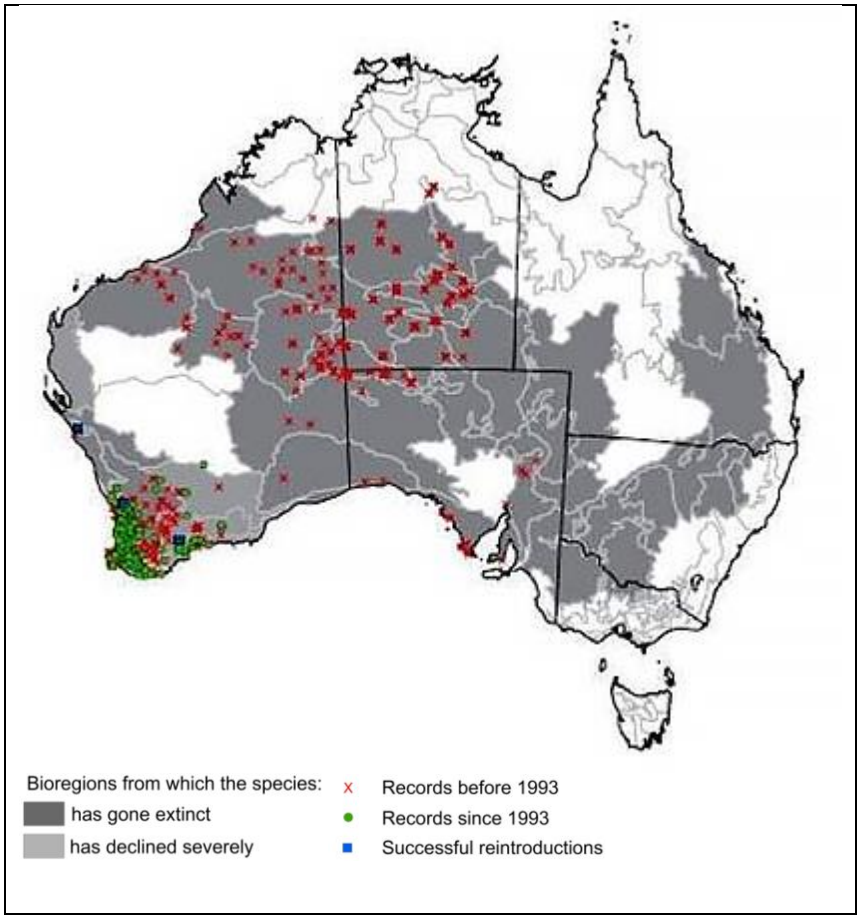


Figure 9: Western Quoll distribution (from Mammal Action Plan, Woinarski et al. 2014)

Major threats (Mammal Action Plan)

- Foxes: severe, entire
- Cats: the Mammal Action Plan notes the actual impact of cats is unknown: cats have been significant predators of Western Quolls in a recent reintroduction to Flinders Ranges, SA

Habitat preferences

Habitat generalist. At European settlement, the Western Quoll occupied a wide range of habitats from forests and woodlands to desert; Krefft (1866) refers to it inhabiting the “Murray scrubs”. Its current distribution in WA includes “most kinds of wooded habitat including eucalypt forest, dry woodland and mallee shrublands”. In south-west WA, before the implementation of broadscale fox baiting, the Western Quoll was mostly restricted to dense riparian vegetation; after fox baiting, the species has expanded into more open forest types. In central Australia, the Western Quoll occupied “all types of country” (Burbidge et al. 1988, Parker 1973, Finlayson 1961).

Population density

In south-west WA, density varies with predator control (by up to an order of magnitude (Woinarski et al. 2014) and with rainfall: reported densities range from 0.0004-0.007 individuals/ha (Rayner et al. 2012), the lowest at low rainfall sites not subject to feral predator control. Densities in higher rainfall locations subject to predator control (but not exclusion) are reported to range from 0.003-0.007 individuals/ha. Female core home range

reported as 90-200 ha, suggesting female density of 0.005-0.01/ha in locations where feral predators are controlled and habitat suitable. In the NT, quolls were reported to be 'plentiful' in the southern Tanami. The species was considered 'generally abundant' across its former range (DEC 2012) with numerous historical records of 'hyperabundant' populations (Peacock and Abbott 2014). The ecologically similar Eastern Quoll attains much higher densities in Tasmania (0.01-0.06/ha, in places up to 0.4/ha), albeit in more productive environments than generally present at Mallee Cliffs.

Reintroduction history

Six reintroductions of Western Quolls have been conducted to mainland sites in Western Australia, in conjunction with broadscale fox control. Three of these reintroductions are reported to have been successful. Since 2014, a reintroduction of Western Quolls to the Flinders Ranges, South Australia, has been attempted in conjunction with a program of intensive control of feral predators. Cats (mostly large male cats) have been responsible for most known mortalities.

Expected population size within fenced area

Predicted population size is challenging to estimate given large variation in density estimates. The population size within a 9,570 ha enclosure is estimated to be around 90 animals (c. 0.01/ha). This estimate may be conservative, given historical records of the abundance of the Western Quoll in southern Australia (Peacock and Abbott 2014).

Individual quolls may be able to disperse from the inside to outside the fence. However, given the large area inside the fence relative to quoll home ranges, it is expected that a population will remain within the fenced area. The species may build a population outside the fenced areas in conjunction with intensive feral predator control, such that the total population sizes will be larger than the fenced area alone. Population densities outside the fence, assuming intensive feral predator control, are predicted to be 0.007/ha at Mallee Cliffs, so the potential population size outside the fence would be 350.

Prospects for release outside fenced area

Moderate-high chance of success, when coupled with successful intensive broadscale predator control. Populations have persisted at low densities on the mainland in south-west WA in the presence of cats and foxes. Following broadscale fox baiting, populations have increased in abundance and in the range of habitats used. Three of six translocation attempts to non-fenced areas in WA are reported to be successful to date. The recent reintroduction of quolls to the Flinders Ranges has suffered heavy losses to cats; it is too early to determine the success of that project.

AWC experience with species

The Western Quoll is resident on AWC's Paruna sanctuary, with one or two records from AWC's Karakamia and Mt Gibson sanctuaries, in south-west WA. Camera traps are used to monitor the population on Paruna. AWC plans to reintroduce Western Quolls to a fenced feral predator-free area on Mt Gibson and outside the fence in conjunction with feral predator control.

Likely source populations

Captive-bred animals (from Perth Zoo) were used to stock the three successful WA reintroductions. However, the recent reintroduction to SA was sourced mostly from wild populations in WA, supplemented by a few captive-bred animals from Alice Springs Desert Park. AWC's reintroduction to Mt Gibson plans to source animals from wild populations in

WA, providing sufficient numbers are available, supplemented with captive-bred animals if required.

For this project, AWC intends to source Western Quolls from a number of wild populations in WA, supplemented with captive-bred animals if required. The intention would be to maximise the genetic diversity of the reintroduced population.

4.4.2 Red-tailed Phascogale

Conservation status

NSW: Extinct; EPBC: Vulnerable

Distribution

Pre-European: south-west WA, north as far as Cape Range and into the deserts of western and central Australia, through to western NSW and South Australia (Figure 10). Last record from NSW was in 1857, when specimens were collected from Gol Gol by the Blandowski expedition (Krefft 1866).

Current: Restricted to the wheatbelt of south-west WA (Figure 10).

Ecology (overview)

- Size: 40-70 g
- Diet: invertebrates, small vertebrates
- Breeding: annual, up to 8 young
- Average lifespan in wild: males 1 year, females 1-2 years
- Nocturnal
- Terrestrial / arboreal
- Dens in hollow trees, logs, skirts of grass trees

Major threats (Mammal Action Plan)

- Foxes: minor-moderate, entire
- Cats: severe, entire
- Habitat loss: severe, entire
- Climate change: severe, entire
- Inappropriate fire regimes: moderate, entire

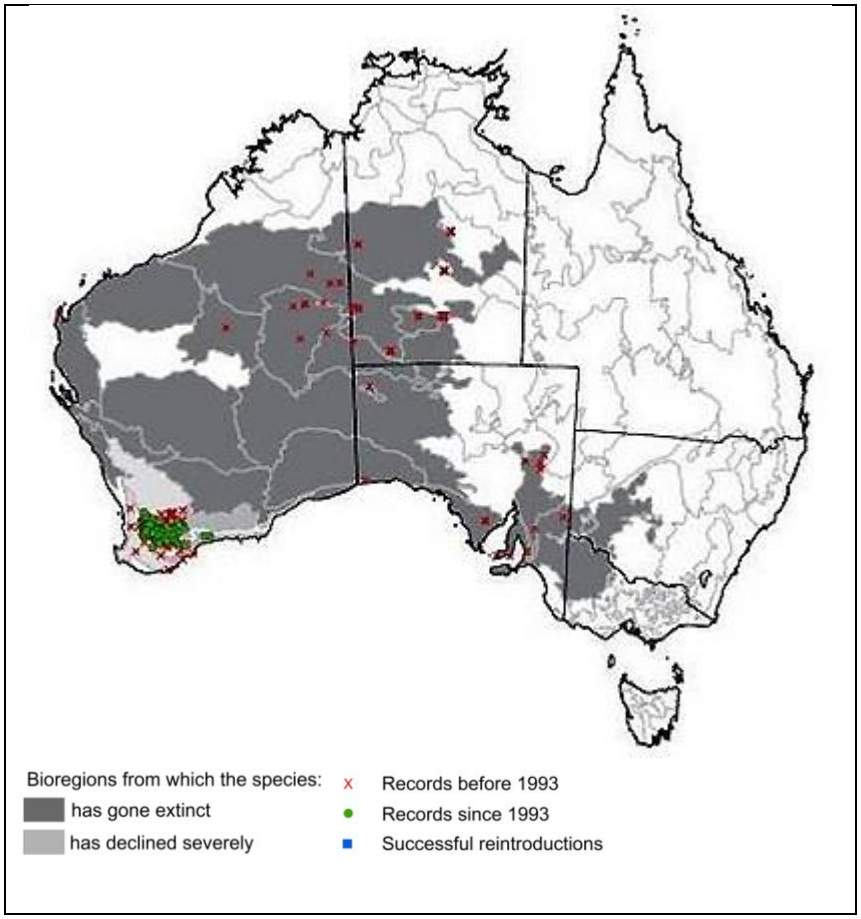


Figure 10: Red-tailed Phascogale distribution (from Mammal Action Plan, Woinarski et al. 2014)

Habitat preferences

Relative habitat generalist over pre-European range: forests and woodlands through to desert with scattered trees. Currently mostly restricted to remnant eucalypt woodlands in the wheatbelt (Short and Hide 2014, Short et al. 2011, Woinarski et al. 2014).

Population density

Female home range c. 8 ha, equivalent to 0.125 females/ha, or population density of 0.25/ha.

Reintroduction history

Reintroduced to two areas of remnant woodland in the WA wheatbelt, one fenced (Wadderin) and the other unfenced (Kojonup).

Expected population size within fenced areas

Predicted population size within a 9,570 ha fenced area (as proposed for Mallee Cliffs) would be 1,700 animals, assuming 75% of the fenced area supports suitable habitat (woodlands). It is envisaged that the species may build a population outside the fenced area in conjunction with intensive, effective feral predator control, such that the total population size on Mallee Cliffs could become larger than that in the fenced area alone.

Prospects for release outside fenced areas

Moderate chance of success, when coupled with successful intensive broadscale predator control. Populations have persisted in remnant forest in the WA wheatbelt in the presence of cats and foxes. Cats are a more significant threat than foxes. A translocation has recently been made to Kojonup, which is unfenced, although long-term success of the translocation has yet to be determined.

AWC experience with species

In 2017, AWC began reintroduction of Red-tailed Phascogales to a 7,800 ha fenced area at its Mt Gibson sanctuary from remnant populations in south-west WA.

Likely source populations

For this project, AWC intends to source Red-tailed Phascogales from several wild populations in WA, if possible, supplemented with captive-bred animals if required. The intention would be to maximise the genetic diversity of the reintroduced population.

4.4.3 Numbat

Conservation status

NSW: Extinct; EPBC: Vulnerable.

Distribution

Pre-European: much of southern semi-arid and arid Australia from south-west WA through to South Australia and western NSW (Figure 11). Persisted in central Australia to mid 20th century (Finlayson 1961, Burbidge et al. 1988). Krefft (1866) obtained specimens from the lower Darling. Last record from NSW was in 1900.

Current: A few remnant populations in south-west WA (Figure 11).

Ecology (overview)

- Size: 480-600 g
- Diet: termites
- Breeding: annual, 4 young
- Average lifespan in wild: <5 years
- Diurnal
- Terrestrial
- Dens in hollow trees, logs, burrows.

Major threats (Mammal Action Plan)

- Foxes: severe-catastrophic, entire
- Cats: severe, entire
- Habitat loss: minor-moderate, large
- Predation by raptors: moderate-severe (in remnants)

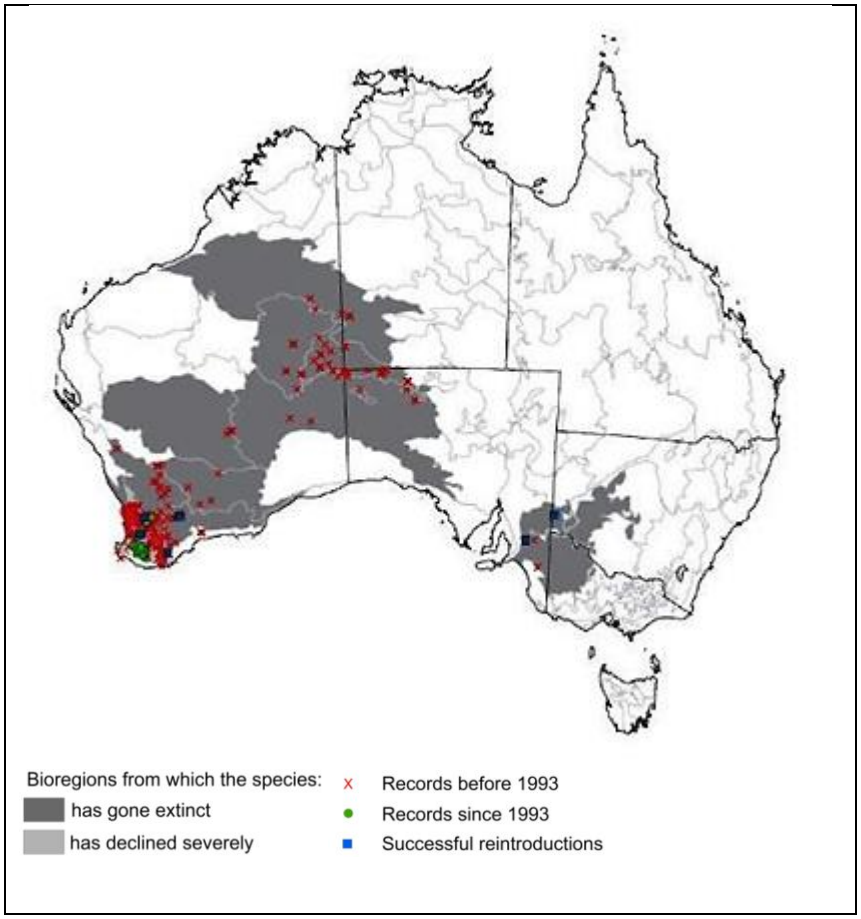


Figure 11: Numbat distribution (from Mammal Action Plan, Woinarski et al. 2014)

Habitat preferences

Relative habitat generalist over pre-European range: forests and woodlands, mulga, desert with spinifex.

Population density

Home range estimated 25-50 ha (Friend 2008), equivalent to 0.02-0.04/ha. Estimated population density at AWC's Scotia sanctuary (Stage 1, 4,000 ha) from 2006-2014 0.01-0.05/ha (varies with rainfall), currently 0.05/ha. Estimated density at AWC's Yookamurra sanctuary from 2011-2014 is 0.04/ha. Density in Mallee Cliffs fenced area is predicted to be 0.04/ha.

Reintroduction history

Numbats have been reintroduced to nine sites in south-west WA; populations are reported to persist at two of these sites. Numbats have been successfully reintroduced to three fenced areas on AWC sanctuaries: Scotia (NSW), Yookamurra (SA) and Mt Gibson (WA).

Expected population size within fenced areas

Predicted population size within a 9,570 ha fenced area (as proposed for Mallee Cliffs) would be 270 animals, assuming 75% of the fenced area supports high quality habitat (woodlands).

Prospects for release outside fenced areas

Reintroductions outside fenced areas have a low chance of success unless cats and foxes can be locally eradicated or maintained at very low densities, which is not currently feasible in an open landscape. Populations in south-west WA initially responded to fox control, but have since declined due to cat predation (Woinarski et al. 2014). The collapse of Numbat populations suggests a high degree of vulnerability to feral predators.

AWC experience with species

AWC supports reintroduced populations of Numbats at Yookamurra (SA), Scotia (NSW) and Mt Gibson (WA). These populations represent an estimated 30-40% of the Numbat population.

Likely source populations

Given the decline in remnant populations, it is likely to be necessary to obtain some or all of the founders from reintroduced populations (Scotia, Yookamurra, Mt Gibson or other reintroduced WA populations), supplemented with captive-bred animals to supplement genetic diversity.

4.4.4 Western Barred Bandicoot

Conservation status

NSW: Extinct; EPBC: *Parameles bougainville fasciata* Extinct; *P. b. bougainville* Endangered

Distribution

Pre-European: South-west WA, through SA to central western NSW and south-west Victoria (Figure 12). Krefft (1866) reported it common on all parts of the Murray River.

Current: Bernier and Dorre Islands, WA; reintroduced populations on Faure Island WA, Arid Recovery (SA) (Figure 12).

Ecology (overview)

- Size: 210-240 g
- Diet: omnivorous: invertebrates, very small vertebrates, fungi, tubers
- Breeding: winter months, 1-3 young, up to 4 litters a season
- Average lifespan in wild: 2-3 years
- Nocturnal
- Terrestrial
- Nests in shallow scrape beneath low shrubs.

Major threats (Mammal Action Plan)

- Foxes: catastrophic, potentially entire
- Cats: catastrophic, potentially entire
- Climate change: severe, large

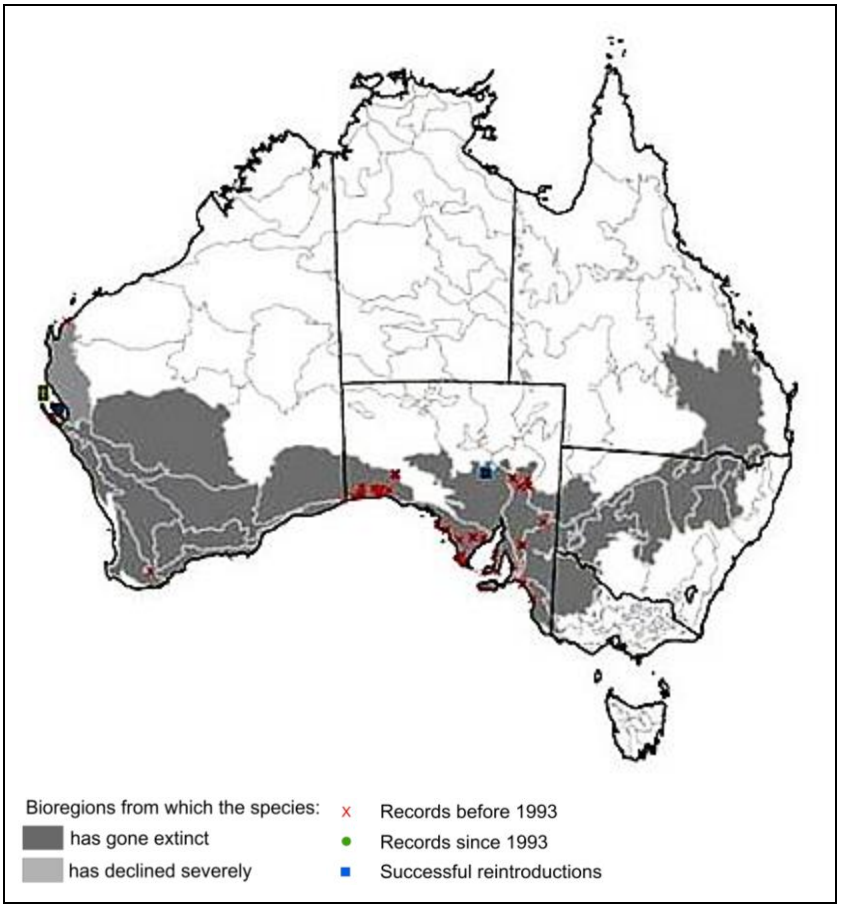


Figure 12: Western Barred Bandicoot distribution (Mammal Action Plan, Woinarski et al. 2014)

Habitat preferences

Habitat generalist: occupied a wide variety of vegetation types in the southern arid and semi-arid zones including fairly open vegetation types (Richards 2012).

Population density

The species was reported to be abundant in some areas of its former range (Krefft 1866). Short et al. (1997, 1998) estimated density of remnant populations on Bernier and Dorre Islands at around 0.3/ha, with six-fold variation with rainfall. More recently, Chapman et al., (2015) reported density on the islands varied by an order of magnitude with rainfall, from 0.03 to 0.3/ha. The density estimate of Richards (2012) – 0.18/ha – is used as an average, noting considerable variation with rainfall.

Reintroduction history

Western Barred Bandicoots have been introduced successfully to two feral predator-free locations: AWC's Faure Island in Shark Bay (WA) and Arid Recovery (SA). An introduction to a partly fenced mainland location on WA (Heirisson Prong) failed, presumably because of predation.

Expected population size within fenced area

Based on an average density of 0.18/ha, predicted population size within a 9,000 ha fenced area (as proposed for Mallee Cliffs) would be 1,600 animals, although substantial variation could be expected with rainfall (c. 500-3,000 individuals).

Prospects for release outside fenced area

Reintroductions outside fenced areas have a very low chance of success unless cats and foxes can be locally eradicated, which is not currently feasible in an open landscape..

AWC experience with species

Western Barred Bandicoots were introduced to AWC's Faure Island wildlife sanctuary in 2005. This population has persisted, with population estimates of several hundred in recent years.

AWC plans to reintroduce Western Barred Bandicoots to a 7,800 ha fenced area at Mt Gibson from 2017.

Likely source populations

For this project, AWC intends to source Western Barred Bandicoots from wild populations in WA (Bernier and Dorre Islands), if possible, to maximise the genetic diversity of the reintroduced population. Additional sources include reintroduced populations on AWC's Faure Island, Mt Gibson and Arid Recovery (if available). Captive breeding may be used to increase the number of founders.

4.4.5 Bilby

Conservation status

NSW: Extinct; EPBC: Vulnerable

Distribution

Pre-European: most of arid and semi-arid Australian mainland south of about 18^{o}S (Figure 13). Collected by the Blandowski expedition to the Murray (Krefft 1866). Last record from NSW was in 1912.

Current: Tanami, Gibson and Sandy Deserts, Pilbara, south-west Qld (Figure 13). Reintroduced to AWC's Scotia (NSW), Yookamurra (SA) and Mt Gibson (WA) sanctuaries, as well as Arid Recovery (SA), Thistle Island (SA) and Lorna Glen (WA).

Ecology (overview)

- Size: 0.8-2.5 kg
- Diet: omnivorous: invertebrates (termites, beetles), tubers, forbs, fungi, fruit/ seed
- Breeding: continuous given favourable conditions, 1-3 young
- Average lifespan in wild: 4-5 years
- Nocturnal
- Terrestrial
- Nests in deep burrows.

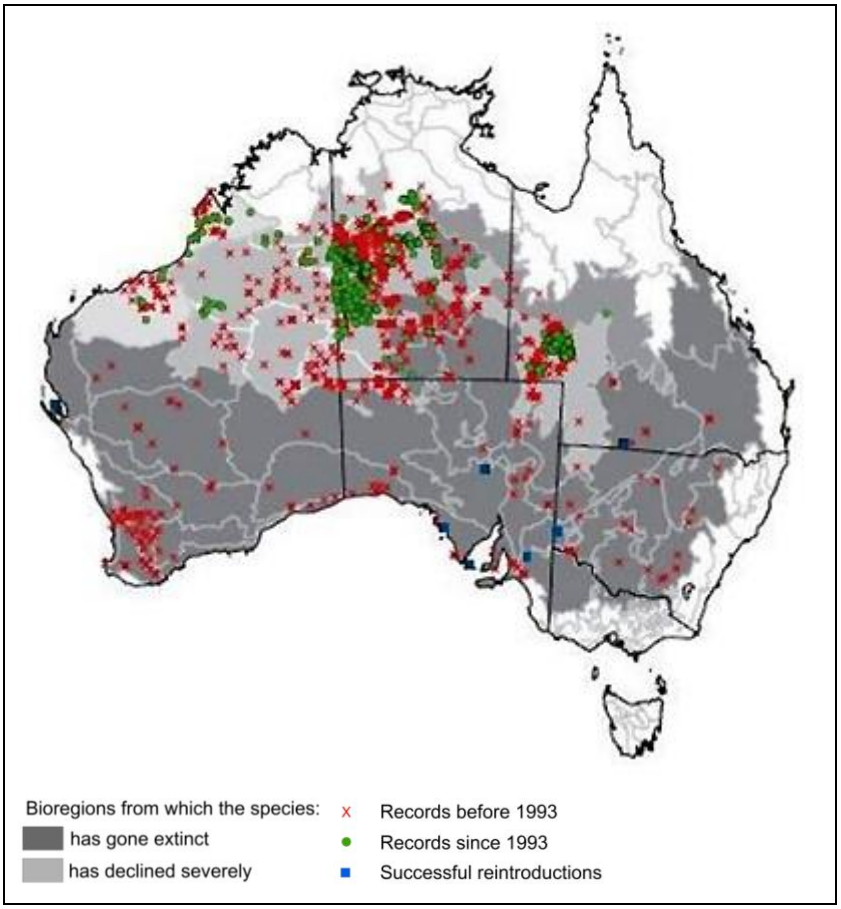


Figure 13: Bilby distribution (Mammal Action Plan, Woinarski et al. 2014)

Major threats (Mammal Action Plan)

- Foxes: catastrophic, almost entire
- Cats: severe-catastrophic, entire
- Inappropriate fire regimes: moderate, large

Habitat preferences

Prior to European settlement, the Bilby was found in a wide range of habitats including eucalypt open forests and woodlands, shrublands and grasslands. Vegetation within current range described as “open tussock grasslands on uplands and hills, mulga woodland/ shrubland on ridges and rises, and hummock grassland in plains and alluvial areas”. In central Australia, the Bilby was ‘one of the most plentiful and universally distributed of central Australian mammals’ (Finlayson 1961). Burbidge et al., (1988) have it in “all types of country except ranges”. In the Tanami, according to Gibson (1986), the Bilby utilised “a wide variety of habitats but primarily open sandplain with regenerating forbs, grasses and shrubs”.

Population density

Mean population density at AWC’s Scotia and Yookamurra sanctuaries is 0.12/ha. Pavey (2006) states 0.12/ha as density in high quality habitat. Density on Thistle Island estimated at 0.13/ha and 0.08/ha on Arid Recovery.

Reintroduction history

Bilbies have been successfully reintroduced to predator-free locations at AWC's Scotia (NSW), Yookamurra (SA) and Mt Gibson (WA) sanctuaries, and to Arid Recovery (SA), Thistle Island (SA) and Lorna Glen (WA). However, populations in several partly or inadequately fenced areas have collapsed due to incursions of feral predators: Currawinya (Qld), Venus Bay (SA) and Francois Peron NP (WA).

Expected population size within fenced area

Assuming density of 0.12/ha, population size within a 9,570 ha fenced area (as proposed for Mallee Cliffs) would be in the order of 1,100 animals.

Prospects for release outside fenced area

Reintroductions outside fenced areas have a very low chance of success unless both cats and foxes can be locally eradicated or maintained at very low numbers, which is not currently feasible in an open landscape. Throughout its (unfenced) range, the Bilby is declining and occurs at low densities in isolated populations.

AWC experience with species

Bilbies have been introduced successfully to AWC's Scotia (NSW), Yookamurra (SA) and Mt Gibson (WA) sanctuaries.

Likely source populations

AWC will aim to source Bilbies from a mix of reintroduced populations on AWC's Scotia, Yookamurra and Mt Gibson sanctuaries and possibly other reintroduced populations, supplemented as necessary by animals from wild populations (from one or more of the populations in the NT, Qld and WA) to maximise the genetic diversity of the reintroduced population. Captive breeding is likely be used to increase the genetic diversity of founders.

4.4.6 Burrowing Bettong

Conservation status

NSW: Extinct; EPBC: Vulnerable.

Distribution

Pre-European: most of arid and semi-arid Australia from Western Australia, south of the Kimberley, central Australia, South Australia to western NSW and Victoria and south-west Queensland (Figure 14). Persisted in central Australia to mid 20th century (Finlayson 1961, Burbidge et al. 1988). Recorded by the Blandowski expedition to the Murray (Krefft 1866). Last record in NSW was in 1892.

Current: Restricted to Bernier and Dorre Islands, Shark Bay and Barrow Island (WA) (Figure 14). Thought to have persisted in remote areas of the NT and WA till the late 1950s. Reintroduced to Boodie Island (WA) and AWC's Faure Island (WA), to AWC's Scotia (NSW) and Yookamurra (SA) sanctuaries, Arid Recovery (SA) and Heirisson Prong (WA).

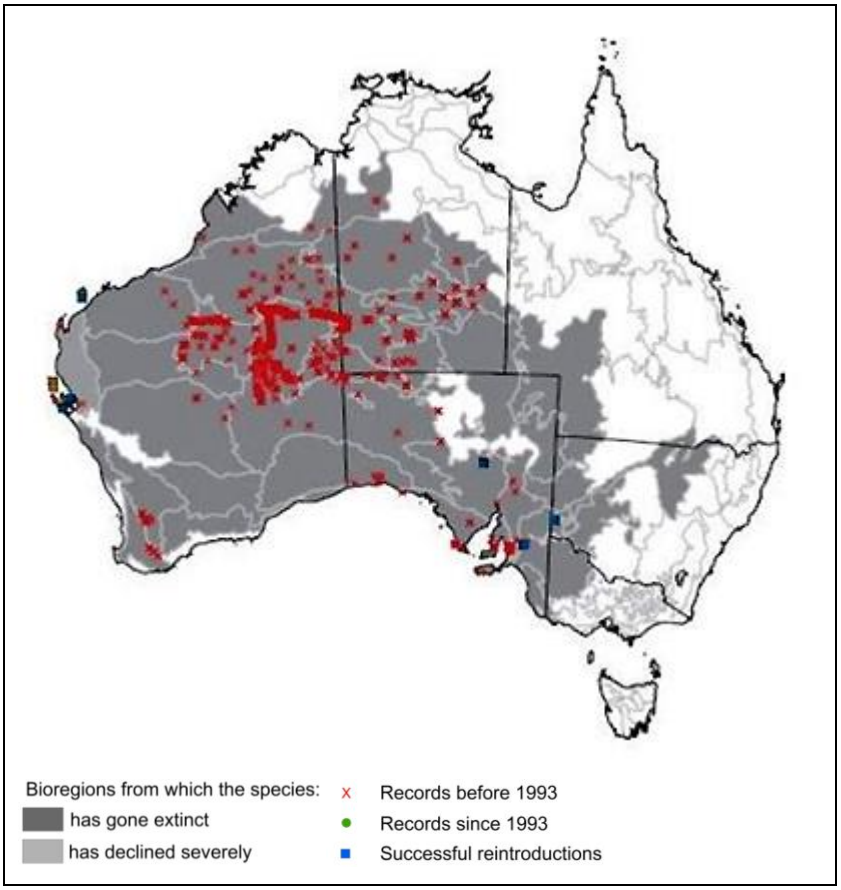


Figure 14: Burrowing Bettong distribution (Mammal Action Plan, Woinarski et al. 2014)

Ecology (overview)

- Size: 0.9-1.6 kg
- Diet: omnivorous: fungi (truffles), invertebrates, herbage, tubers, fruit/ seeds, carrion
- Breeding: continuous under favourable conditions, 1 young, 3 young a year
- Average lifespan in wild: 5 years
- Nocturnal
- Terrestrial
- Nests in communal burrows

The burrows made by Burrowing Bettongs were utilised by a number of other arid-zone species including Western Quolls and Brushtail Possums.

Major threats (Mammal Action Plan)

- Foxes: potentially severe to catastrophic
- Cats: potentially severe to catastrophic
- Climate change: severe, large (Shark Bay islands)

Habitat preferences

Habitat generalist within range: a wide variety of open habitat types including spinifex, sandhill and claypan desert country, saltbush scrub on limestone karst, low heath and scrub. On Barrow Island, avoids rocky substrate. In central Australia, Finlayson (1958) provided a detailed description, as follows: “with the exception of rocky hills and ranges and dense thickets, it colonises most types of country: grassy and herbaceous loam flats within the

major ranges, open mulga and ironwood parks skirting the ranges, and penetrates deep into the true sandridge areas as well… [in some areas] burrowing is often done into slight outcrops of friable limestone and gypseous rock. Not normally found in [spinifex tracts] but burrows in areas where the small plant community tends to be rather varied, with salsolae [saltworts] and succulents".

Population density

Reported densities are 0.5/ha on Bernier and Dorre Islands. Densities on Barrow Island much lower, but not all the island provides suitable habitat. Population densities on AWC sanctuaries are: Faure Island (5,000 ha), between 1-2/ha (trap saturation limits precision of estimates); Scotia Stage 1 (4,000 ha), 0.32/ha (average from 2011-2014); Yookamurra, 0.2/ha (average from 2011-2014). Densities at other reintroductions: Arid Recovery, 0.38/ha; Heirisson Prong, 0.33-0.42/ha; Boodie Island, 1.2/ha. Populations vary considerably with rainfall: on Bernier and Dorre Island, populations doubled in size within 12 months during wet conditions and declined at the same rate during drought (Short and Turner 1999). At Scotia, densities varied from 0.2-0.6/ha between 2011 and 2014. In central Australia, Finlayson (1961) noted it as "formerly exceedingly plentiful". In a more detailed account, Finlayson (1958) stated that "its numbers fluctuate greatly and its occurrence is local and discontinuous and not uniform".

Reintroduction history

Successfully reintroduced to Boodie Island (WA), AWC's Faure Island (WA) and to 'mainland islands' at AWC's Scotia (NSW) and Yookamurra (SA) sanctuaries, as well as Arid Recovery (SA) and Heirisson Prong (WA). Recent reintroductions to Alpha Island (WA) and to fenced area at Lorna Glen (WA). Reintroductions to Kangaroo Island (SA) in 1924 and Gibson Desert (WA) in 1992 failed due to predation (Short and Turner 2000).

Expected population size within fenced areas

Assuming a density of 0.32/ha (Scotia average density), population size within a 9,570 ha fenced area (as proposed for Mallee Cliffs) would be in the order of 2,900 animals. Numbers would be predicted to vary substantially with rainfall (possible range, based on variation observed at Scotia: 1,500-5,000).

Prospects for release outside fenced areas

The Burrowing Bettong is highly vulnerable to feral predators. Reintroductions outside fenced areas have a very low chance of success unless cats and foxes can be locally eradicated, which is not currently feasible in an open landscape.. A recent release of 1,600 animals outside the fence at Arid Recovery failed completely within months, largely due to cat predation (Bannister et al. 2016). The Gibson Desert release failed because of predation.

AWC experience with species

AWC manages reintroduced populations of the Burrowing Bettong on three sanctuaries: Faure Island (WA), Scotia (NSW) and Yookamurra (SA). Together, these comprise around 30% of the total population.

Likely source populations

For this project, AWC intends to source Burrowing Bettongs from reintroduced populations on Scotia and Yookamurra, supplemented if necessary from wild populations in WA (Bernier, Dorre and possibly Barrow Islands), to maximise the genetic diversity of the reintroduced population. Additional sources include reintroduced populations on AWC's Faure Island and Arid Recovery (if available).

4.4.7 Brush-tailed Bettong

Conservation status

NSW: *Bettongia penicillata* Extinct; EPBC: *B. p. penicillata* Extinct; *B. p. ogilbyi* Endangered.

Distribution

Pre-European: Arid and semi-arid Australia in southern and central Australia. Persisted in central Australia to 1930s, possibly later (Finlayson 1961; Gibson 1986; Burbidge et al. 1988). Collected by the Blandowski expedition to the Murray (Krefft 1866). Last record from NSW was in 1906. Various accounts of the Brush-tailed Bettong (including those represented in maps in Figure 15 and Figure 16) differ in their interpretation of pre-European distribution, compounded by difficulties in determining the boundaries between taxa closely related to *B. penicillata*: *B. tropica* (north-east Australia) and *B. gaimardia* (south-east Australia and Tasmania); as well as the recent recognition of cryptic taxa: *B. anhydra* (central-western Australia) and *B. pusilla* (Nullabor). The Brush-tailed Bettong was recorded as far east as the Liverpool Plains in NSW (Paull and Date 1999). There is some contention as to whether this record represents *B. penicillata* or *B. tropica*, but these taxa may represent clines of the same species (Woinarski et al. 2014).

Current: remnant populations in south-west WA (Figure 15); successfully reintroduced to various locations within south-west WA in association with fox control or to fenced areas, including AWC's Karakamia and Mt Gibson sanctuaries; reintroduced outside WA to AWC's Scotia (NSW), Yookamurra (SA) sanctuaries and several islands in South Australia. Populations in unfenced areas in Southwest WA have declined catastrophically (by around 90%) since 2000.

Ecology (overview)

- Size: 1-1.5 kg.
- Diet: fungi (truffles), otherwise omnivorous: invertebrates, herbage, tubers, fruit/ seeds
- Breeding: continuous under favourable conditions, 1 young, up to 3 young a season
- Average lifespan in wild: 3-5 years
- Nocturnal, terrestrial, nests in shallow scrape under vegetation thicket, in logs, rock cavities, occasionally burrows.

Major threats (Mammal Action Plan)

- Foxes: severe-catastrophic, large
- Cats: severe-catastrophic, large
- Inappropriate fire regimes: severe in presence of cats and foxes, large

Habitat preferences

Habitat generalist: occupied a wide range of habitats from spinifex grasslands to forests and woodlands. Currently restricted to forests and open woodlands in WA. Reintroduced populations in WA, SA and NSW inhabit forests and mallee shrublands with understorey of grasses or shrubs.

Population density

Well-supported density estimates for Brush-tailed Bettongs in Jarrah forest in south-west WA before recent population declines were 0.2-1.6/ha; median density after decline was 0.08/ha (Wayne et al. 2013). Density at AWC's Karakamia sanctuary is around 1.2/ha, while density

on St Peters and Wedge Islands (SA) is around 1/ha. Density at AWC's sanctuaries at Yookamurra and Scotia sanctuaries is around 0.1/ha.

Expected population size within fenced area

Assuming a density of 0.4/ha (lower end of the range reported for WA, well below density at Karakamia), population size within a 9,570 ha fenced area (as proposed for Mallee Cliffs) would be 3,600 animals. However, due to competition from the Burrowing Bettong, population may be reduced by 50% or 1,800 animals). Given the large size of the proposed fenced area on Mallee Cliffs, both species should be able to co-exist even if competitive interactions are strong.

Reintroduction history

Brush-tailed Bettongs have been introduced successfully to various locations in south-west WA in conjunction with broadscale fox control, to fenced areas in WA (including AWC's Karakamia and Mt Gibson sanctuaries, as well as Perup, Whiteman Park and Wadderin) and fenced areas outside WA including AWC's Scotia (NSW) and Yookamurra (SA) sanctuaries, and to St Peters and Wedge Islands (SA). Several reintroductions to unfenced or partly-fenced areas (e.g., Francois Peron NP, WA; Yathong NR, NSW), have failed because of predation. As indicated above, unfenced populations have declined catastrophically since 2000.

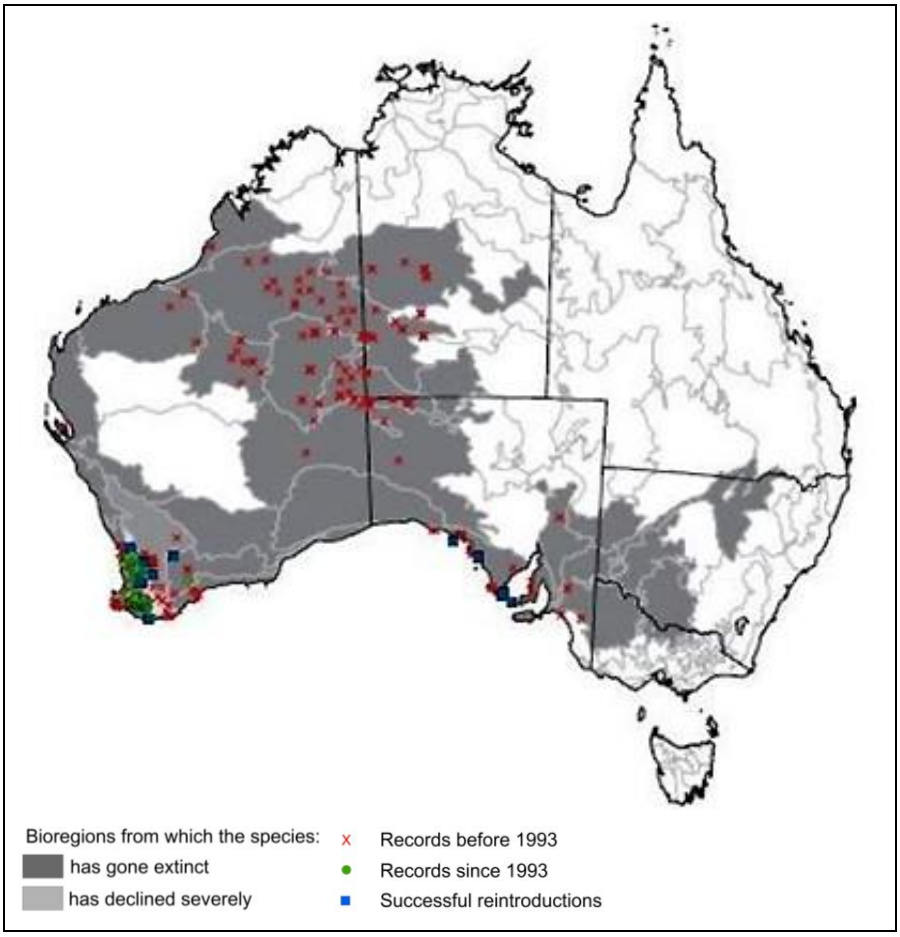


Figure 15: Brush-tailed Bettong distribution (Mammal Action Plan, Woinarski et al. 2014)

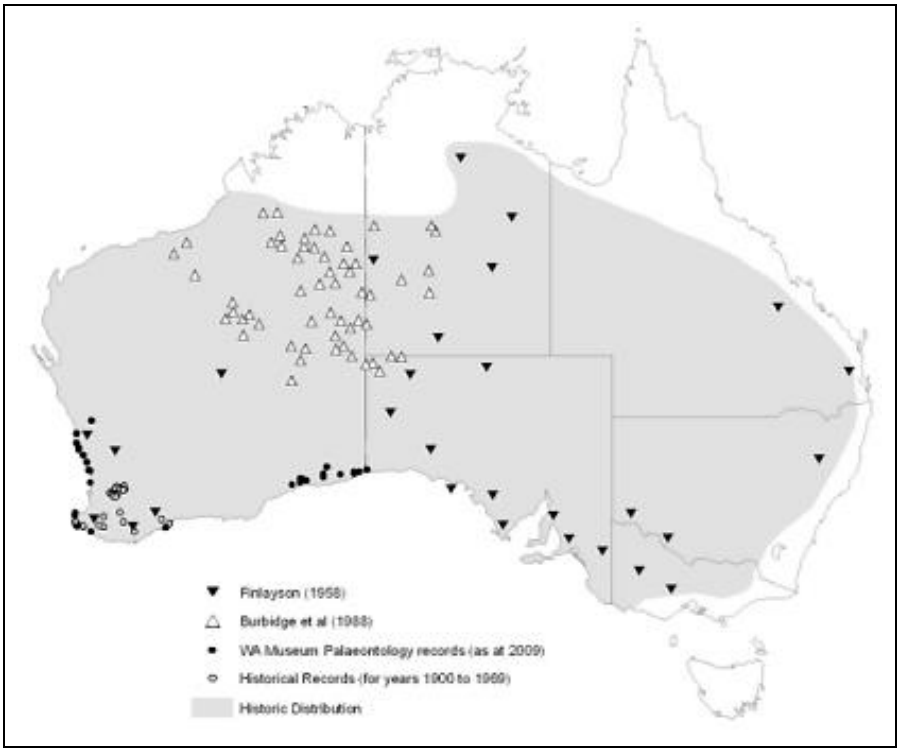


Figure 16: Brush-tailed Bettong distribution (Yeatman and Groom 2012)

Prospects for release outside fenced areas

Reintroductions outside fenced areas have a very low chance of success unless both cats and foxes can be locally eradicated, or suppressed to very low levels, which is not currently feasible in an open landscape.

AWC experience with species

Reintroduced populations of Brush-tailed Bettongs are present on four AWC sanctuaries: Karakamia (WA), Mt Gibson (WA), Scotia (NSW) and Yookamurra (SA).

Likely source populations

Considerations in relation to obtaining Brush-tailed Bettongs for translocations are (i) the major decline in wild populations (Wayne et al. 2013), and (ii) genetic issues, considered in detail for the Brush-tailed Bettong by Pacioni et al., (2013). For the Mt Gibson project, AWC has sourced Brush-tailed Bettongs from two genetically divergent populations in WA: Perup, a fenced area in Jarrah forest and from AWC's Karakamia sanctuary in WA (neither affected by population declines).

Likely source populations include AWC's Scotia, Yookamurra, Karakamia and Mt Gibson sanctuaries, supplemented with founders from wild or semi-wild populations in WA.

4.4.8 Bridled Nailtail Wallaby

Conservation status

NSW: Extinct; EPBC: Endangered

Distribution

Pre-European: eastern Australia west of the coastal ranges from near Charters Towers, Qld, south to north-west Victoria and possibly into South Australia (Figure 17). Krefft (1866) noted it was the most common of the small kangaroos along the Murray. Last record from NSW was in 1924.

Current: One remnant population at Taunton National Park (Qld) (Figure 17). Reintroduced to 8,000 ha fenced area at AWC's Scotia Sanctuary (NSW) which currently supports c. 2,000 animals.

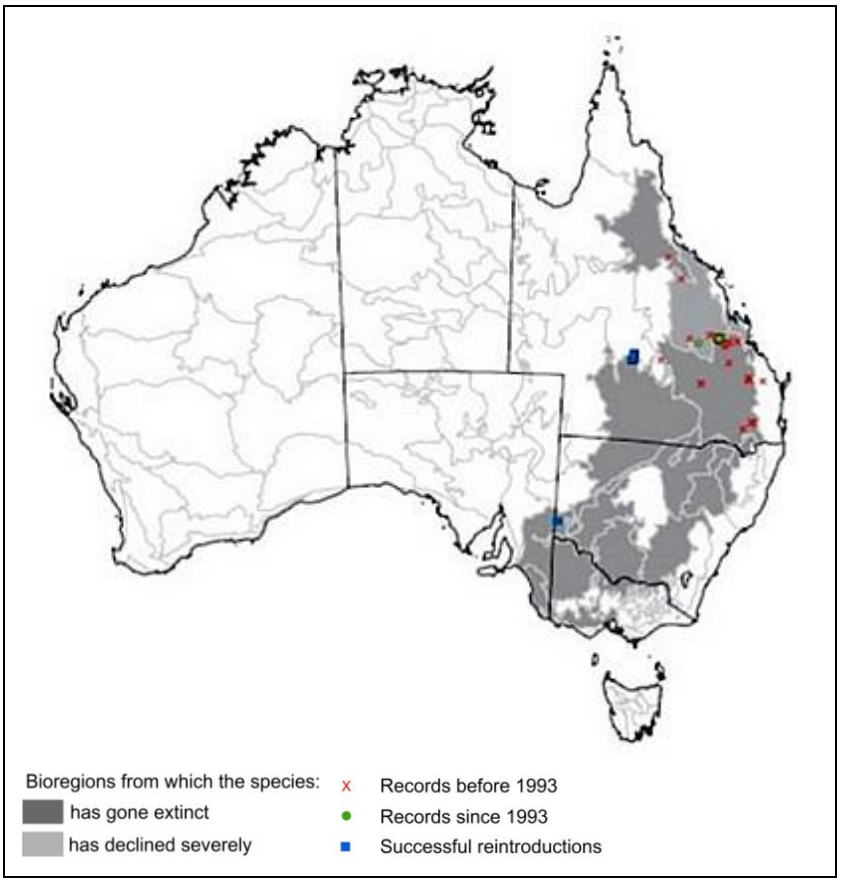


Figure 17: Bridled Nailtail Wallaby distribution (Mammal Action Plan, Woinarski et al. 2014)

Ecology (overview)

- Size: 4-6 kg
- Diet: herbivorous, mostly grasses and forbs, but can shift to browse during droughts
- Breeding: throughout year, 1 young, up to 3 young a year in favourable conditions
- Average lifespan in wild: 5-6 years
- Nocturnal
- Terrestrial
- Shelters in scrapes in dense vegetation and hollow logs.

Major threats (Mammal Action Plan)

- Foxes: catastrophic, large
- Cats: severe, entire
- Dogs: severe, entire
- Drought: severe, entire

- Habitat degradation (weeds, feral herbivores): severe, large – entire
- Habitat loss: severe, entire
- Inappropriate fire regimes: moderate, entire

Habitat preferences

Acacia shrubland and grassy woodland.

Population density

Densities reported at Taunton range from 0.14-0.25/ha (for areas supporting the population). At Scotia, mean density from 2011-2014 was 0.24/ha (range 0.07-0.36/ha) across the entire fenced feral-predator free area. Populations of the Bridled Nailtail Wallaby vary considerably with rainfall: the population at Taunton collapsed by 70% during drought conditions.

Reintroduction history

Reintroduced to unfenced areas on Idalia National Park in 1993 and Avocet Nature Reserve in 2001. Although feral predators are controlled at these locations, the Idalia reintroduction has essentially failed and the Avocet population is small. Successfully reintroduced to AWC's fenced Scotia Sanctuary in 1998; this population has expanded to c. 2,000 animals.

Expected population size within fenced area

Population size within a 9,570 ha fenced area (as proposed for Mallee Cliffs) would be in the order of 2,150 animals, based on mean density at Scotia (0.24/ha across the entire fenced area) and Taunton; abundance is likely to vary with rainfall from c. 600-3,000.

Prospects for release outside fenced area

Reintroductions outside fenced areas have a low chance of success unless both cats and foxes can be locally eradicated or maintained at very low densities, which is not currently feasible in an open landscape. The remnant Queensland population has declined despite intensive predator control; the reintroduction to Idalia has essentially failed. Cats are a significant predator. An attempt by AWC to establish a population outside the fence at Scotia, in an area subject to intensive fox baiting, failed due to predation (Woinarski et al. 2014). Dogs can also be a significant source of mortality.

AWC experience with species

AWC manages the largest population of Bridled Nailtail Wallabies at Scotia sanctuary (NSW).

Likely source populations

For this project, AWC intends to source Bridled Nailtail Wallabies from Scotia sanctuary, supplemented with captive bred animals sourced from Queensland populations to maximise the genetic diversity of the reintroduced population. The Bridled Nailtail Wallaby recovery group recently commissioned a study of the genetic structure of remnant and reintroduced populations of the species (Pacioni and Armstrong 2013) and are expected to produce a genetic management plan in 2017.

4.4.9 Greater Stick-nest Rat

Conservation status

NSW: Extinct; EPBC: Vulnerable.

Distribution

Pre-European: distributed across the south-eastern, southern and south-western boundaries of the arid zone, from western Victoria to North West Cape WA (Figure 18). Last record from NSW was in 1857, when it was collected on the lower Darling. Krefft (1866) noted the species had previously occurred along the Murray; it had earlier been recorded by the explorers Sturt and Eyre near the Murray-Darling junction (Copley 1999).

Current: Franklin Islands, SA (Figure 18). Reintroduced populations at Reevesby and St Peters Islands (SA), Salutation Island (WA), and fenced areas at Arid Recovery (SA) and AWC's Mt Gibson.

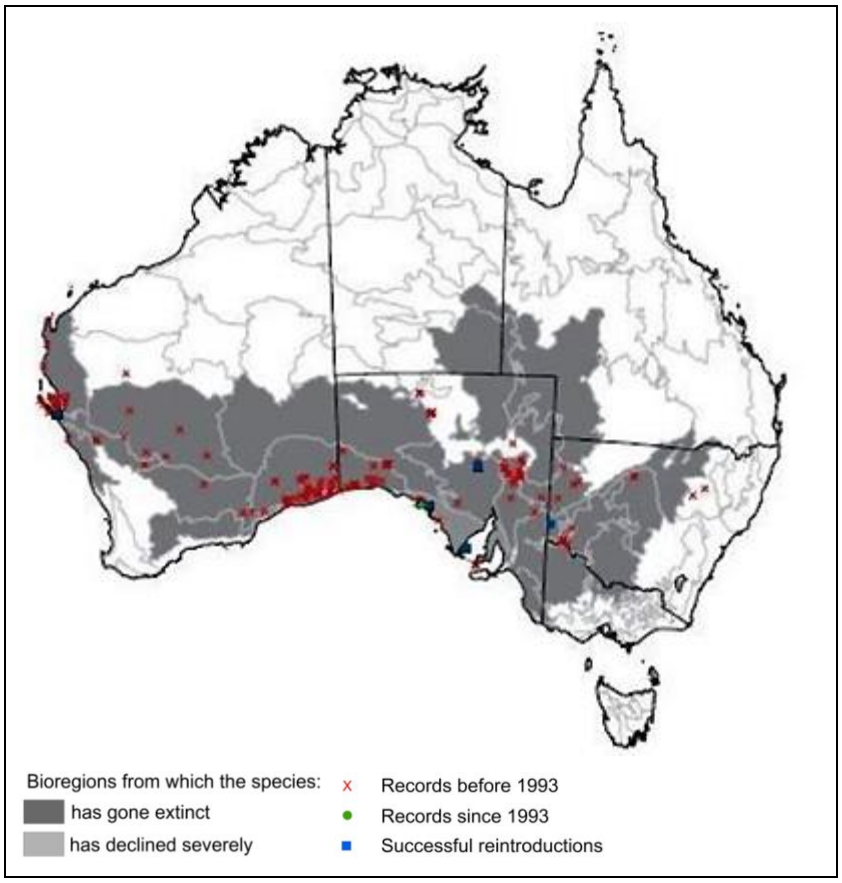


Figure 18: Greater Stick-nest Rat distribution (Mammal Action Plan, Woinarski et al. 2014)

Ecology (overview)

- Size: 190-450 g
- Diet: herbivorous; leaves and fruits of succulent plants
- Breeding: may occur throughout year, but peak in March-April, 1-3 young
- Average lifespan in wild: 2-3 years
- Nocturnal
- Terrestrial
- Nests communally in large mounds of sticks, usually beneath shrubs or amongst rocks, but also in root balls of eucalypts and large hollow logs, and above burrows.

Major threats (Mammal Action Plan)

- Foxes: catastrophic, nil at present
- Cats: catastrophic, nil at present

Habitat preferences

Occupied a broad expanse of semi-arid shrub country from the Murray River to Shark Bay. Within its range, associated with habitats such as drainage lines, calcareous soils and outcrops supporting perennial, semi-succulent shrubs: saltbush, bluebush and other chenopods, nitre-bush and pig-face, which are an important part of the diet of stick-nest rats (Copley 1999).

Population density

Density on SA islands around 1/ha. Density at Arid Recovery 0.11/ha, but population likely to be still establishing.

Reintroduction history

Greater Stick-nest Rats have been successfully reintroduced to Reevesby and St Peters Islands (SA), Salutation Island (WA), and fenced areas at Arid Recovery (SA) and at Mt Gibson (WA); it is too early to determine the success of the Mt Gibson reintroduction, with additional translocations planned in 2018. A reintroduction to the partly fenced Heirisson Prong 'mainland island' (WA) in 1999 was reported to persist "albeit at very low numbers" in 2004 (www.wildliferesearchmanagement.com.au/gsnr.htm). An attempted reintroduction to AWC's Faure Island (WA) in 2006 was not successful. A reintroduction to the fenced area at AWC's Scotia sanctuary (NSW) persisted for several years; it is not known whether the species still occurs there.

Expected population size within fenced areas

It is difficult to predict population density, as there are no well-established mainland populations. It is assumed that densities will be well below that reported for SA islands (1/ha), but above the current reported density for Arid Recovery where the population is still becoming established (0.11/ha). At a density of 0.2/ha, population size within a 9,570 ha fenced area (as proposed for Mallee Cliffs) would be 1,800 animals.

Prospects for release outside fenced areas

Reintroductions outside fenced areas have a very low chance of success unless both cats and foxes can be locally eradicated, which is not currently feasible in an open landscape.

AWC experience with species

AWC has recently reintroduced Greater Stick-nest Rats to a 7,800 ha fenced area at Mt Gibson. AWC has previously reintroduced the Greater Stick-nest Rat to a feral predator-free fenced area at Scotia (NSW); it is unknown if this population persists. An attempted reintroduction to Faure Island (WA) in 2006 did not succeed. Protocols to increase the likelihood of successful reintroduction, based on experience by AWC and others in previous reintroductions, will be incorporated in the Translocation Proposal to be prepared for Mallee Cliffs.

Likely source populations

For this project, AWC would seek to obtain Greater Stick-nest Rats from remnant populations on the Franklin Islands (SA), supplemented with individuals from reintroduced populations on one or more of the following: Reevesby and St Peters Islands (SA), Salutation Island (WA), Arid Recovery (SA) and potentially Mt Gibson.

4.4.10 Mitchell's Hopping-mouse

Conservation status

NSW: Extinct; EPBC: Not listed.

Distribution

Pre-European: Semi-arid south-west Western Australia through to South Australia, western Victoria and far south-west NSW (Figure 19). Last record from NSW was in 1857, where Krefft (1866) noted it was plentiful on the Darling.

Current: Declined from areas cleared for agriculture in south-west WA and SA.

Ecology (overview)

- Size: 40-60 g
- Diet: omnivorous: roots, leaves, seed, invertebrates
- Breeding: winter-spring, 3-4 young
- Average lifespan in wild: probably 2-3 years
- Nocturnal
- Terrestrial
- Dens in burrows, sometimes communal.

Major threats

- Foxes: possibly severe, entire
- Cats: probably severe, entire
- Habitat loss: severe, large (approximately 50-60% cleared)

Habitat preferences

Remnant mallee woodland with open, shrubby or spinifex understorey.

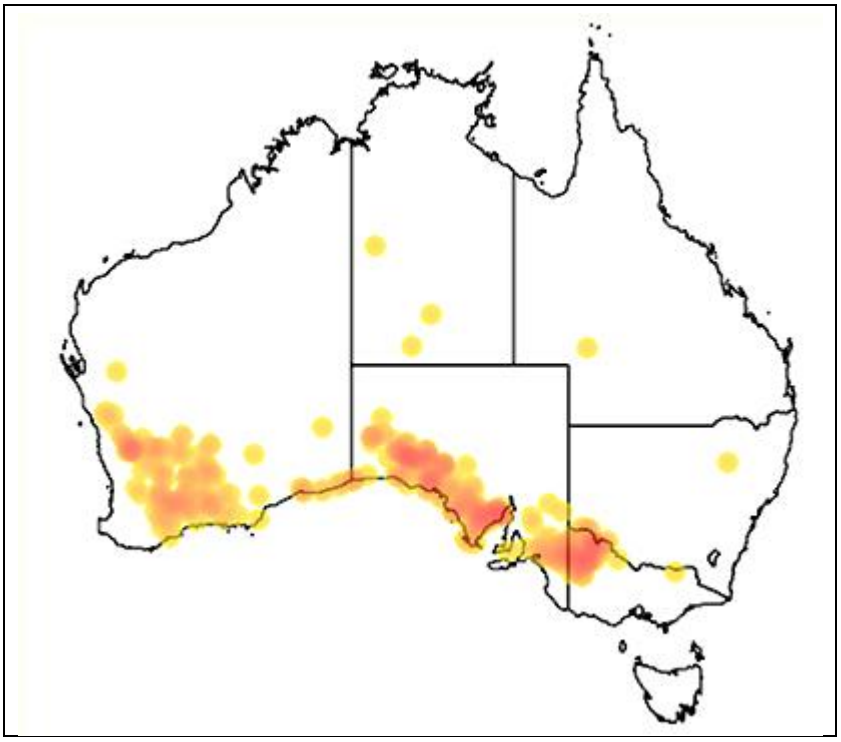


Figure 19: Mitchell's Hopping-mouse distribution (Atlas of Living Australia)

Population density

No reported densities. Based on related species (*Notomys aquilo*, *N. cervinus*, *N. fuscus*), density likely to be in the range of 0.1-1/ha, with major variation with rainfall.

Reintroduction history

No reintroductions known.

Expected population size within fenced areas

Based on the suggested likely density range for Mitchell's Hopping-mouse of 0.1 to 1/ha, corresponding to rainfall-induced troughs of busts and peaks of booms, the likely population within the 9,570 ha fenced area would be of the order of 1,000 to 10,000 animals.

Prospects for release outside fenced areas

Moderate. The species persists in remnant vegetation including areas not subject to broadscale predator control. Establishment of a secure population in a fenced area may facilitate the establishment of a population in the surrounding unfenced area.

AWC experience with species

AWC conserves Mitchell's Hopping-mouse at Dakalanta and Mt Gibson sanctuaries.

Likely source populations

Wild populations, ideally in relatively close proximity to NSW (Victoria or South Australia).

4.5 REASON FOR THE PROPOSAL

The reason for the activity is the conservation, including reintroduction and restoration, of threatened mammal species. This rationale is set out in detail in relevant NSW Government policies including the Saving our Species (SOS) policy (OEH 2016). The key objectives of SOS are:

- to maximise the number of threatened species in NSW that can be secured in the wild for the next 100 years;
- to control key threats facing threatened plants and animals.

The EMA, incorporating this proposal, is a key partnership between the NSW Government and AWC under SOS.

This proposal gives effect to a specific policy commitment of the NSW Government – to reintroduce mammals that are listed as extinct in NSW. The activity will also:

- increase the health of ecosystems by restoring ecological processes (e.g., digging mammals, native predators);
- increase the level of scientific knowledge related to threatened mammal conservation and conservation in Mallee Cliffs NP generally;
- increase opportunities for community engagement in conservation.

There are no practical alternatives which will achieve the relevant objective in the SOS. In particular, there is no practical alternative that will ensure the successful reintroduction of regionally extinct mammals. Failure to take action to protect and restore threatened mammal populations will increase the risk of additional extinctions.

4.6 TIMING OF THE PROPOSAL

Subject to relevant approvals, it is proposed that construction of the conservation fence will commence as soon as possible after approval is granted (about November 2017). The fence will be constructed within 10 months of approvals being granted (by about mid-late 2018). Feral predator removal is scheduled for completion within 8 months of completion of the fence (i.e. 18 months after approvals – by early 2019 or earlier if possible). The proposed operations base will be completed within 18 months of approvals being granted (i.e. by about early 2019). Reintroductions will occur between March 2019 (earlier if possible) and April 2021. Reintroductions are dependent on eradication of feral predators from within the fenced area (see Section 4.3.4). The details of reintroductions will be provided in the Translocation Proposal to be developed for the proposal site. In brief, the herbivorous and omnivorous species will be reintroduced first, the carnivorous Western Quoll will be reintroduced last. Amongst herbivorous and omnivorous species, in general there will be no particular order of reintroductions, as no specific interactions amongst most species are expected. However, competition is possible between the Brush-tailed Bettong and the Burrowing Bettong, based on experience at AWC's Scotia Wildlife Sanctuary, with the Burrowing Bettong being numerically dominant. For this reason, the Brush-tailed Bettong will be reintroduced before the Burrowing Bettong. The timing of reintroductions will otherwise depend on the availability of source animals and other factors to be identified in the Translocation Proposal. Animals will be released directly into areas of suitable habitat within the large fenced area. For some species, in particular Greater Stick-nest Rats, temporary fencing may be used to establish a small holding pen to prevent a 'flight response' in released animals; again, details will be provided in the Translocation Proposal.

Generally, construction of the proposed fence, operations base and track would be undertaken during standard construction hours:

- Monday to Friday 7 a.m. to 6 p.m.

- Saturday 8 a.m. to 1 p.m.
- no work on Sundays or public holidays.

Some construction may occur outside these hours if required for operational reasons.

5 EXISTING ENVIRONMENT

5.1 METEOROLOGICAL DATA

The climate of the project area is temperate with hot summers and cool winters. Mean maximum temperatures range from 16°C in winter to 32°C in summer (Figure 20). Mean annual rainfall is 290 mm (Mildura Airport weather station, the closest weather station to Mallee Cliffs NP) (BOM 2017). Rainfall, on average, is distributed throughout the year with a peak in the spring, however, heavy rainfall events may occur at any time of the year (Figure 21).

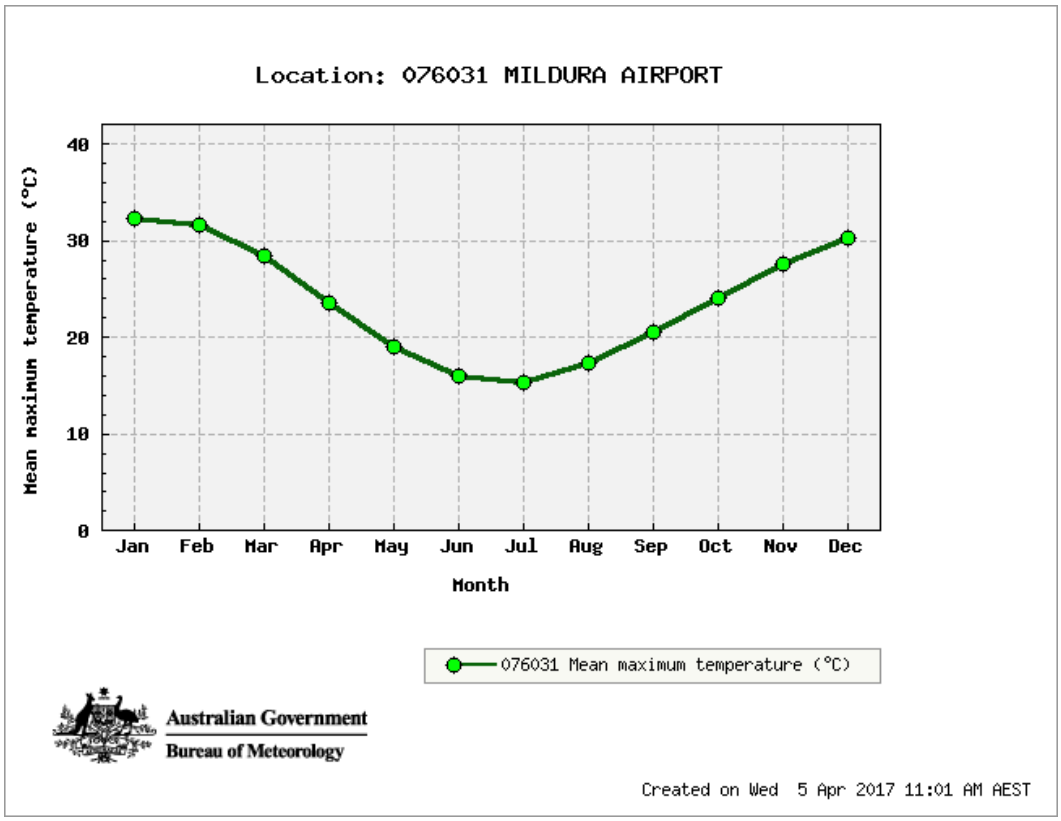


Figure 20: Average monthly maximum temperatures (degrees Celsius) at the Mildura Airport

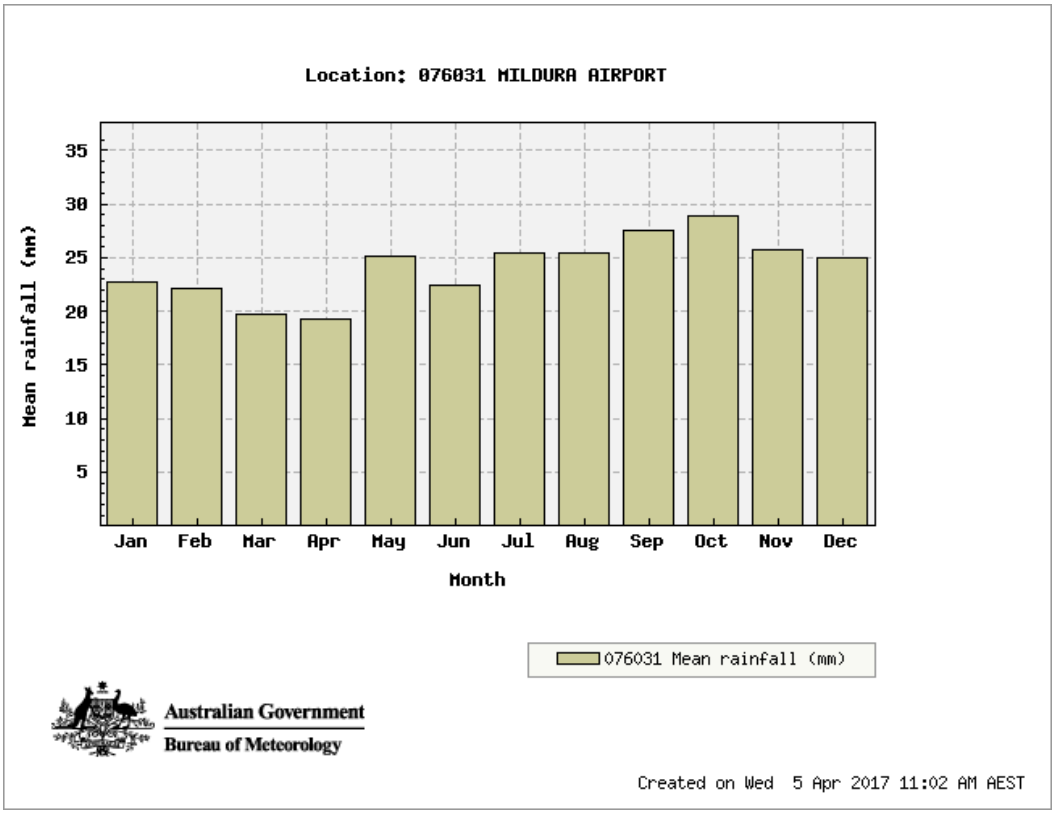


Figure 21: Average monthly rainfall (mm) at the Mildura Airport.

5.2 TOPOGRAPHY

The landform of the project area is largely east-west dunefields and relatively flat topography (Mitchell 2002). Elevation ranges between 50 and 90 m ASL. Relief is generally 5 to 20 m.

5.3 SURROUNDING LAND USE

The surrounding land use is entirely native vegetation. The proposal is entirely surrounded by Mallee Cliffs NP. Outside the park, agriculture including grazing and dryland cropping is the dominant land use.

5.4 GEOLOGY/GEOMORPHOLOGY

The Murray Darling Basin is underlain by early Permian marine sediments (NPWS 1998). The study area is within the Mallee Cliffs Sandplains, Mallee Cliffs Dunes and Mallee Cliffs Linear Dunes (Mitchell 2002; Figure 22). Mallee Cliffs Sandplains are extensive, comprising slightly undulating sandplain of Quaternary aelioan sands with east-west trending dunes, often with ‘blow-outs’, partially scalded broad swales and small depressions. Mallee Cliffs Dunes are Quaternary dunefields of parabolic and unaligned dunes merging into slightly undulating sandplains. Dunes and swales are characteristic. Mallee Cliffs Linear Dunes are extensive Quaternary dunefields and sandplains with large dunes and narrow swales.

5.5 SOIL TYPES AND PROPERTIES

The dunes and swales of the Mallee Cliffs Dunes and Mallee Cliffs Linear Dunes landscape units (Mitchell 2002) are characterised by deep red-brownish earthy sands and calcareous

earths. Dunes of the Mallee Cliffs Sandplains consist of sands while the plains are underlain by solonised brown soils, calcareous loamy sand and texture-contrast soils. In depressions, non-cracking grey or brown clays are present.

5.6 WATERWAYS

There are no major waterways within the project area. Drainage is relatively ill-defined within the Mallee Cliffs NP, with swales providing some passage to overland flow in times of heavy rainfall. The Murray River is about 15 km south-west of the project area (Figure 23).

5.7 CATCHMENT VALUES

Mallee Cliffs NP is a significant protected area within the Murray-Darling Basin. It comprises extensive areas of flat to undulating sandplains and sand dunes, supporting large areas of plant communities typical of south-west NSW (mallee, and Belah-Rosewood woodland). The Mallee Cliffs NP provides habitat for a regionally significant population of the nationally threatened Malleefowl.

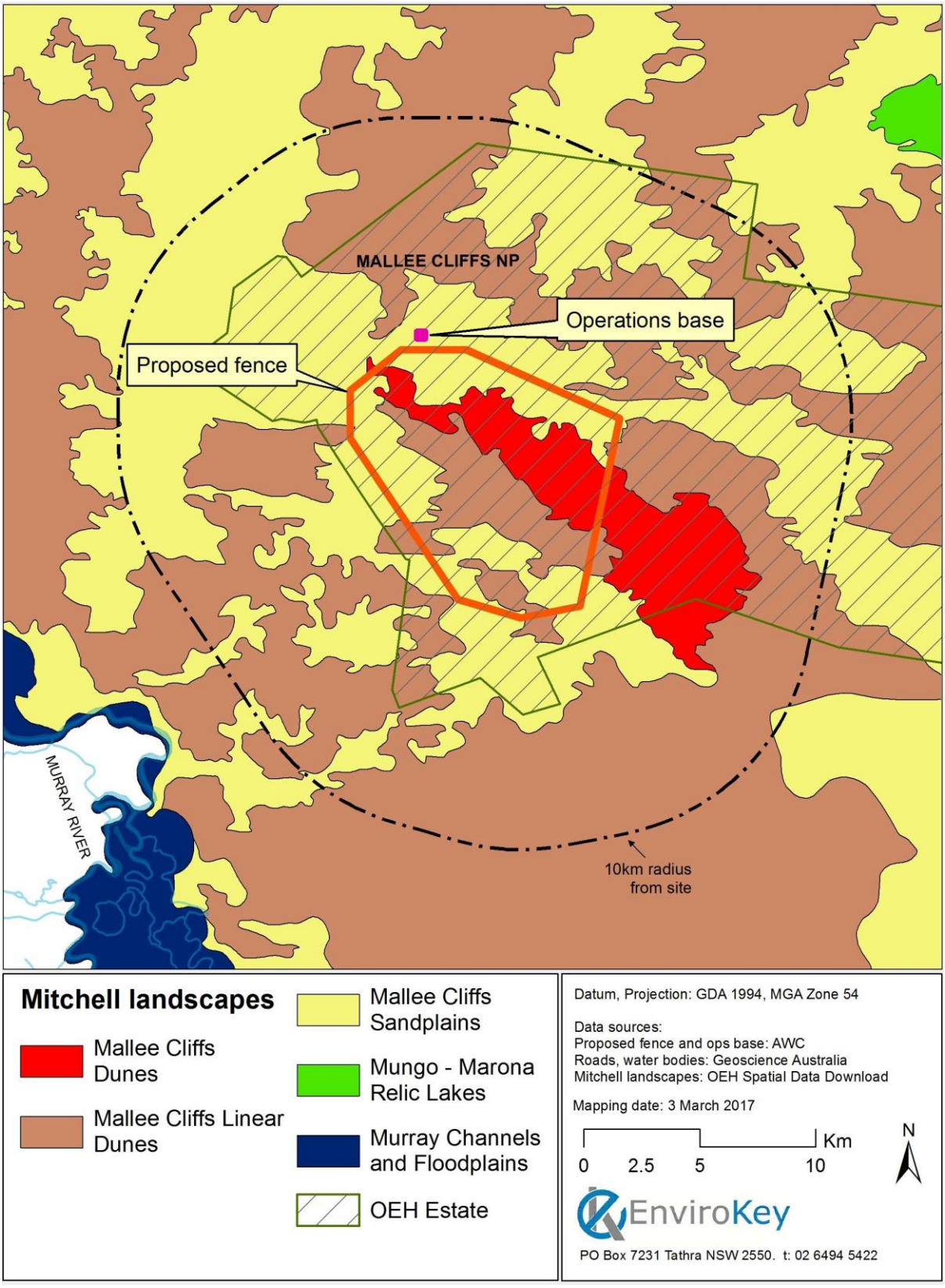


Figure 22: Mitchell landscapes of the locality

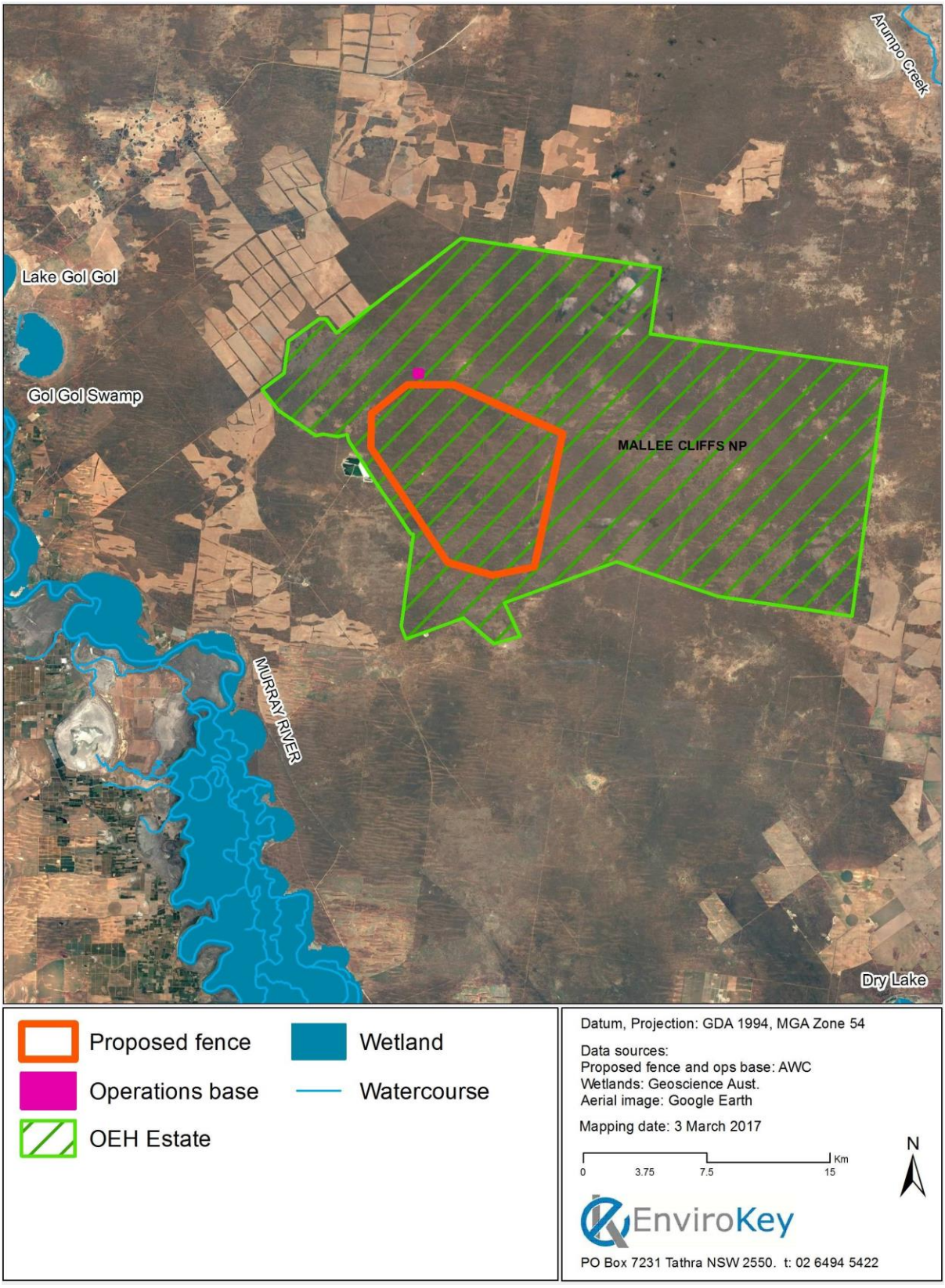


Figure 23: Watercourse and wetlands in the wider locality

5.8 FLORA AND FAUNA

This Section of the REF describes the existing flora and fauna of the study area using information from relevant databases and from extensive field surveys carried out by AWC. The survey methods are outlined in Section 5.8.2 and the results presented in Section 5.8.4.

5.8.1 Desktop analysis

A desktop analysis was completed to source information on threatened and migratory biota that might use the resources of the study area. Information was sought from BioNET - the Atlas of NSW Wildlife (which includes flora) – for records of threatened flora and fauna recorded within a 10 km radius of the study area on 21 February 2017. These records are detailed in Figure 24 to Figure 26 at a scale permissible by OEH data licence agreement (1:250,000). Similarly, information on threatened and migratory species listed under the EPBC Act that could occur in the locality was sourced using the Protected Matters Search Tool and a radius of 50 km around the centre of the study area (Appendix 2).

5.8.2 Field survey

Flora and vegetation community surveys

The Plant Community Type (PCT) classification system (Benson et al. 2006) is a component of the OEH Native Vegetation Information Strategy (NVIS; OEH 2014) that has been designed to enable conservation, planning and regulation of native vegetation and plant communities across NSW. Detailed vegetation mapping of Mallee Cliffs NP was carried out by Morcom and Westbrooke (1990), before the development of the PCT system. The *Mallee Cliffs National Park Draft Plan of Management: Planning considerations* (OEH 2017e) describes vegetation in terms of PCTs. The Morcom and Westbrooke map is the only detailed vegetation map available for the study site, but to be consistent with both the NVIS and the Mallee Cliffs draft PoM, the PCT system was adopted for this REF. This required the Morcom and Westbrooke vegetation communities to be converted to appropriate PCTs.

The Morcom and Westbrooke classification system and map were based on information collected from 92 quadrats (each 10 m x 10 m, i.e. 0.01 ha) in which all plant species occurring were recorded. From these data, 10 vegetation communities were identified, four of which comprise the majority (99%) of the Mallee Cliffs NP.

Field inspection of the proposed CFAI in autumn 2017 by AWC botanists was carried out to assess the accuracy of the vegetation mapping by Morcom and Westbrooke. Vegetation communities were then converted to the appropriate PCT class based on:

- descriptions of defined PCTs (Benson et al. 2006);
- descriptions in Morcom and Westbrooke (1990);
- Appendix C of the *Mallee Cliffs National Park Draft Plan of Management: Planning considerations* (OEH 2017e) which is reproduced in Appendix 13 of this REF; and
- information from the field surveys.

AWC botanists also searched for threatened flora in the areas of proposed impact, including all new tracks and the alternative access route.

Fauna surveys

AWC conducted baseline inventory and monitoring surveys across 58 sites in Mallee Cliffs NP during spring 2016 and autumn 2017. Habitat types were allocated to four groups for the purpose of designing the fauna monitoring surveys. Survey sites were selected in a spatially-blocked design and were spatially stratified by habitat type. The habitat groups and numbers

of sites in each are listed below and described under the heading Fauna and their habitats in Section 5.8.4.

- Mallee with spinifex (n=16)
- Mallee with shrub (n=14)
- Low open woodland (n=14)
- Low open herbland (n=14)

The two additional sites in Mallee with spinifex were in a large, continuous patch of the type, which is habitat for endangered Malleefowl.

The Spring 2016 survey period consisted of bird surveys, spotlighting transects for native and introduced mammals along roads in the Mallee Cliffs NP, and motion camera arrays, again targeting native and introduced mammals.

Bird surveys were conducted at 50 of the monitoring sites (three replicates), using the *Birdlife Australia* standard 20-minute survey over 2 ha. A 10-minute 'spot count' (all birds seen or heard within 50 m) was followed by a 10-minute active search (all birds seen or heard within 200 x 100 m transect; 2 ha).

Motion cameras (targeting introduced predators) were deployed at 1.5 km intervals along roads (spring 2016 n=66; autumn 2017 n=62) and at each monitoring site (spring 2016 n=50; autumn 2017 n=58). Cameras were programmed to take three images per trigger, with a five-minute delay between triggers. Each camera was attached to a star picket or other suitable structure at 50 cm above ground level; a bait tube containing a chicken neck was placed in front of the camera to attract predators.

Vehicle-based spotlighting transects to survey both wildlife and introduced animals were conducted across four nights. Vehicles were driven along established 10 km transects at 10 km/hour (n=8; two replicates). A 'spotter' standing in the tray of the vehicle observed all animals in the vicinity of the vehicle using a handheld spotlight. Upon sighting an animal, the vehicle was stopped, while the spotter recorded the species, distance along transect, compass bearing and distance using a range-finder.

Malleefowl mound surveys were carried out in conjunction with searches for threatened flora (see previous section) along the proposed fenceline, new track network, and at the operations base site. Locations and activity status of all mounds encountered were recorded.

5.8.3 Nomenclature

Flora classification in this REF follows the online version of the Flora of NSW (PlantNET 2017) and relevant OEH databases (OEH 2017a; OEH 2017c). The allocation of vegetation communities to PCTs (see Table 7) was based on a combination of:

- descriptions in Morcom and Westbrooke (1990)
- the guide (Appendix C) provided by NPWS in the *Mallee Cliffs National Park Draft Plan of Management: Planning consideration* (2017), reproduced in Appendix 13 of this REF
- information from the field surveys.

Nomenclature for fauna was guided by the following texts: birds, Morcombe (2004); mammals (except microchiropteran bats), Menkhorst and Knight (2010); microchiropteran bats, Churchill (2008); frogs, Tyler and Knight (2009); and reptiles, Swan et al., (2004), except where modified by recent taxonomic review (Sass 2011a, Sass 2011b, Swan 2013). Where no common name is provided within these texts, a generally accepted name is used.

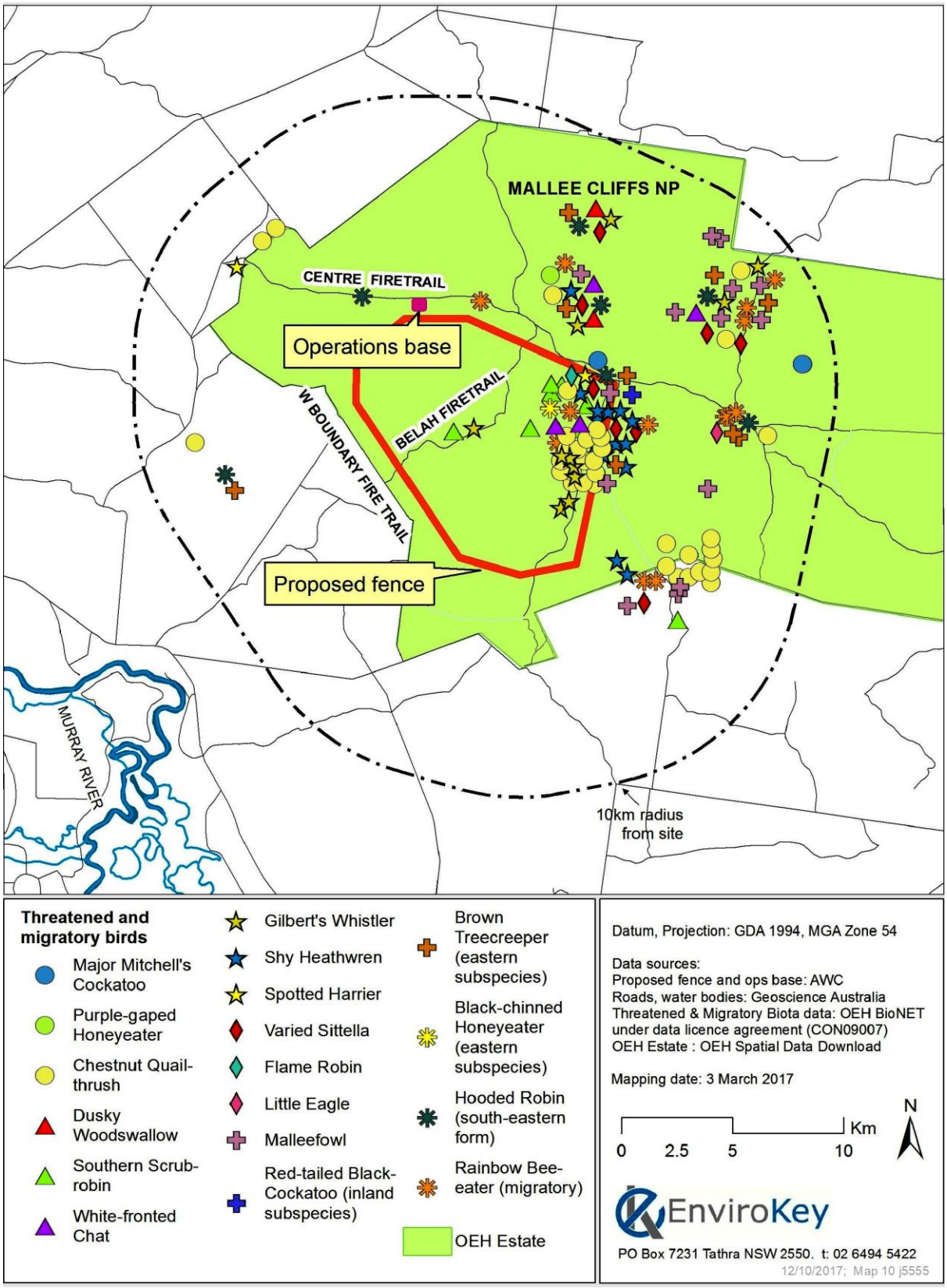


Figure 24: Previous records of threatened and migratory birds in locality

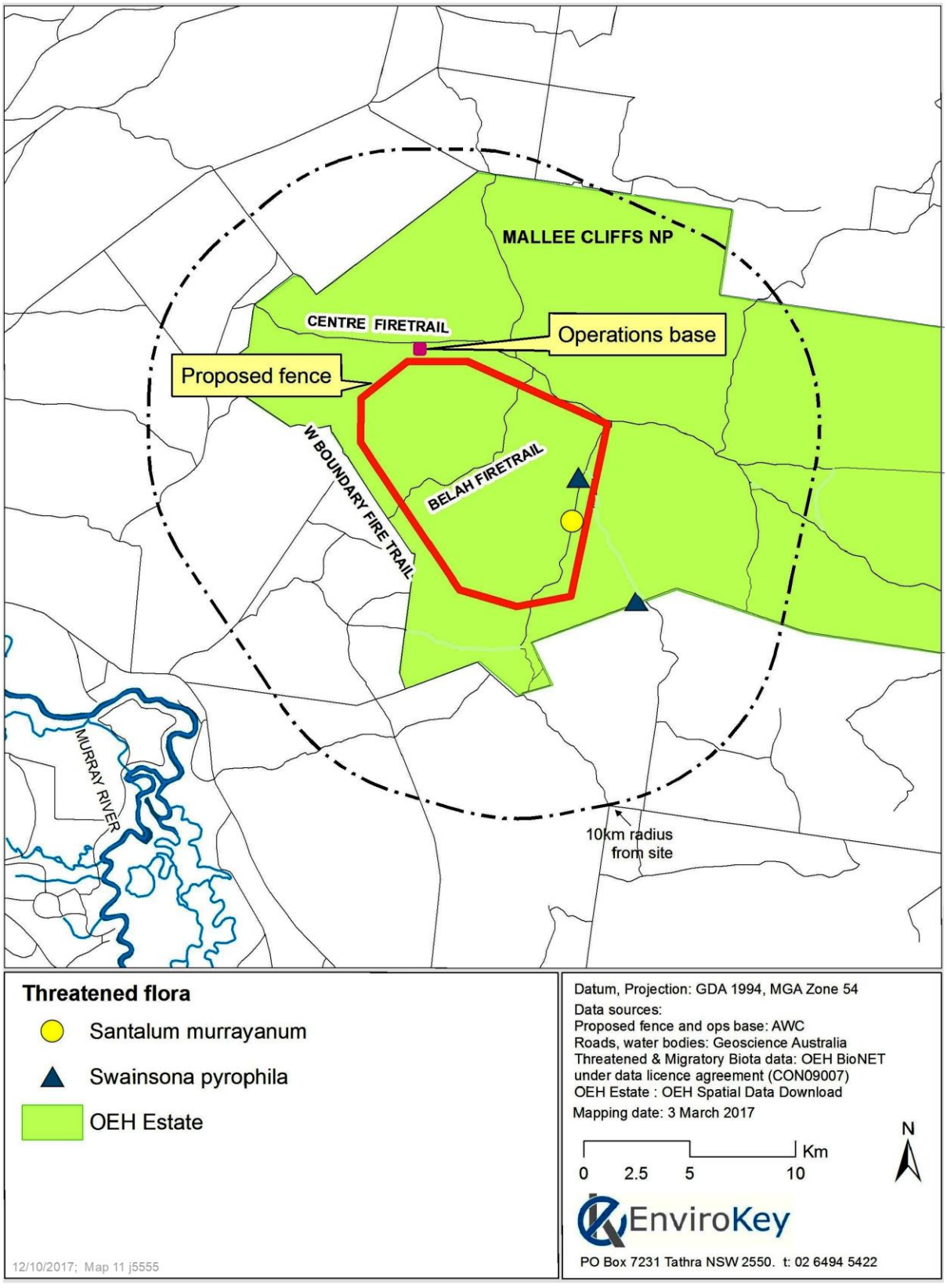


Figure 25: Previous records of threatened flora in locality

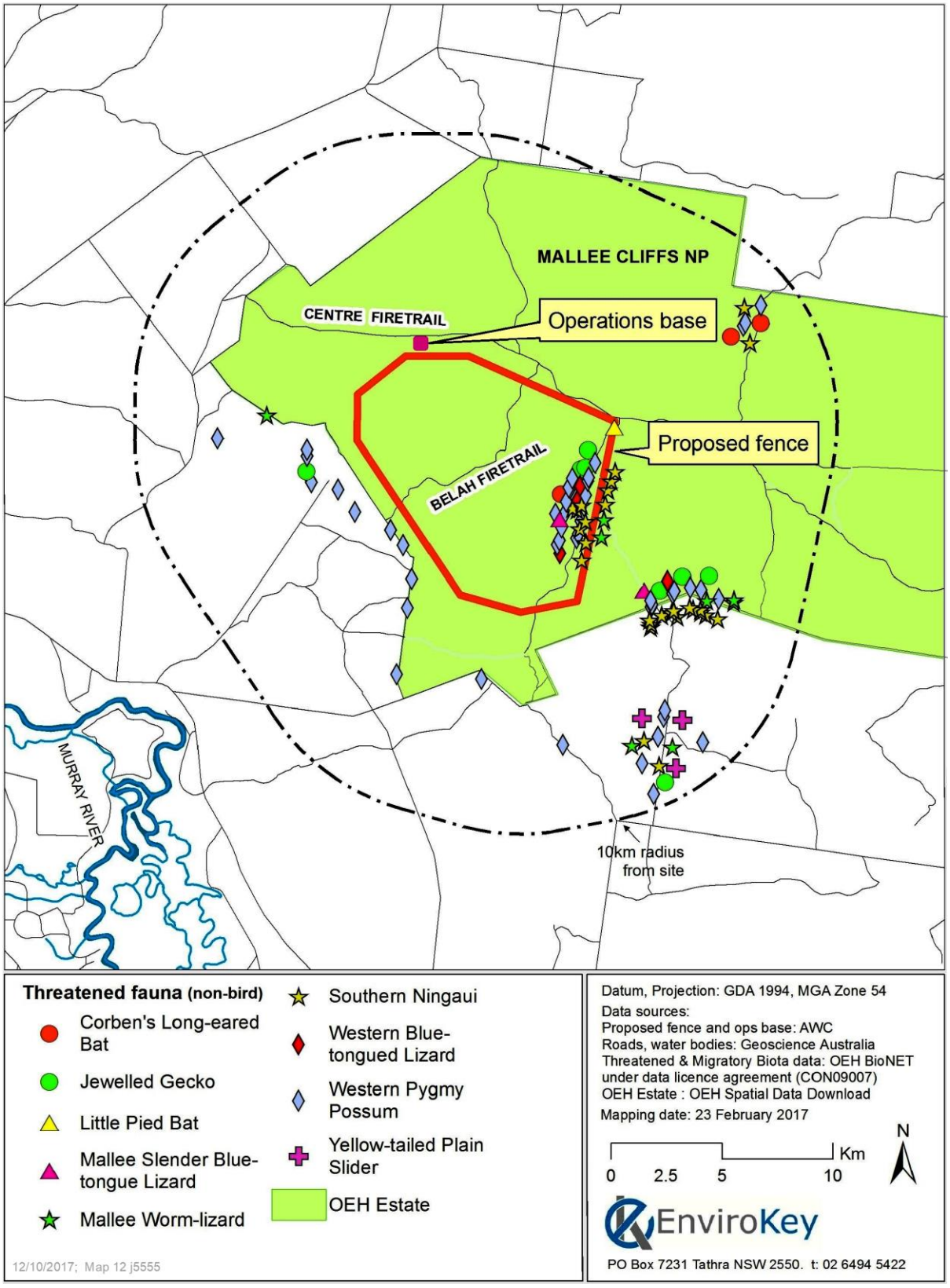


Figure 26: Previous records of other threatened fauna in locality

5.8.4 Results

Flora and Vegetation Communities

Species richness

A total of 213 species from 50 families was recorded, including 43 exotics, most of which were pasture species or weeds commonly associated with agriculture. Detailed floristic descriptions of each of these communities, including full species lists within each of these communities, is provided by Morcom and Westbrooke (1990).

Plant Community Types

Field inspections by AWC botanists confirmed that vegetation mapping by Morcom and Westbrooke (1990) was mostly accurate. Minor observed differences included:

- the location of the boundary between communities was in error in the vicinity of the proposed operations base (see caption for Figure 4);
- the community of *Eucalyptus gracilis*/*E. dumosa*/*E. socialis* open-scrub included patches that were dominated by *Eucalyptus oleasa* with few shrubs but a groundcover of exotic forbs and grasses, and were associated with areas of heavier soils; the description of the community was expanded to incorporate these more disturbed areas.

Five of the Morcom and Westbrooke communities occur in the vicinity of the proposed CFAI (which includes the area to be fenced, the operations base, and the routes of all proposed tracks, including the alternative access track); they are listed in Table 7. Three of the communities correspond well with types within the PCT system (which was developed to describe native vegetation communities), although one of them (*Casuarina cristata* low open woodland) contains patches dominated by exotic forbs and grasses (for instance, at the site of the operations base) and with atypically low tree cover, presumably as a result of clearing or lack of recruitment due to previous pastoral grazing regimes.. However, the *Dodonaea viscosa* subsp. *angustissima* shrubland community identified by Morcom and Westbrooke was interpreted by them as having developed following clearing of eucalypt open scrub, and in this REF this community is referred to as Derived shrubland from PCT 170. (NB: in the draft PoM for Mallee Cliffs (OEH 2017e), the *Dodonaea* shrublands were equated to PCT 143, Narrow-leaved Hopbush-Scrub Turpentine-Senna shrubland of semi-arid and arid sandplains and dunes, but the definition of the PCT (Benson et al. 2006) estimated its pre-European extent as 10,000-190,000 ha; that is, PCT 143 does not apply to a community derived from clearing eucalypt open scrub.)

Another of the Morcom and Westbrooke classes, Herbland/open-herbland, was interpreted by them to be a disturbed type, probably resulting from grazing pressure on chenopod shrublands and arid woodlands. Unlike the derived *Dodonaea* shrublands, the species that have established are mainly exotic grasses and forbs. In this REF, these communities are referred to as Disturbed annual saltbush forblands from PCT 166. (NB: in the draft PoM for Mallee Cliffs (OEH 2017e), Herbland/open-herbland was equated to PCT 165, Corkscrew grassland/forbland on sandplains and plains. However, the herbland communities in the study area are mostly associated with heavy soils so were considered more likely to have been derived from PCT 166, in agreement with the Morcom and Westbrooke interpretation. In addition, Morcom and Westbrooke did not include Corkscrew grass in the list of characteristic species found in the Herbland/open-herbland community, which also suggests it is not a good match with PCT 165.)

Table 7: Vegetation communities (Morcom and Westbrooke 1990) and Plant Community Types (PCTs) occurring within the vicinity of the proposed CFAI (feral predator-free fenced area, operations base and new tracks, including the alternative access track)

Vegetation community (Morcom and Westbrooke 1990)	PCT identity number (Benson et al. 2006)	PCT name (Benson et al. 2006)
1 *Eucalyptus gracilis*/*E. dumosa*/*E. socialis* open-scrub	170	Chenopod sandplain mallee woodland/shrubland of the arid and semi-arid (warm) zones
2 *Eucalyptus gracilis*/*E. dumosa*/*E. socialis* open-scrub with *Triodia* understorey	171/172	Spinifex linear dune mallee mainly of the Murray-Darling Basin Bioregion/Deep sand mallee of irregular dunefields of the semi-arid (warm) zone
3 *Casuarina cristata* subsp. *pauper* low open woodland	58	Black Oak-Western Rosewood open woodland on deep sandy loams of Murray Darling Depression and Riverina Bioregions
7 *Dodonaea viscosa* subsp. *angustissima* shrubland	Derived from 170	*Derived from* Chenopod sandplain mallee woodland/shrubland of the arid and semi-arid (warm) zones
10 Herbland/open-herbland	166 (disturbed)	*Disturbed* annual saltbush forbland on clay plains and inundation zones mainly of south-western NSW

The distribution of the PCTs within and adjacent to the proposal are shown in Figure 27 and the extents of each within the Mallee Cliffs NP and the extents to be included within the proposed fence are listed in Table 8.

As noted above, the long history of grazing by sheep and cattle in Mallee Cliffs NP has substantially degraded pre-existing vegetation communities and has resulted in the establishment of derived communities. Sheep were removed from the Mallee Cliffs NP in 1977 but large numbers of goats and rabbits (and kangaroos) maintain a high grazing pressure. In Mallee Cliffs high grazing pressures are a major threatening process affecting vegetation community characteristics. Through the elimination or control of grazing by introduced herbivores, in conjunction with the continued implementation of a scientifically-based fire management regime, AWC and NPWS expect to assist in the control of weeds and the regeneration of vegetation communities in the Mallee Cliffs NP.

The following descriptions of PCTs (including derived and disturbed types) are drawn mainly from Morcom and Westbrooke (1990).

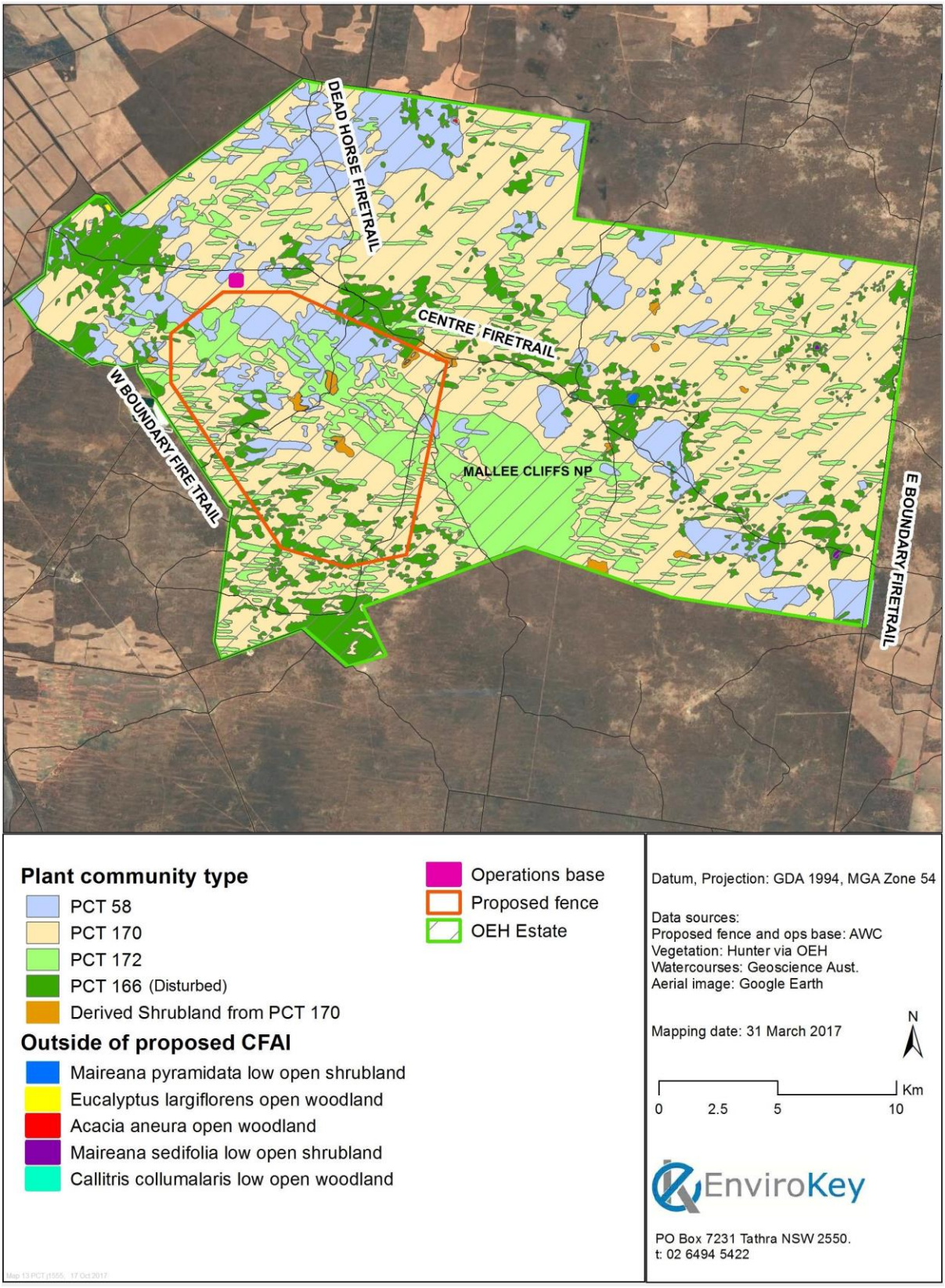


Figure 27: Plant Community Types (PCTs) within and adjacent to the proposal

Table 8: Extent of Plant Community Types (PCTs) within the Mallee Cliffs NP and the proposal area

Plant Community Types	Estimated PCT in Mallee Cliffs NP (ha)	Estimated PCT in proposed fenced area (ha)	Estimated portion of Mallee Cliffs NP PCT in proposed fenced area (%)	Estimated portion of proposed fenced area (%)
PCT 170	34,008	4,666	13.7	48.8
PCT 171/172	9,040	2,441	27.0	25.5
PCT 58	7,914	1,518	19.2	8.6
PCT 166 (disturbed)	6,805	821	12.1	15.9
Derived shrubland PCT 170	241	125	51.9	1.3
Other	111	0	0.0	0.0
TOTALS	**58,118**	**9,570**		**100**

PCT 170 Chenopod sandplain mallee woodland/shrubland of the arid and semi-arid (warm) zones

Distribution and habitat: This is the most extensive and widespread community within Mallee Cliffs NP, covering 34,008 ha. Within the proposed feral-free fenced area, it makes up 4,666 ha or approximately 49% of the vegetation cover. Mallee open scrub communities are found on inter-dune plains or swales of sandy-loam solonised soils.

Vegetation description: Mallee low open woodland (trees up to up to 8 m high) (Figure 28) – this community is co-dominated by an assemblage of mallee eucalypts including Yorrell *Eucalyptus gracilis*, White Mallee *Eucalyptus dumosa* and Red Mallee *Eucalyptus socialis*. Within areas mapped as this community, AWC field surveys identified patches of *Eucalyptus oleaosa* that occurred at sites with more clay-rich soils. They have less shrub cover but high percentages of groundcover dominated by exotic species; predominantly Ward's weed (*Carrichtera annua*) and grasses. These are considered to be part of PCT 170 in this REF.

In the areas with mixed eucalypts and shrubs, the common shrubs include *Cassia eremophilla*, *Dodonaea viscosa* subsp. *angustissima, Zygophyllum* spp, *Westringia rigid*a, *Eremophila glabra*, *Chenopodium curvispicatum* and *Grevillia heugelii*. Invasive and exotic species occur infrequently in the shrubby parts of this community.

Figure 28: Example of PCT 170 within the proposed CFAI

PCT 171/172 Spinifex linear dune mallee mainly of the Murray-Darling Basin Bioregion/Deep sand mallee of irregular dunefields of the semi-arid (warm) zone

Distribution and habitat: This is the second most extensive community within Mallee Cliffs NP covering 9,040 ha. This vegetation community represents 2,441 ha or about 26% of the vegetation cover within the proposed predator-free fenced area. Mallee with spinifex communities occur throughout the project area predominantly on linear east-west dunes with shallow sand soils. There is a large contiguous area of this PCT in the south of the park which is one of the largest continuous areas of mallee in NSW. Additionally, much of the Mallee with spinifex vegetation in Mallee Cliffs NP has remained unburnt since large fires in 1974 and 1975 – even within the outer boundaries of these fires there are many patches which were unburnt.

Vegetation description: Mallee low open woodland (trees up to 8 m high) – this community is co-dominated by an assemblage of mallee eucalypts including *Eucalyptus gracilis*, *Eucalyptus dumosa* and *Eucalyptus socialis*. This community is distinguished from Mallee with shrubland communities by the dominance of *Triodia scariosa* in the understorey (Figure

29). Several plant species are limited in occurrence to this community including *Eucalyptus incrassata, Baeckea crassifolia* and *Exocarpos sparteus*. Shrub associates in the community include *Dodonaea viscosa* subsp. *angustissima*, *Eremophila glabra, Myoporum platycarpum, Cassia eremophilla, Baeckea crassifolia*, *Acacia wilhelmiana, Acacia macrocarpa* and *Pittosporum phillyraecoides*.

Figure 29: Example of PCT 171/172 within the proposed CFAI

PCT 58 Black Oak-Western Rosewood open woodland on deep sandy loams mainly in the Murray Darling Depression Bioregion

Distribution and habitat: This vegetation community covers 7,914 ha within Mallee Cliffs NP. This vegetation community represents 1,518 ha or approximately 16% of the vegetation cover within the proposed predator-free fenced area. *Casuarina pauper* woodland occurs on loamy sand soils in swales. These soils hold moisture for longer periods than surrounding sandy areas and may support small ephemeral pools.

Vegetation description: Low open woodland (up to 12 m high) (see Figure 30), Belah *Casuarina pauper* stands are often associated with Rosewood *Alectryon oleifolius* subsp. *canescens*, although stand of these single species also can occur throughout the Mallee Cliffs NP. Common understorey plants include *Olearia muelleri*, *Zygophyllum apiculatum*, *Atriplex vesicaria*, *Exocarpos aphyllus* and *Actinobole uliginosum*. Occasionally, shrubs such as *Dodonaea viscosa, Cassia eremophila, Myoporum platycarpum*, *Acacia colletiodes* and *Maireana pyramidata* may dominate the understorey. In the north-east of the Mallee Cliffs NP, *Geijera parviflora* occurs in a small isolated patch within this community. The dense canopy of this species can provide important habitat for fauna, although its limited distribution within the Mallee Cliffs NP restricts this role.

Within *C. pauper* woodlands, *Callitris glaucophylla*, growing to 10 m high, occurs as scattered individuals. *C. glaucophylla* is of conservation concern within Mallee Cliffs NP as almost no tree recruitment has been recorded within the last decade. Existing areas of *C. glaucophylla* are associated with open understoreys largely consisting of exotic herbs and grasses.

Figure 30: Example of PCT 58 within the proposed CFAI

PCT 166 Disturbed annual saltbush forbland on clay plains and inundation zones mainly of south-western NSW

Distribution and habitat: This vegetation community covers 6,805 ha within Mallee Cliffs NP. It represents 821 ha or about 9% of the vegetation cover within the proposed predator-free fenced area. Herblands in Mallee Cliffs are an artificial community derived from areas that were probably previously dominated by forbs with only ancilliary grasses. They are the consequence of prior intensive grazing practices in the park and are mostly associated with earth tank sites with heavy soils (Morcom and Westbrooke 1990). Open herblands are distributed primarily along the central road through the park, although large areas also occur in the south and south-east.

Vegetation description: Open herbland (up to 0.8 m high) (see Figure 31). These herblands consist largely of annual forbs and grasses, many of which are exotic. Common species include *Bromus rubens, Psilocaulon tenue*, *Erodium* spp, *Scleroleana obliquicuspis*, *Salvia verbenaca*, *Hordeum leporinum*, *Medicago* spp, *Omphalolappula concave* and *Sisymbrium irio*. The relative abundance of species fluctuates seasonally, and is highly dependent upon rainfall.

Figure 31: Example of PCT 166 within the proposed CFAI

Derived Shrubland from PCT 170 Chenopod sandplain mallee woodland/shrubland of the arid and semi-arid (warm) zones

Distribution and habitat: This vegetation community covers 241 ha within Mallee Cliffs NP. It represents 125 ha or about 1% of the vegetation cover within the proposed predator-free fenced area. This community is an early coloniser following clearing of mallee communities for grazing and agricultural purposes, and therefore represents an artificial vegetation community within the project area. This community occurs as small isolated patches within Mallee Cliffs NP, the largest ones occurring within the centre of the proposed feral-free fenced area, with other small scattered patches in the east of the NP.

Vegetation description: Shrubland (up to 2 m), *Dodonaea viscosa* subsp. *angustissima* forms dense stands in open areas, with largely no canopy.

Additional vegetation communities within Mallee Cliffs NP outside of the proposed CFAI

Additional vegetation communities occur as very small isolated remnants within Mallee Cliffs NP. These include: *Maireana pyramidata* low open shrubland; *Maireana sedifolia* low open shrubland; *Acacia aneura* open woodland; and *Eucalyptus largiflorens* open woodland. In total these additional communities comprise 111 ha of the Mallee Cliffs NP and do not occur within the proposed feral predator-free area, fenceline clearing, operations base or along routes of new tracks.

Weeds

A 2013 internal NPWS report (*Weed recording and mapping – Mallee Cliffs National Park, Spring 2011*, R. Enke, January 2013) documented 52 weed species that were known to occur in the Mallee Cliffs NP. Details of populations of some weeds species found along vehicle tracks in the park in late 2011 were mapped and recorded, however some species were too prevalent to record in the time available for the survey:

> "Wild Sage and Match-head Plant were only recorded in part of the reserve as it soon became apparent that the weeds were so wide spread and almost continuous along some tracks that it became difficult and time consuming to record. The wide spread weed Ward's Weed *Carrichtera annua* was not recorded as it was present in nearly all areas of the park." (from page 1, *Weed recording and mapping – Mallee Cliffs National Park, Spring 2011*, R. Enke, January 2013, internal NPWS report).

The report identified six weed taxa that were considered to require management:

- African boxthorn *Lycium ferocissimum*
- Bathurst/Noogoorra burrs *Xanthium spinosum*/*occidentale*
- horehound *Marrubium vulgare*
- onion weed *Asphodelus fistulosus*
- Paterson's curse *Echium plantagineum*
- thornapples *Datura* sp.

The EPBC Protected Matters Search Tool listed six weeds of national significance (WoNS) as "Species or species habitat likely to occur within area" in the vicinity Mallee Cliffs NP:

- bridal creeper (*Asparagus asparagoides*)
- cabomba (*Cabomba caroliniana*)
- Ward's weed (*Carrichtera annua*)
- boneseed (*Chrysanthemoides monilifera*)
- water hyacinth (*Eichhornia crassipes*)
- African boxthorn (*Lycium ferocissimum*)
- willows (*Salix* spp).

Of these, only Ward's weed and African boxthorn have been found in the Mallee Cliffs NP. They are listed as noxious under the NSW *Noxious Weeds Act 1993* and are subject to the following control requirements. Willows, water hyacinth and cabomba are riparian or aquatic plants for which there is virtually no suitable habitat on the park.

- African boxthorn is a Class 4 Locally Controlled Weed: the growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed.

- Ward's weed is a Class 5 Restricted Plant: the requirements in the *Noxious Weeds Act 1993* for a notifiable weed must be complied with but there are no requirements to control existing plants.

Threatened Flora and Threatened Ecological Communities

Field surveys by AWC botanists and ecologists were carried out in March 2017 and August 2017. The possible presence of one threatened plant species, Bitter Quandong (*Santalum murrayanum*, endangered, BC), was noted in the vicinity of the proposed CFAI (including along the route of the alternative access track). No other threatened plants were recorded within the proposed CFAI.

No threatened ecological communities (TEC) were recorded within the proposed CFAI, although remnants of the Endangered Ecological Community, 'Sandhill Pine Woodland in the Riverina, Murray-Darling Depression and NSW South Slopes Bioregions' in poor condition are reported to remain in Mallee Cliffs NP (Ryan Duffy, OEH, pers. comm. 2017).

AWC botanists considered that another three BC-listed threatened plant species (of which, one, Yellow Swainson-pea, *Swainsona pyrophila,* is also EPBC listed) have a moderate to high chance of occurring in the vicinity of the proposed CFAI (Table 20). However, the timing of the field surveys were not conducive to locating these species, either because they germinate only after fire (Yellow Swainson-pea), are annual (Mossgiel Daisy, *Brachyscome papillosa*) or would likely be reduced to underground tubers at the time of survey (Cobar Greenhood, *Pterostylis cobarensis*).

AWC botanists also noted the occurrence of a single stand (37 individuals) of a regionally-significant tree species, *Callitris verrucosa* (Figure 32), near the proposed fenceline. Recruitment of this species and its cogener *Callitris glaucophylla* has been suppressed by feral herbivores on Mallee Cliffs NP (NPWS Buronga, pers. comm.).

Santalum murrayanum, endangered, BC Act

This species is found between inland southern WA through SA, east to north-western Victoria and south-west NSW. In NSW, it is usually found in mallee communities on dune crests with deep, well-drained soils (OEH 2017d).

Four individuals of a *Santalum* species were detected close to the proposed fenceline. They are almost certainly *Santalum acuminatum* (Sweet Quandong) rather than *Santalum murrayanum* based on the very green, rather than grey-green leaves, and the large leaf size. However, fruit is required to confirm the plants are this species. One of the four trees was old enough to be fruiting but no fruit could be located. For the purpose of this REF, in line with the precautionary principle, it will be assumed that these four individuals are *S. murrayanum.* However, none of them are closer than 20 m to the proposed fence and would not be directly impacted.

No *S. murrayanum* were detected along or near the locations of the proposed management tracks (including the alternative access track), nor at the proposed operations base site.

Callitris verrucosa, Regionally Significant, not listed under BC Act or EPBC Act

A single colony of *Callitris verrucosa* was found along the proposed fenceline (Figure 32). Grazing by rabbits and goats may affect successful recruitment of this species. Most of the colony (37 individuals) would be avoided by the current fence and track alignments.

Figure 32: *Callitris verrucosa* recorded near the proposed CFAI

Fauna and their habitats

Species Richness

AWC conducted fauna surveys in spring 2016 and autumn 2017, during which a total of 130 species were recorded. These comprised:

- 78 species of bird
- 8 species of mammal
- 37 species of reptile
- 7 invasive species.

A full list of the fauna detected during the AWC field surveys to date is provided in Appendix 4. Fauna are referred to by their common names in this section of the REF. The corresponding scientific names are provided in Table 9.

Table 9: Scientific and common names of fauna species mentioned in Section 5.8.4 of this REF

Common name	Scientific name
Broad-banded Sand-swimmer	*Eremiascincus richardsonii*
Chestnut Quail-thrush	*Cinclosoma castanotum*
Dusky Woodswallow	*Artamus cyanopterus cyanopteru*
Gilbert's Whistler	*Pachycephala inornata*
Hooded Robin	*Melanodryas cucullata cucullata*
Jewelled Gecko	*Naultinus gemmeus*
Major Mitchell's Cockatoo	*Lophochroa leadbeateri*
Mallee Worm-lizard	*Aprasia inaurita*
Malleefowl	*Leipoa ocellata*

Common name	Scientific name
Pied Honeyeater	*Certhionyx variegatus*
Plains-wanderer	*Pedionomus torquatus*
Purple-gaped Honeyeater	*Lichenostomus cratitius*
Australian Pipit	*Anthus novaeseelandiae*
Shrubland Morethia Skink	*Morethia obscura*
Shy Heathwren	*Calamanthus cauta*
Southern Mallee Ctenotus	*Ctenotus atlas*
Southern Ningaui	*Ningaui yvonneae*
Southern Scrub-robin	*Drymodes brunneopygia*
Spotted Harrier	*Circus assimilis*
Striated Grasswren	*Amytornis striatus*
Varied Sitella	*Dapoenositta chrysopters*
Western Blue-tongue Lizard	*Tiliqua occipitalis*
Western Pygmy-possum	*Cercartetus concinus*
White-fronted Chat	*Epthianura albifrons*

Fauna habitats

Mallee Cliffs NP comprises extensive areas of flat to undulating red sandy plains and sand dunes. There are no permanent streams or natural water bodies within the Mallee Cliffs NP.

At least 205 animal species have been recorded in Mallee Cliffs NP. Eighteen of those known to still occur are listed as threatened under NSW legislation, while a further eight listed species are considered to have a moderate to high likelihood of being present in the park (Appendix 5). Threatened species include Malleefowl, Major Mitchell's Cockatoo, Southern Scrub-robin, Shy Heathwren, Varied Sittella, Chestnut Quail-thrush, Gilbert's Whistler, Hooded Robin, Western Pygmy-possum, Southern Ningaui, Mallee Worm-lizard, and Jewelled Gecko. The Lower Murray-Darling Rivers region, of which Mallee Cliffs NP is a part, contains 62% of all recent Malleefowl records in NSW.

Key landscape processes that have substantially influenced habitat complexity and availability at Mallee Cliffs are fire and grazing (with associated woodland clearing). Historic grazing regimes in Mallee Cliffs have resulted in the establishment of derived vegetation communities. The most notable effects are the existence of open herblands and *Dodonaea viscosa* subsp. *angustissima* shrubland. It is likely that these areas once supported communities associated with heavy soils such as chenopod shrublands or arid woodlands, and mallee open scrub. Mallee Cliffs NP presents some regionally-unique habitat features, particularly in mallee woodland communities, as it has remained largely unburnt following major fires in 1974 and 1975. Large areas of long-unburnt mallee are important habitat for the endangered Malleefowl and are associated with higher bird species richness and abundance than younger successional stages and smaller unburnt areas (Berry et al. 2015). Old-growth mallee also supports tree-hollows which provide habitat for Western Pygmy-possums and a range of threatened bird species.

There are six habitat types relevant to this REF. The types are based on the Morcom and Westbrooke (1990) vegetation community classifications augmented by information about

vegetation structure and available habitat resources derived from field observations of AWC staff. The six habitat types within the vicinity of the proposal are:

- Mallee woodland with open understorey
- Mallee woodland with shrub understorey
- Mallee woodland with spinifex understorey
- Open casuarina woodland
- Shrubland
- Open herbland.

These habitats are described below. For the purpose of designing the fauna surveys, these six types were condensed to four by combining two similar habitats that occur as a mosaic and excluding the shrublands which occupy only a small area. The fauna survey groupings were:

- Mallee with shrub (combined Mallee woodlands with open and shrub understoreys)
- Mallee with spinifex
- Low open woodland (equivalent to the Open casuarina woodland habitat)
- Low open herbland (equivalent to the Open herbland habitat)

A summary of the main fauna species occurrences within the four habitat groups is presented in Appendix 4.

Mallee woodland with open understorey and Mallee woodland with shrub understorey

These two habitat types comprise 34,008 ha or approximately 59% of the Mallee Cliffs NP. The open understorey woodlands are dominated by single stands of *Eucalyptus oleosa*, which differs from Mallee woodlands with shrub or spinifex understoreys which have several species of mallee in the canopy. The open understorey has a high cover of exotic species; predominantly Ward's weed (*Carrichtera annua*), grasses and scattered small shrubs (*Sclerolaena* spp and *Maireana* spp). These woodlands occur on heavier clay soils than Mallee woodlands with shrubby understoreys. The presence of *E. oleosa* as the dominant canopy species also suggests that the distribution of this habitat type is driven by gradients in soil moisture and salinity. However, the presence of open understoreys in Mallee woodland communities can also be partly attributed to the historical pastoral use of Mallee Cliffs NP. Recovery of shrubs in these communities may be suppressed by potentially high current grazing pressures and fire suppression.

The structure of Mallee woodland with an open understorey is variable. Groundcover plants such as grasses present important foraging resources (seeds, pollen and nectar) for a range of woodland birds, small mammals and reptiles. Thick tussocks also provide sources of cover from predators. However, the high cover of exotic weeds such as Ward's weed may limit the use of this habitat type by some species.

Mallee woodlands with shrubby understorey are co-dominated by stands of mallees including *Eucalyptus gracilis*, *Eucalyptus dumosa* and *Eucalyptus socialis*. Common shrubs include *Cassia eremophilla*, *Dodonaea viscosa* subsp*. angustissima*, *Zygophyllum* spp, *Westringia rigida*, *Eremophila glabra*, *Chenopodium curvispicatum* and *Grevillia heugelii*. Invasive and exotic species occur infrequently in this habitat. It has a diversity of food shrubs that are critical to ensure continuity of food for Malleefowl during lean times such as droughts (Harlen and Priddel 1996). This is supported by studies showing that Malleefowl are more abundant in areas where shrubs are more diverse (Woinarski 1989).

Mallee woodlands with shrubby understorey habitat provide a wide range of foraging (seeds, pollen, nectar) and shelter (logs, tussocks, shrubs, tree hollows) resources for fauna. The high heterogeneity in niche availability presented by the richness in available micro-habitats within this habitat type indicate that reptile, amphibian, mammal and bird species richness is

likely to be higher in this community than in surrounding open woodland habitats. Complex midstorey structures of a mature shrub layer provide opportunities for perching and nesting. Hollow-bearing trees, decorticating and fallen bark, logs and fallen branches all provide suitable nesting and foraging substrates for a range of fauna.

Mallee with spinifex understorey

Mallee woodlands with a spinifex understorey comprise 9,040 ha or about 16% of the Mallee Cliffs NP, representing the second most common habitat group. Mallee with spinifex woodlands are co-dominated by stands of mallees including *Eucalyptus gracilis*, *Eucalyptus dumosa* and *Eucalyptus socialis*.

Mallee with spinifex communities occur throughout the project area predominantly on linear east-west dunes with shallow sand soils but there is a large contiguous area in the south of the park.

Mallee with spinifex habitats within Mallee Cliffs NP are of high conservation value. In long-unburnt areas of Mallee with spinifex, there is a large amount of bare ground between large spinifex rings, with high levels of litter accumulation. These long-unburnt areas provide breeding habitat for Malleefowl, which construct mounds in the soft sandy soils and utilise moist litter during egg incubation. Additionally, Mallee with spinifex habitats are associated with a number of mallee-specialist species, which make use of the dense and spiny structures provided by spinifex as shelter from predators and as a source of food. The soft sandy substrates in this community are also ideal for burrow construction. Mallee with spinifex specialists include Southern Ningaui, Striated Grasswren, Shrubland Morethia Skink, Broad-banded Sand-swimmer and Southern Mallee Ctenotus.

Open casuarina woodland

Open casuarina woodlands comprise 7,914 ha or about 14% of Mallee Cliffs NP. Open casuarina woodlands are dominated by stands of *Casuarina cristata* subsp. *pauper*. These communities are also associated with patches of Western Rosewood, *Alectryon oleifolius* subsp. *canescens*, although this species can occur in single stands throughout the Mallee Cliffs NP. Open casuarina woodland occurs on loamy sand soils in swales. These soils hold moisture for longer periods than surrounding sandy areas and may support small ephemeral pools.

Open casuarina woodland habitat provides a wide range of foraging (seeds, pollen, nectar) and shelter (logs, tussocks, shrubs, tree hollows) resources for fauna. This community is one of the few in Mallee Cliffs where the establishment of substantial, large tree hollows is likely (besides very ancient mallees). These larger tree hollows may act as nesting or denning sites for apex predators such as raptors or owls. The dense cover provided by *A. oleifolius* also presents habitat for a range of small woodland birds for shelter and nesting. These trees also provide resting and shade spots for macropods.

Shrubland

Shrublands comprising *Dodonaea viscosa* subsp. *angustissima, Maireana pyramidata* and *Maireana sedifolia* cover approximately 241 ha of the Mallee Cliffs NP. Shrublands can provide important habitat for threatened birds and mammals which present important foraging resources (seeds, nectar, pollen) and thick cover for protection from predators for shelter or nesting. Shrublands have a patchy and isolated distribution throughout Mallee Cliffs NP. Patches of *D. viscosa* shrubland can be associated with high levels of historic grazing and other disturbances.

Open herblands

This habitat covers 6,805 ha or 12% of Mallee Cliffs NP. Herblands in Mallee Cliffs are derived from prior intensive clearing and grazing practices in the park. Open herblands are distributed primarily along the central road through the Mallee Cliffs NP, although large areas also occur in the south and south-east. These herblands consist largely of annual herbs and grasses, many of which are exotic. The relative abundance of species fluctuates seasonally, and is highly dependent upon rainfall. Open herblands provide habitat for a limited number of open-country specialist birds such as Australian Pipit and White-fronted Chat. In sufficiently large areas, open herblands have the potential to provide habitat for the endangered Plains-wanderer, however this species has not been recorded in Mallee Cliffs NP. With a substantial reduction in grazing pressures, for example associated with the control of feral herbivores in the proposed fenced area, these areas have the potential to regenerate as chenopod shrubland.

Tree hollows

Key habitat components within Australian forest ecosystems are hollow-bearing trees (HBTs) which are crucially important for fauna species requiring tree hollows for diurnal shelter and nesting. The protection of HBTs, and the future supply of hollows used as shelter by hollow-dependent fauna, have been identified as important management objectives for the forests and woodlands of southern Australian forests for over four decades (Cowley 1971, Recher et al. 1987, Lunney et al. 1988, Law 1996).

In mallee woodlands hollows may form in vegetation between 50 and 60 years post-fire (Haslem et al. 2012). Fire-intervals also influence the occurrence and development of substantial tree hollows in mallee vegetation. Long inter-fire intervals result in an increased density of large, dead hollow-bearing stems.

In February 2017, AWC ecologists conducted detailed surveys for HBTs along the route of the proposed fenceline clearing. During the survey, trees with hollows were recorded by species, number of visible hollows and GPS co-ordinates.

AWC counted all types of tree hollows, beginning with those with hollow entrances 2-5 cm in diameter, which may be only suitable for small fauna such as *Antechinus* spp (previously present in the region – Krefft (1867) – but not recorded by NPWS or AWC to date) or micro-bats. Note that the survey covered a strip 12 m wide along the route of the fenceline, whereas it is proposed to clear only between 10 and 11 m. The total number of hollow-bearing trees found in each vegetation community along the surveyed route is shown in Table 10. About 500 trees possessing at least one small hollow were recorded in the 45 ha area surveyed (which contained the 41 ha strip to be cleared) along the 37.2 km length of the conservation fence.

It is important to note that this represents less than 0.1% of the total hollow-bearing trees in the project area – i.e. the loss of hollows as a result of the project is not environmentally significant.

The operations base has a low density of trees, and very few, if any are likely to be removed. Any hollow-bearing trees will be retained.

Table 10: Total number of hollow-bearing trees recorded within 6 m either side of the proposed conservation fence, by Plant Community Type (PCT).

Plant Community Type (PCT)	Estimated area of PCT in the 12 m wide strip centred along the fenceline (ha)	Total number of hollow-bearing trees	Average number of hollows per tree
PCT 170	26.3	336	1.2
PCT 166 (disturbed)	9.0	63	1.5
PCT 171/172	5.3	27	1.4
PCT 58	3.5	54	0.9
Derived Shrubland from PCT 170	0.6	3	2.0
Other	0.0	0	0.0
Total		**514**	

Biological Legacies

Fallen timber, large bark strips, hollow-bearing logs, dense layers of leaf litter and other habitat can provide essential habitat for ground and fossorial mammals, reptiles, birds and invertebrates. These habitat features form over long periods of time in the absence of major disturbances such as logging and large-scale high-intensity wildfires. As such, they are commonly referred to as 'biological legacies'. Due to the long-term absence of fire and the selective nature of past logging operations in the project area, there is a high availability of such features in the landscape. Within the fenceline and operations base clearings, there is likely to be a loss of such features. However, given the high abundance of these features across the landscape and the minimal area to be cleared, there is likely to be little adverse effect of the loss of these features on fauna. Additionally, trees which will be felled to clear the fenceline corridor can be placed on the ground to supplement the initial loss of hollow-bearing logs and dense litter cover. These new logs will degrade over time, providing habitat for ground-dwelling fauna.

Threatened Fauna

A thorough evaluation of the threatened and migratory biota which are likely to occur within the vicinity of the CFAI study area was carried out and identified that:

- 18 fauna species listed as threatened under NSW legislation were known to occur (of which one, the Malleefowl is also listed under the EPBC Act);
- 8 additional fauna species listed as threatened under NSW legislation had a moderate to high potential of occurring (with none listed under EPBC Act);
- 1 migratory species listed under the EPBC Act had a moderate likelihood of occurring (Fork-tailed Swift).

Details of the evaluation and its results are in Appendix 5.

A total of 17 of the threatened fauna species were confirmed in Mallee Cliffs NP during the spring 2016 and autumn 2017 surveys by AWC. Most bird species were recorded during formal bird surveys. Those that were recorded multiple times appear not to be confined to a single area, but rather distributed across the Mallee Cliffs NP. The threatened animal species recorded are:

- Chestnut Quail-thrush, vulnerable BC Act
- Dusky Woodswallow, vulnerable BC Act
- Gilbert's Whistler, vulnerable BC Act
- Hooded Robin, vulnerable BC Act
- Major Mitchell's (Pink) Cockatoo, vulnerable BC Act
- Malleefowl, endangered BC Act, vulnerable EPBC Act
- Pied Honeyeater, vulnerable BC Act
- Purple-gaped Honeyeater, vulnerable BC Act
- Shy Heathwren, vulnerable BC Act
- Southern Scrub-robin, vulnerable BC Act
- Spotted Harrier, vulnerable BC Act
- Varied Sittella, vulnerable BC Act
- White-fronted Chat, vulnerable BC Act
- Western Pygmy-possum, Endangered BC Act
- Mallee Worm-lizard, Endangered BC Act
- Jewelled Gecko, Vulnerable BC Act
- Western Blue-tongue Lizard, vulnerable BC Act

The locations of threatened bird species recorded by AWC during the field surveys are shown in Figure 33 and the number of observations and relative abundances are provided in Table 11. Several species were incidental sightings rather than records from surveys, and these are not included in Table 11.

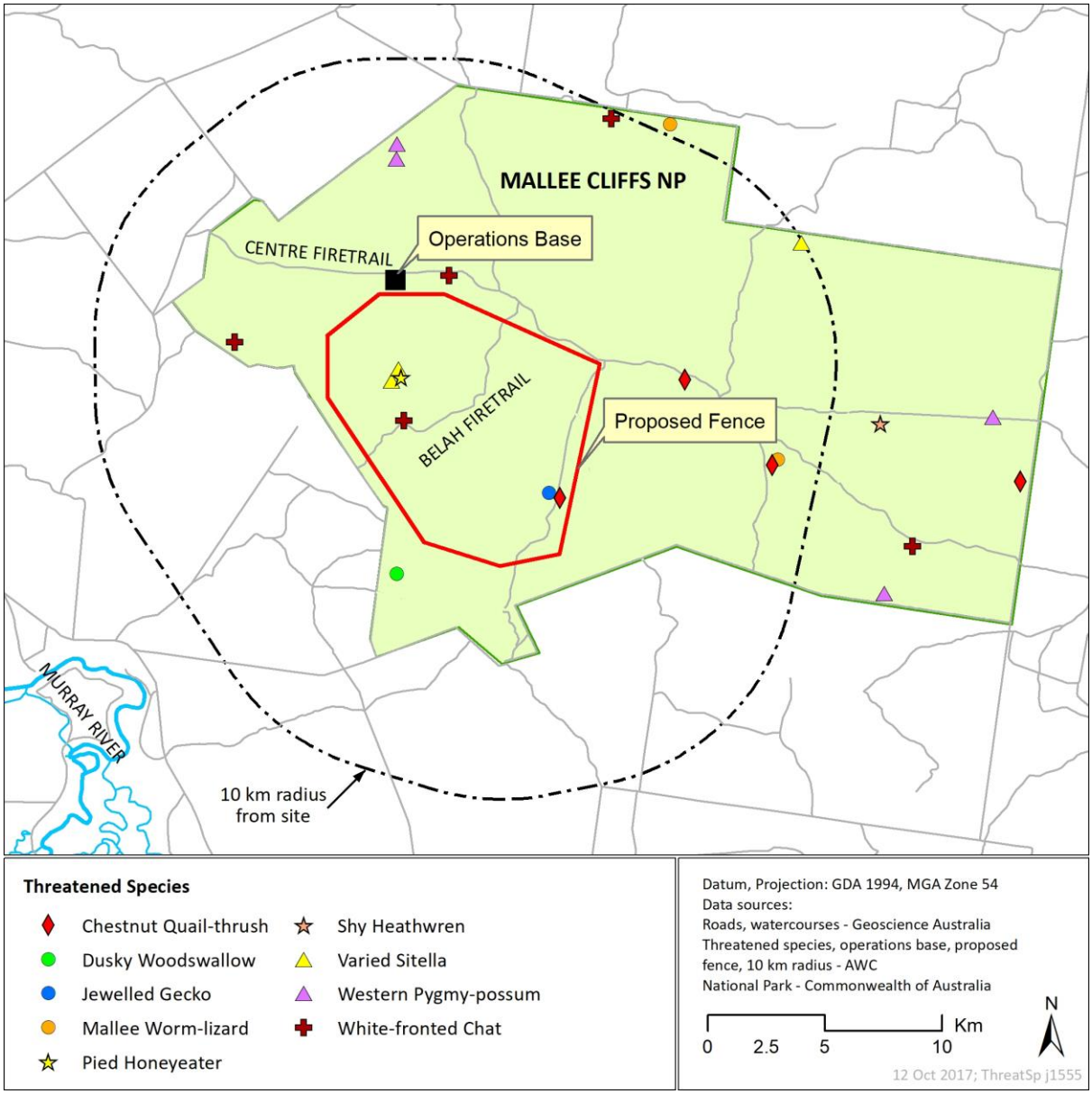


Figure 33: Locations of threatened fauna recorded by AWC during the spring 2016 and autumn 2017 field surveys

Table 11: Threatened species observed during the spring 2016 surveys conducted in Mallee Cliffs NP. EPBC (Environment Protection and Biodiversity Conservation Act 1999) and BC (Biodiversity Conservation Act 2016) threatened status is provided, with total observations and relative abundance (* diurnal bird records per total counts, n=150)

Birds	EPBC	BC	Observations	Relative Abundance
Varied Sittella (*Dapoenositta chrysopters*)		Vulnerable	22	0.147
Dusky Woodswallow (*Artamus cyanopterus cyanopteru*)		Vulnerable	7	0.047
Chestnut Quail-thrush (*Cinclosoma castanotum*)		Vulnerable	4	0.027
Gilbert's Whistler (*Pachycephala inornata*)		Vulnerable	11	0.073
Pied Honeyeater (*Certhionyx variegatus*)		Vulnerable	3	0.020
Shy Heathwren (*Calamanthus cauta*)		Vulnerable	1	0.007
White-fronted Chat (*Epthianura albifrons*)		Vulnerable	14	0.093
Hooded Robin (*Melanodryas cucullata cucullata*)		Vulnerable	2	0.04
Mallee Worm-lizard (*Aprasia inaurita*)		Endangered	2	0.11
Jewelled Gecko (*Naultinus gemmeus*)		Vulnerable	1	0.04
Western Pygmy-possum (*Cercartetus concinus*)		Endangered	4	0.22

The potential for other threatened fauna species to occur within the vicinity of the proposed CFAI has been assessed in the threatened and migratory biota evaluations in Appendices 5 and 7.

The locations of Malleefowl mounds recorded near the proposed routes of new tracks are shown in Figure 34.

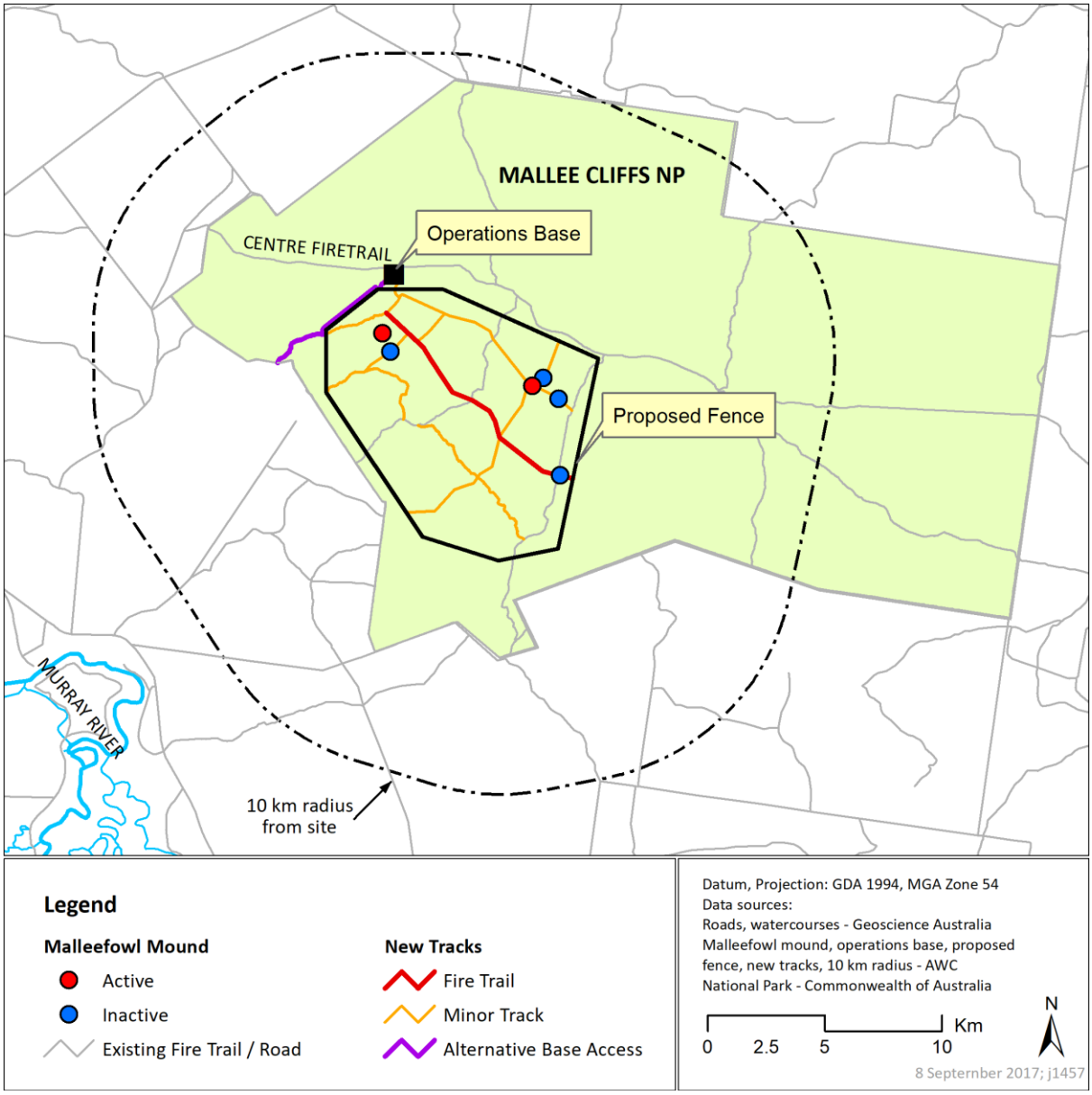


Figure 34: Locations of Malleefowl mounds (active and inactive) recorded during surveys of routes of proposed tracks, August 2017

5.8.5 Assessment of affected species

Affected species are those considered to have some potential to be impacted by the proposal as they are known to either occur within the study area, or have a high potential to occur within the study area based on available habitat but went undetected. Affected species are identified in the threatened and migratory biota assessments in Appendices 5 and 7, and are the subject of detailed impact assessments (5-part tests of Significance Assessments, Appendix 6, and EPBC assessments, Appendix 7).

5.8.6 Impact assessment

This REF provides a detailed assessment of the anticipated potential direct and indirect impacts of the proposal in Section 6. This REF includes a range of recommended impact

amelioration measures designed specifically to mitigate any adverse effect of the proposal on threatened and migratory biota.

This REF assumes that the amelioration measures detailed would be fully implemented should the proposal be approved.

5.9 AREAS OF OUTSTANDING BIODIVERSITY VALUE

No areas of outstanding biodiversity value as listed under the BC Act occur within the study area. Therefore, these will not be affected.

5.10 WILDERNESS (NOMINATED OR DECLARED)

There is no area of wilderness (nominated or declared) within or adjoining the study area. Therefore, the proposal will not affect any area of wilderness.

5.11 HISTORIC HERITAGE

Searches of relevant databases (Protected Matters Search Tool, NSW State Heritage Register and Australian Heritage Database), Wentworth LEP and information obtained from NPWS by AWC were carried out. No known heritage items were located in the vicinity of the proposed fence, operations base or new tracks. However, a field survey for Aboriginal cultural heritage by Onsite Cultural Heritage Management (see Section 5.12 below and Appendix 10) identified a site of 'Historical artefact scatter' (consisting of tin cans, bottles and a 1963 coin) that was probably a transient stockman's camp. The site (referred to as HS1 in Appendix 10) is close to the proposed fenceline, and although it was considered unlikely that it would be classified as having local or state heritage significance, the recommendation was made that the fence alignment be changed by 20 m to avoid the site. This recommendation was adopted in the siting of the fenceline.

5.12 ABORIGINAL CULTURAL HERITAGE

AWC engaged Onsite Cultural Heritage Management to prepare an Aboriginal Cultural Heritage Assessment report in relation to the proposal. The report is appended to this REF in full (Appendix 10).

The assessment report was prepared in accordance with the OEH *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW* (OEH 2011) and the *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW* (OEH 2010).

The assessment identified no heritage items that would be affected by the proposal. An Aboriginal Heritage Impact Permit will not be required. The report recommends that the location of any potential sites will be near or adjacent to non-permanent water sources such as clay pans and that the fence should avoid these sites by 200m. This has been taken into consideration with the fence alignment and there is no impact on non-permanent water sources.

5.13 RECREATION VALUES

Mallee Cliffs NP is limited in terms of recreational values, and a policy of limited public access is consistent with the priority given to the protection of Malleefowl and other threatened species (NPWS 1998). The Mallee Cliffs NP receives a limited amount of use by community groups and educational institutions, including for the purpose of Malleefowl surveys.

5.14 SCENIC AND VISUALLY SIGNIFICANT AREAS

Mallee Cliffs NP is a generally homogenous landscape in western NSW. The PoM does not identify any specific scenic or visually significant areas within the Mallee Cliffs NP.

5.15 EDUCATION AND SCIENTIFIC VALUES

Mallee Cliffs NP provides opportunities for education and scientific study particularly in areas such as fire ecology and threatened species such as Malleefowl. These are supported by OEH policy and outlined within the existing PoM.

5.16 MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

The Protected Matters Search Tool (EPBC Act) was used to provide a summary of Matters of National Environmental Significance (NES) for a 50 km radius around a central point in the proposal area (34.23519 degrees S; 142.68376 degrees E). The matters of NES identified were:

- 1 Listed Threatened Ecological Community
- 26 Listed Threatened species
- 8 Listed Migratory Species

This REF includes analysis and assessment of the threatened ecological community and listed threatened and migratory species (Appendix 7). The assessments identified that some biota listed under the EPBC Act have the potential to be affected by the proposal. For these biota, significance assessments under the EPBC Act are provided in Appendix 7. The proposal is *unlikely* to have a *significant impact* in accordance with the Significant Impact Criteria (DOTE 2013).

No other matters of NES are relevant to the proposal. The listed wetlands are located 100 km or more from the proposal and therefore would not be impacted.

The Protected Matters Report is in Appendix 2.

6 IMPACT ASSESSMENT

6.1 DIRECT IMPACTS

6.1.1 Removal of feral predators and herbivores

Feral predators

Feral predators (feral cats and foxes) are considered the primary cause of the extinction of Australia's mammals, and feral cats are rated the primary threat to extant mammal species (Woinarski et al. 2014). Both cats and foxes take a wide range of native species besides mammals, including birds, lizards, frogs and invertebrates. There are millions of feral cats across Australia (Legge et al. 2017) and millions of foxes across the southern two-thirds of Australia (Saunders et al. 2010).

Some threatened native species (especially some small to medium-sized mammals) persist only in the complete absence of cats and foxes. There are currently no effective control techniques for eradicating cats and foxes at a landscape scale. The only option for permanently removing feral cats and foxes from part of mainland Australia is the construction of conservation fencing, the eradication of cats and foxes from within the fenced area, and ongoing maintenance of the integrity of the fence (such as the proposal which is the subject of this REF). In other words, for a suite of threatened mammal species, the establishment of large fenced, feral-free areas is the only effective strategy for delivering a significant recovery in populations.

Some threatened native species can persist in the presence of feral cats and foxes, provided densities of these feral predators are sufficiently low and/or habitats are sufficiently complex to provide refuge for native animals. However, outside of south-western Australia, there are very few, if any examples of sustained, long-term control of foxes and cats that have driven significant improvements in threatened fauna populations, especially reintroduced threatened mammals, at a landscape level. In particular, there is no effective strategy for the large-scale eradication of feral cats. The options for fox control at the landscape scale are more effective: however, control of foxes alone is not sufficient for conservation of many threatened species and recent evidence has shown that fox control can result in an increase in the cat population, with adverse consequences for vulnerable wildlife. For example, the recent decline of Brush-tailed Bettongs in south-west Western Australia has been attributed to increased levels of cat predation following long-term fox control (Marlow et al. 2015).

The eradication of feral cats and foxes is therefore an integral component of AWC's plans to reintroduce 'extinct in NSW' mammals as described in this REF. Eradication of feral predators will also benefit extant native species, particularly small to medium-sized mammals, and ground-active birds including threatened species such as Malleefowl and Chestnut Quail-thrush.

If implemented, the proposal will have a substantial positive impact on native fauna by permanently removing feral cats and foxes from a 9,570 ha area. Many of the fauna species in this area – including threatened species such as the Malleefowl, Chestnut Quail-thrush, Western Pygmy-possum, Southern Ningaui, Western Blue-tongued Lizard – are currently or likely subject to substantial predation by feral cats and foxes. The removal of this predation is likely to result in an increase in the population of these species within the feral predator-free area.

- The densities of cats and foxes in Mallee Cliffs NP have yet to be robustly quantified. Both species were frequently detected in baseline surveys conducted by AWC in

2016 and 2017. Foxes were detected in 53 of 62 cameras and cats in 16 of 62 cameras set along roads in the Mallee Cliffs NP in 2017. Spotlighting surveys conducted by AWC in 2016 estimated cat density at 0.3 individuals/km^2 and fox density at 1.1 individuals/km^2. However, spotlighting generally underestimates densities of foxes and cats, often by a large margin (Read and Eldridge 2010; McGregor et al. 2015). That is, the spotlight data place a lower bound on likely densities.

- Density estimates from more robust survey methods (camera, telemetry or removal studies) from moderately similar locations are:
    - Hattah-Kulkyne NP, Victoria: cats 0.34-3.5/km^2 (mean: 1.6/km^2) (Jones and Coman 1982);
    - Yathong NP, NSW: foxes 2.0/km^2, cats 0.9/km^2 (Newsome et al. 1989);
    - Scotia, NSW: foxes 3/km^2, cats 2.4/km^2 (Silvey et al. 2015);
    - Big Desert National Park, Victoria: cats 1.1/km^2 (Legge et al. 2016).
- Extrapolating from these studies, there may be between 30 and 150 cats (density 0.3-1.6/km^2) and 100 and 200 foxes (density 1.1-2/km^2) in the 9,570 ha area proposed for fencing on Mallee Cliffs NP.
- Both feral cats and foxes are opportunistic, generalist predators (Jones and Coman 1982; Saunders et al. 2010; Doherty et al. 2015): in Mallee Cliffs NP, they can be expected to eat native animals (small mammals, reptiles, birds and frogs) and feral animals (rabbits, mice). Feral cats are reported to kill in the order of 7 prey items per cat per night (McGregor et al. 2015).
- Assuming native animals make up half the prey of feral cats in Mallee Cliffs NP, 30-150 feral cats may be killing in the order of 100-500 native animals per night or between 36,000 and 180,000 native animals per year in the 9,570 ha area proposed for fencing.
- Foxes can be assumed to be having a similarly large impact, given their density in Mallee Cliffs.

The permanent exclusion of feral cats and foxes from this area will therefore deliver a very substantial benefit for a large number of extant fauna species. Long-term monitoring by AWC at Scotia has shown increased numbers/activity of extant ground-dwelling mammals (Southern Ningaui, Bolam's Mouse) and ground-active birds including Chestnut Quail-thrush and Malleefowl following the permanent exclusion of foxes and cats.

Finally, the implementation of more intensive feral cat and fox control across the balance of the project area is also expected to deliver substantial benefits for a range of extant fauna, although the scale of the response will depend on the effectiveness of such intensive control.

Eradication of feral predators also has the potential to result in increased populations of smaller introduced herbivores (rabbits and hares). For this reason, AWC will conduct integrated control of feral predators and herbivores within the proposed feral-free fenced area.

Feral herbivores

Feral herbivores present within the vicinity of the proposal include goats and rabbits. Feral herbivores can have a range of adverse impacts on native species and ecosystems, including:

- a reduction in ground cover of palatable plant species, particularly in heavily utilised areas (productive soils, river flats and other vegetation near water);
- inhibition of the recovery of ground cover on recently burnt sites;
- an increased exposure of ground-dwelling mammals, birds and reptiles to predation by feral predators (McGregor et al. 2014);

- a reduction in seeds of palatable grasses, affecting seed-eating fauna such as finches;
- increased soil erosion and reduced water quality due to loss of ground cover, trampling of stream channels and fouling of waterholes;
- increased spread of some weeds (Parsons and Cuthbertson 2001; Muntze et al. 2016).

AWC will aim to eradicate all large feral herbivores from within the proposed feral-free fenced area, and reduce the densities of small feral herbivores (rabbits, hares) to ecologically insignificant levels. Outside the proposed feral-free fenced area, AWC will aim to reduce densities of all feral herbivores to ecologically insignificant levels. What constitutes this level will be determined empirically, by implementation of AWC's Ecological Monitoring Framework (Appendix 12). Available literature suggests rabbit densities need to be reduced below 0.5/ha for impacts to be below ecologically significant levels (Muntze et al. 2016).

The ecological consequences of AWC's actions are likely to be the reverse of those listed above, i.e. an increase in cover of palatable plant species, more rapid recovery after fire, reduced exposure of native animals to predators, reduced soil erosion and a reduction in the spread of some weeds. This will deliver substantial benefits to the biodiversity of Mallee Cliffs NP.

6.1.2 Reintroduction of extinct mammals

In NSW, 25 mammals are listed as extinct under the NSW BC Act, while over 50% of surviving mammal species are listed as threatened. Extinctions and declines have fallen most heavily on small to medium-sized terrestrial mammals, in particular on the following taxa (Woinarski et al. 2014):

- Bettongs and potoroos (62% extinct or threatened)
- Bandicoots and bilbies (50% extinct or threatened)
- Small macropods (<5.5 kg) (45% extinct or threatened)
- Rodents (39% extinct or threatened)
- Dasyurids (20% extinct or threatened).

Most of AWC's reintroductions to Mallee Cliffs NP would be from these guilds (details of each species were provided in Section 4.4).

The direct benefit associated with the reintroductions will be a substantial increase in the population of 10 nationally threatened mammals: see Table 1 (reproduced below as Table 12). The establishment of a new population for each of these nationally threatened species, and the increase in the overall population for each species, highlights the enormous environmental benefit of the proposal.

Table 12: Reproduction of Table 1: Population of locally extinct mammals proposed for reintroduction into Mallee Cliffs National Park and the likely increase to population size should this proposal proceed

Species	Population estimate (2012)	Proposed Mallee Cliffs feral predator-free fenced area: potential population estimate*	Increase
Western Quoll	13,500	90 inside fence, plus up to 350 outside fence	1-3%
Red-tailed Phascogale	<10,000	1,700	17%
Numbat	<1,000	270	27%
Western Barred Bandicoot	3,000	1,600	53%

Species	Population estimate (2012)	Proposed Mallee Cliffs feral predator-free fenced area: potential population estimate*	Increase
Bilby	10,000	1,100	11%
Burrowing Bettong	14,500	2,900	20%
Brush-tailed Bettong	<18,000	1,800	10%
Bridled Nailtail Wallaby	2,300	2,150	93%
Greater Stick-nest Rat	4,500	1,800	40%
Mitchell's Hopping-mouse	>10,000	c. 1,000	c. 1%

*Note: Population estimates are based on best available data, using information on home range and/or density from areas of similar habitat and from other locations where feral predators are effectively controlled or absent, to the extent possible. Populations are expected to vary considerably with rainfall.

Consequences of reintroductions for ecological processes

Small to medium-sized terrestrial mammals participate in a number of important ecological processes (Garkaklis et al. 1998, James and Eldridge 2007, Eldridge and James 2009, James et al. 2009, Fleming et al. 2014, Hayward et al. 2016) including:

- soil and litter turnover, with consequences for nutrient and water retention, litter volume and potentially fire risk (bettongs, bandicoots, Bilbies);
- the dispersal of plants (e.g., Brush-tailed Bettongs are an important disperser of Sandalwood *Santalum* spp (Murphy et al. 2005);
- the dispersal of fungi (bettongs are specialist fungivores, but bandicoots, Bilbies, rodents and some macropods also eat fungi and disperse spores);
- herbivory (all except dasyurids);
- predation (dasyurids are specialist predators, but most other species are at least partly omnivorous).

Australian ecosystems are the product of millions of years of evolution involving small to medium-sized terrestrial mammals and the ecological processes in which they participate. For these reasons, the extinction and decline of small to medium-sized terrestrial mammals can be expected to have disrupted long-standing ecological processes.

Conversely, the reintroduction of small-medium terrestrial mammals can be expected to deliver a substantial ecological benefit by helping to restore historically-prevailing ecological processes. For example, the return of digging animals can be expected to result in rapid changes to rates of soil and litter turnover, and associated nutrient and water retention (Fleming et al. 2014, Garkaklis et al. 1998). The return of omnivores and predators is likely to help restore the structure of faunal assemblages. At AWC's Scotia sanctuary, the reintroduction of Bilbies and bettongs has resulted in a decline in scorpions (predatory invertebrates) and a subsequent increase in particular spiders (Silvey et al. 2015). Some of the changes in invertebrate assemblages associated with mammal reintroductions may have considerable knock-on impacts: e.g., termite activity at Scotia at the soil surface is much reduced in the presence of Bilbies, Burrowing Bettongs and Numbats, with possible consequences for rates of decomposition and turnover of organic matter (Coggan et al. 2016).

In summary, the changes to plant and animal assemblages and ecosystem processes that are associated with reintroductions can be assumed to be returning the system towards the historical condition. That is, reintroductions can be seen as a fundamental step in the

restoration of a wide range of long-standing, important ecological processes in the Australian biota.

Consequences of reintroductions for extant fauna

As noted above, the mammal species proposed for reintroduction to the Mallee Cliffs EMA project area participate in a number of ecological processes, including predation. The consequences for some invertebrates preyed on by these species (e.g. scorpions, termites) and knock-on effects for other invertebrates and ecological processes (more spiders, potentially slower decomposition) have been outlined above.

Consequences of reintroductions for extant vertebrates are less well understood. At AWC's Scotia sanctuary there is evidence that some species of skink are less common inside the fenced area than outside. The mechanisms involved are presumably indirect, given that skinks are diurnal and mammals nocturnal. In contrast, there is good evidence that extant small mammals at Scotia are much more abundant inside the fenced area than outside. That is, any impacts of potential competition or predation by reintroduced mammals on extant small mammals is outweighed by the positive impacts on extant mammals resulting from the eradication of feral cats and foxes from inside the fenced area. Similarly, there is evidence from Scotia that ground-active birds (e.g. quail-thrush) are more abundant inside than outside the fenced area, again presumably because of the control of feral predators inside the fenced area. Based on mound activity, Malleefowl breeding success also appears to be much higher inside the fenced area than outside.

The comprehensive monitoring planned at sites both inside and outside of the fence is designed to identify changes that may occur (see the draft EHMF in Appendix 12).

Consequences of reintroductions for vegetation

This REF addresses the issue of whether the reintroduction of regionally extinct mammals is likely to have any adverse impact on vegetation. Given the important ecological roles played by many small to medium-sized terrestrial mammals and the deep co-evolutionary history of the Australian biota, it is difficult to conclude that the restoration of native mammals is likely to have a negative impact on vegetation. However, it is necessary to consider whether, in the absence of pre-European predators (Dingoes and humans), population sizes of reintroduced mammals might reach 'artificially high' densities at reintroduction sites. At high densities, grazing by large native herbivores such as kangaroos can have significant impacts on vegetation (Letnic et al. 2012); however, impacts of smaller herbivores (bettongs, small macropods) are largely undocumented.

At Arid Recovery in SA, Burrowing Bettongs have been reintroduced and have reached relatively high densities within large fenced feral predator-free areas. A recent paper showed that some plant species are at low abundance in the presence of Burrowing Bettongs at Arid Recovery (Linley et al. 2017). However, that study focused on vegetation close to the communal burrows of the Burrowing Bettongs, where grazing pressure could be expected to be especially high. Whether the effects were more general across the area have yet to be established. Also, whether these effects are likely to occur in locations other than Arid Recovery is unknown; it may be that this particular impact associated with the reintroduced Burrowing Bettong is evident at Arid Recovery because it is generally so dry. For example, there is no obvious evidence of 'over-browsing' by reintroduced mammals at AWC sanctuaries in more mesic locations. Quantification of more subtle impacts is currently being assessed by AWC's monitoring program (see below).

In some cases, particular concern has been raised about impacts of reintroduced herbivores on threatened plants. For example, at Mulligan's Flat in the ACT there has been some concern that the reintroduced Eastern Bettong may reduce numbers of a threatened ground

orchid. While bettongs do favour the orchid for food, current research suggests those impacts may be balanced by positive impacts of the bettong on the orchid through soil engineering (diggings facilitate nutrient and water retention, and hence can increase recruitment: Ross 2016).

When considering the consequences of the project for vegetation, the positive impacts of the control of feral herbivores, including the eradication of goats and other large feral herbivores from inside the fenced area, must also be taken into account. These consequences are outlined in Section 6.1.1 above. The removal and control of feral herbivores, including rabbits, will have a very substantial positive environmental impact.

AWC is currently establishing a research project to study the outcomes of reintroductions and associated feral animal control on vegetation on all sanctuaries with existing or proposed fenced areas. Replicate permanent plots, stratified by vegetation type, have been established inside and outside fenced areas at Scotia, Newhaven and Mt Gibson sanctuaries, with plots to be established at remaining sanctuaries during 2017 and 2018. In Mallee Cliffs NP, AWC would apply the same methodology to monitor the consequences of reintroductions and associated control of feral herbivores for vegetation structure and composition. Permanent 1 ha vegetation plots will be established inside and outside the fenced area proposed for reintroductions. Baseline surveys will be conducted in 2017.

The initial plot set-up and ground stratum measurements are based on a systematic two-stage sampling design. The base plot for ground structure is 100 x 20 m in size, and within each of these, 120 subplots (1 x 1 m) are placed along five transects to record the frequencies of each ground and shrub layer species. Plant species are also allocated to guilds to identify any changes in broader groups. Along each of the five transects in a base plot, the substrate type, ground layer cover, shrub cover, and canopy cover are recorded at 101 points using a point intercept method. Woody debris and hollow logs are recorded by size class using a line intercept or transect method. Tree densities are measured over an area of 1 ha around each base plot to capture all tree size classes.

AWC would also establish plots in areas of known habitat for threatened plant species, and monitor outcomes of mammal reintroductions for these species by comparing sites inside and outside the fence.

Consequences of reintroductions: summary

The reintroduction of regionally extinct mammals is expected to help restore the structure of plant and animal assemblages, and ecological processes, to the historical condition prevailing in the Mallee Cliffs EMA project area. There are not expected to be any significant adverse impacts on extant fauna or flora as a consequence of reintroductions; rather, positive outcomes are expected. AWC will robustly monitor outcomes for plant and animal assemblages, and selected ecological processes. The project and associated monitoring and research will add significantly to existing knowledge of the Australian biota.

6.1.3 Management of any excess reintroduced mammals

As noted above, in the absence of pre-European predators (Dingoes and humans), population sizes of some reintroduced mammals may eventually become relatively abundant within the fenced area. Reintroduced mammals are expected to alter the abundances of some extant plants and animals, such as preferred prey species; these impacts are likely to be particularly evident when reintroduced mammals attain high densities (Linley et al. 2017). Adverse impacts on species of particular conservation concern at Mallee Cliffs NP, such as Malleefowl, are not expected – for example, Malleefowl breeding success is higher inside the fence at AWC's Scotia sanctuary, in the presence of populations of reintroduced mammals established for over 10 years, than outside the fence. However, given the lack of baseline

data, such as quantitative information on the historically prevailing abundances of any species, it is difficult to determine the 'carrying capacity' of the fenced area for reintroduced mammals ahead of the reintroduction, or whether abundances are 'too high' when compared with the historical condition. Further, to the extent the abundances of reintroduced mammals are regulated primarily by resource availability, rather than by predation, considerable variation in the abundance of both reintroduced mammals and their preferred food plants or prey can be expected over time, ultimately driven by rainfall. These 'boom/bust' cycles are characteristic of biota in the Australian semi-arid zone (e.g. Peacock and Abbott 2014).

For these reasons, it is not possible to identify 'triggers' for management intervention ahead of reintroductions. Instead, in accord with the draft EHMF and with the Translocation Proposal to be developed, AWC will monitor key elements of the biota (vegetation, fauna) as well as population sizes of reintroduced mammals, and ecological processes such as soil disturbance, to determine empirically the consequences of reintroductions. AWC's thorough and long-term monitoring programs are designed to provide the information needed to identify whether any trends are significant. If impacts of reintroduced mammals on extant biota develop that are considered to lie outside the bounds of acceptable change, AWC may seek to reduce those impacts by:

- reducing the population size of reintroduced mammals through:
    - release of a proportion of individuals outside the fence (this action is part of the next stage of the project, but would only occur in conjunction with intensive feral predator control outside the fence);
    - translocation of individuals to another reintroduction site (AWC has multiple reintroduction sites for the candidate species); or
    - other means, such as introduction of terrestrial native predators such as the Western Quoll (which is planned for reintroduction at Mallee Cliffs NP).
- reducing impacts of reintroduced mammals on particular plants – e.g. threatened plants – by exclusion fencing within the reintroduction site; this approach has been adopted at Mulligan's Flat, although there it is primarily for research purposes.

6.1.4 Clearing of vegetation

Vegetation clearing as defined by the OEH refers to the cutting down, felling, thinning, logging or removal of native vegetation (DEC 2004). There are a number of potential impacts as a result of clearing any native vegetation, which include:

- destruction of habitat resulting in a loss of biodiversity;
- isolation of populations resulting in limited gene flow between small fragmented populations;
- reduced potential to adapt to environmental change;
- erosion leading to sedimentation that can affect both terrestrial and aquatic biota;
- disturbed habitat which may encourage the establishment and spread of exotic flora or pioneer species that may displace local native flora;
- loss of leaf litter which provides habitat for vertebrate and invertebrate fauna.

With regard to the proposal, vegetation clearing will occur as part of the construction of the proposed conservation fence, operations base and management tracks (including the alternative access track, if required). No other areas will be disturbed, and no rehabilitation of cleared areas is planned. Land required for temporary storage of fence materials and the like is already taken account of in the planning for the operations base area. Based on spatial data analysis, up to about 76 ha of vegetation would be removed or directly impacted as a result of the proposed feral-free fenced area, operations base and new tracks. This would increase to up to about 78 ha if an alternative access track was required. Additionally,

impacts are likely as a result of the creation of a Strategic Fire Advantage Zone (SFAZ) through the modification or removal of canopy connection and understorey removal.

A summary of the vegetation communities to be impacted and their extents within the study area and total to be modified by the proposed feral-free fenced area, operations base and APZ, and additional management tracks is shown in Table 13. In total, less than 0.14% of the Mallee Cliffs NP would be directly affected by the clearing of vegetation, with no more than 0.16% of any native vegetation type and only 0.37% of the derived shrubland affected by clearing.

Debris resulting from clearing will be managed in one of the following ways, depending on its nature, volume and location:

- stacked into piles, inside and outside the fenced area: these will be allowed to degrade through natural process and are expected to provide habitat for native wildlife;
- windrowed or stacked into piles suitable for burning in accordance with approved burn plans to eliminate the build-up of fuel.

The specific quantities and locations of piles and windrows for burning and for habitat is difficult to predict and will be subject to the site factors encountered during clearing and the characteristics of the material involved. It is AWC's assessment, based upon experience in a similar environment, that alternating the piles inside and out minimises aesthetic impact and fire risk.

Table 13: Estimated extents of Plant Community Types (PCTs) to be removed or modified for the proposed conservation fence, operations base and tracks, based on mapping of Morcom and Westbrooke (1990)

	Mallee Cliffs NP	**Fenced area**		**Fenceline**		**Operations base**		**Tracks**		***Alternative access track*****	
Plant Community Type	**Area of PCT (ha)**	**Area of PCT (ha)**	**Portion of Mallee Cliffs NP PCT (%)**	**Area of PCT (ha)**	**Portion of Mallee Cliffs NP PCT (%)**	**Area of PCT (ha)**	**Portion of Mallee Cliffs NP PCT (%)**	**Area of PCT (ha)**	**Portion of Mallee Cliffs NP PCT (%)**	***Area of PCT (ha)***	***Portion of Mallee Cliffs NP PCT (%)***
PCT 170	34,008	4,666	13.7	24.1	0.07	*(10.6)**	*(0.03)**	13.7	0.04	*1.4***	*0.004***
PCT 171/172	9,040	2,441	27.0	4.9	0.05	0.0	0.0	2.0	0.02	*0.2***	*0.002***
PCT 58	7,914	1,518	19.2	3.2	0.04	*(0.0)**	*(0.0)**	4.9	0.06	*0.6***	*0.008***
PCT 166 (disturbed)	6,805	821	12.1	8.1	0.12	0.0	0.0	2.8	0.04	*0.6***	*0.009***
Derived shrubland PCT 170	241	125	51.9	0.6	0.25	0.0	0.0	0.3	0.12	*0.0*	*0.0*
Total	**58,118**	**9,570**	**16.5**	**40.9**	**0.07**	**10.6**	**0.02**	**23.7**	**0.04**	***2.8*****	***0.005*****

*: The site of the operations base was mapped as PCT 170 by Morcom and Westbrooke (1990) but this is in error. The site is partially cleared, but is derived from PCT 58 (see Figure 39). Correct mapping would therefore show the operations base as 10.6 ha of PCT 58.

**: These areas have been estimated in case a new access track is required to the proposed operations base. This would only be needed if the use of the current access from the west was restricted.

6.1.5 Removal of threatened flora

No direct impact on threatened flora has been identified. Several small trees of the *Santalum* genus (probably the common Sweet Quandong, but possibly Bitter Quandong) are within the vicinity of the proposed fenceline clearing but none are closer than 20 m to it. None were found in the vicinity of the proposed operations base, the proposed new tracks, or the alternative access route.

A further three threatened species are assessed as having a moderate chance of occurring within the clearing areas of the proposed CFAI (including the alternative access track) but were not detected in the surveys: Mossgiel Daisy (*Brachyscome papillosa*), Yellow Swainson-pea (*Swainsona pyrophila*) and Cobar Greenhood (*Pterostylis cobarensis*).

6.1.6 Barrier effects created by the conservation fence

Establishment of the fence involves clearing the fenceline and erecting a 1.8 m netting fence with floppy top. The fence is a key component of AWC's plan to reintroduce 'extinct in NSW' mammals as it permits permanent exclusion of feral predators, the primary threat to small to medium-sized mammals. As noted, the return of 'extinct in NSW' mammals is expected to help restore a range of ecological processes with positive consequences for ecological health.

The impact of the fence may include:

(i) barrier effects; and
(ii) mortality through collision or entanglement.

These impacts are discussed below, along with potential mitigation measures.

Barrier effects

The fence will be a permanent barrier to the movement of medium and large non-volant mammal species, large reptiles and Emus. The fence will not be a barrier to the movement of other bird species, small reptiles, frogs or invertebrates. Plants dispersed by birds (with the exception of species dispersed by the Emu), wind and water will also be unaffected by the fence.

As a consequence, populations of some species inside the fence will be isolated from populations in the broader landscape. The primary guild affected will be extant medium-sized mammals, principally Echidnas. Reintroduced medium-sized mammals will not have populations outside the fence, at least in the initial stages of the EMA project. Large kangaroos (several hundred) and Emus (approximately 10-20 individuals) will be removed from inside the proposed feral-free fenced area to prevent damage to the fence (adults would fight each other through the fence). While large reptiles will not be able to cross the fence, juveniles of most species, with the possible exception of the Sand Goanna, will be able to do so, and hence the fence will not act as a barrier to most reptiles at the population level.

Isolation of populations of extant medium-sized mammals inside the fence can be expected to have a number of demographic and genetic consequences, if populations are small. These consequences are well-documented in the ecological literature and include increased vulnerability to local extinction as a result of stochastic events and loss of genetic diversity, given drift and inbreeding (Weeks et al. 2015). A related consequence is the effective removal of the population inside the fence from the broader regional population. If the regional population is small, this may increase the vulnerability of the population to local extinction through the mechanisms outlined above.

Population sizes of extant medium-sized mammals (including Echidnas) and large reptiles will be monitored in AWC's EHMF both inside and outside proposed feral-free fenced areas. Monitoring of reintroduced species will follow protocols in the Translocation Proposal which will be developed prior to any reintroduction taking place. The long-term monitoring programs will be designed to ensure any significant population trends are identified. Most medium-sized mammals are expected to benefit from removal of predation by feral cats and foxes inside proposed feral-free fenced areas, resulting in population increases. Nevertheless, populations may still be sufficiently small to be subject to loss of genetic diversity. In these cases, occasional manual dispersal (capture and release) across the fence will maintain connectivity between populations. The required rate of dispersal to maintain genetic diversity is likely to be low: a widely accepted number is one individual per generation from either side of the fence, although the optimal rate will vary with population size, breeding systems and other factors (Weeks et al. 2015). AWC will conduct targeted research to inform strategies for maintaining genetic diversity in any threatened species that may be subject to a barrier effect from the fence.

Large macropods (Red Kangaroo, Eastern Grey Kangaroo, Western Grey Kangaroo and possibly Common Wallaroo) and Emus within the fenced area would reduce the prospect of success for the reintroductions by impacting on vegetation (i.e. removing cover and food for reintroduced mammals), as well as posing a risk to the structure of the fence. Methods used to remove large macropods and Emus from the fenced area are described in detail in Section 4.3.6 and are summarized below.

1. Ensure there are no artificial water sources within the fenced area during the construction phase, before gates are closed, so that kangaroos and Emus within the area are encouraged to look for supplies elsewhere.
2. Once gates are closed, establish traps (in the form of small compounds) just inside the gates using water and fodder as attractants; any kangaroos or Emus caught in the traps will be released outside the fence.
3. If any macropods remain in the fenced area, relocate them outside the fenced area by anaesthetising them using darts with non-lethal drugs and removing them.

AWC expects to remove all large macropods and Emus using the non-lethal measures described above; only in the unlikely case that those methods fail to remove every last macropod will AWC consider seeking a permit to remove remaining macropods under an 'Application to harm protected fauna in NSW: Section 121 Occupier's Licence (Commercial) 2017'. Any such activity will then be implemented in accordance with the '*National code of practice for the humane shooting of kangaroos and wallabies for non-commercial purposes*'. Should an 'Application to harm' permit not be granted, AWC will attempt to manage populations through the continued usage of non-lethal drugs and trapping using methods detailed above.

Collision or entanglement of individuals with the fence

A second type of impact associated with fences is elevated mortality of species attempting to cross the fence from collision or entanglement.

In Australia, the main species involved in collisions or entanglements with fences are reported to be birds, especially night-flying and ground-nesting species, as well as the Echidna, medium-sized reptiles, snakes and turtles (Long and Robley 2004, Hayward and Kerley 2009, Hayward et al. 2014). While any mortality of native animals is unfortunate from a welfare perspective and will be avoided to the extent practicable, it is important to keep the scale of the issue in perspective. According to the review conducted by Long and Robley (2004):

> "Most fence managers indicated that native animals had been injured or killed in their exclusion fence. However, in all cases this occurred infrequently and is not considered to constitute a serious impact on resident fauna populations".

As the review conducted by Long and Robley (2004) is now over a decade old, AWC has conducted a review of its own fence mortality data and attempted to obtain more up-to-date information from other managers of fenced areas.

AWC fence mortality

At present, AWC has installed conservation fences enclosing feral predator-free areas on four wildlife sanctuaries, a total length of 109 km (Table 14). These fences are patrolled every 2-3 days. Inadvertent deaths of native animals at these fences were recorded (including detail of species affected) for periods ranging from 2 to 6 years. Deaths were mostly due to collisions, but some instances of entrapment were recorded for reptiles.

Table 14: Conservation fences established on AWC wildlife sanctuaries, and years monitored for fauna collisions and entrapments.

Location	Fence length (km)	Years monitored
Scotia	44	5
Mt Gibson	43	2
Yookamurra	13	6
Karakamia	9	4

During the periods of monitoring, a total of 86 individuals of 28 bird species were reported killed on these fences, equivalent to a rate (across all species) of 1 bird/5 km fence/year. Of the bird species killed, 21 of the 28 were represented by 1 or 2 individuals. The remaining seven species were represented by between 4 and 22 individuals (Table 15). The bird species with the most recorded kills on fences was the Budgerigar, but nearly all of these records (19 of 22) were from a single sanctuary (Scotia) in one year. The Chestnut Quail-thrush, the next most commonly killed bird, was also recorded on the fence at Scotia. This is a ground-active species. As a group, ground-active birds are more than twice as abundant inside than outside the fence at Scotia, presumably due to protection from feral predators. That is, the overall impact of conservation fencing is likely to be positive for ground-active species such as Chestnut Quail-thrush, despite occasional fence mortalities.

Table 15: Bird species represented by more than 2 individuals killed on conservation fences established on AWC wildlife sanctuaries during years monitored for fauna collisions and entrapments.

Species	No. individuals
Stubble Quail	5
Australian Ringneck	6
Budgerigar	22
White-fronted Honeyeater	6
Chestnut Quail-thrush	11
Crested Bellbird	4
Rufous Whistler	4
Collared Sparrowhawk, Brown Goshawk, Nankeen Kestrel, Common Bronzewing, Peaceful Dove, Mulga Parrot, Black-eared Cuckoo, Tawny Frogmouth, Laughing Kookaburra, Sacred Kingfisher, Brown Tree-creeper, Striated Pardalote, Southern Whiteface, Spiny-cheeked Honeyeater, Yellow-plumed Honeyeater, Singing Honeyeater, Gilbert's Whistler, Grey Shrike-thrush, White-winged Chough, Zebra Finch, Silvereye	1-2

Other species recorded killed on fences in the period monitored were a King Brown Snake, a Bearded Dragon and five Sand Goannas. Goannas are more abundant inside the fence at Scotia than outside, so the overall impact of fencing is also likely to be positive for this species, despite the mortalities.

Mortality on other fences

Summary data on fence mortality were provided by managers of Arid Recovery (SA) and Mulligan's Flat (ACT).

Arid Recovery has 34 km of conservation fencing enclosing 6,000 ha. According to the manager:

> "Birds make up the majority of fence deaths (65%). The majority of deaths were pigeons and doves (27%) and waterbirds (27%). Quail and quail-thrushes made up 14% with the rest honeyeaters, finches, parrots and an owl.
>
> 25% of recorded fence deaths were reptiles, comprised of a mix of large dragons, goannas and snakes that had become stuck in the netting or caught on hotwires.
>
> Mammals are less common and mostly found dead from unknown causes (no sign of collision injury) or as a result of raptor predation, with only one recorded as directly killed by the fence." (Kath Tuft, pers. comm. 2016 with AWC).

Mulligan's Flat has 11.5 km of conservation fencing enclosing 400 ha. According to the manager, animals killed on the fence include birds, medium-sized reptiles and turtles. As at Scotia, many of the affected species are expected to be more abundant inside the fence than outside due to removal of feral predators and other threats (Jason Cummings, pers. comm. 2016 with AWC). A recent study found that Long-necked Turtles were vulnerable to entrapment by the fence at Mulligan's Flat when attempting to disperse between wetlands (Ferronato et al. 2014). Conversely, a study of Bush Stone-curlew, a ground-active, nocturnal bird, reintroduced to Mulligan's Flat found individuals of that species readily flew without incident back and forth across the fence (Jason Cummings, pers. comm. 2016 with AWC).

Species affected

Based on the information presented above, the species most likely to experience some level of mortality on fences at Mallee Cliffs are larger reptiles, including the Sand Goanna, and the Echidna. AWC staff will record information on any mortality of native animals by collision with/entrapment by the fence at Mallee Cliffs, and use this information to refine management protocols, if necessary.

Summary

As noted above, overall levels of mortality from the fence are expected to be low, in the order of 1 bird /5 ‘ fence/year, or seven individual birds in Mallee Cliffs NP, per year. Many of the small ground-active bird species are predated by feral cats and foxes, and hence are likely to benefit overall from the fence, despite occasional fence strike. Reptile deaths are likely to be considerably lower than birds.

AWC’s fence design mitigates against one of the potential causes of mortality, namely electrocution of ground-active species such as the Echidna, as there are no hot wires close to the ground. There is little opportunity to mitigate impacts on birds, for example by more frequent patrols, as most of the recorded deaths are due to collision. AWC staff will record information on any mortality of native animals by collision with/entrapment by the fence at Mallee Cliffs, and use this information to refine management protocols, if necessary.

6.1.7 Impacts of changes in fire management on ecological values

The impacts of the proposed hazard reduction burns and mechanical disturbances on the existing environment and ecological values within the project area will vary with the zone type and the area of each burn or mechanical treatment. Across all proposed burns there will be a substantial reduction in surface fuel load and continuity. This is likely to reduce available foraging and shelter habitat for shrub-inhabiting species of fauna within the relatively narrow SFAZs. However, by reducing fuel loads in these targeted and strategic areas we aim to disrupt the potentially catastrophic outcomes of a large-scale, high-intensity wildfire on habitat structure and availability, as well as to protect the nationally-significant populations of regionally-extinct fauna within the fence.

6.1.8 Aboriginal cultural heritage

Potential direct and indirect impacts to Aboriginal cultural heritage have been assessed by Onsite Cultural Heritage Management (OSCHM) and the assessment report is attached (Appendix 10). No direct or indirect impacts were identified and an Aboriginal Heritage Impact Permit will not be required.

6.2 INDIRECT IMPACTS

Indirect impacts as defined by the OEH occur “when project-related activities affect species, populations or ecological communities in a manner other than direct loss”. Indirect impacts include loss of individuals through starvation, exposure, predation by domestic or feral animals, loss of breeding opportunities, loss of shade or shelter, deleterious hydrological changes, increased soil salinity, erosion, inhibition of nitrogen fixation, weed invasion, fertilizer drift or increased human activity within or directly adjacent to sensitive habitat areas (DECC 2007).

Based on this definition, it is anticipated that the clearing of vegetation associated with the proposal would result in a number of cumulative or secondary effects relating to edge

effects, barrier effects, soil erosion, potentially increased traffic, and weed invasion. These indirect impacts are considered under separate headings below.

6.2.1 Edge effects

The removal of vegetation can often result in edge effects; the creation of new environmental conditions that have the potential to have negative impacts on ecological processes along the edges of cleared environments particularly those that originally contained canopy vegetation. Edge effects generally promote the invasion of weeds and may also promote increased visitation by red foxes and feral cats (Lindenmayer and Fischer 2006; Edwards et al. 2001; Priddel et al. 2007; Miles 2006a; Miles 2006b).

In general, potential edge effects associated with the proposal may include:

- changes in microclimate (e.g., temperature, wind, light);
- creation of new ecotones;
- invasion by exotic flora;
- improved access for feral predators;
- isolation of populations resulting in limited gene flow between small fragmented populations;
- reduced potential to adapt to environmental change.

A holistic approach to assessing edge effects is not possible given that edge effects can vary between species and communities. However, this potential impact is considered unlikely to be significant given edge effects are most severe where extensive clearing separates – or fragments – areas of remnant native vegetation by long distances; the proposal does not fragment the native vegetation in this way.

Edge effects will be mitigated by the implementation of intensive control of weeds (Section 6.2.4) and feral animals (Section 4.3.7).

6.2.2 Traffic

During construction, there will be additional traffic along roads in the locality but traffic volumes will decrease once construction is complete. After the construction phase, ongoing operations associated with the proposed project may result in a minor increase in traffic movements along roads. The impacts are not likely to be significant. Roads and tracks will be maintained in accordance with roads management requirements.

6.2.3 Soil erosion

Clearing of vegetation along the line of the fence and the new tracks and for the operations base will expose soil and increase the risk of erosion. The removal of any midstorey vegetation in fire protection zones would require removal of shrubs and seedlings by the roots to minimise regrowth and this would also expose soil to erosion. However, there is a low number of such plants on the proposed site.

Potential impacts resulting from soil erosion may include, but are not restricted to:

- sedimentation in drainage lines
- alterations to habitat
- loss of topsoil and native seedbank
- opportunities for weeds to establish in the absence of native plants.

The potential soil erosion impacts are likely to be limited given the flatness of the landscape and proposed safeguards. All works will follow the guidelines of NPWS field policies and the

Department of Conservation and Land Management 'Urban Erosion and Sediment Control Manual'. The proposed safeguards take into account the added risk associated with any moderate to heavy precipitation events following vegetation clearing.

Design features (such as the retention of groundcover vegetation where possible and the retention of vegetation outside the impact area) and a series of mitigation measures are likely to avoid or limit the potential impacts of soil erosion.

A series of proposed measures and safeguards that will minimise the likelihood of indirect impacts affecting any biota within the study area are provided throughout Section 6 of this REF and in summary within Section 7 of this REF.

6.2.4 Weeds

There is some potential for noxious weed species (and other weed species) to be spread, or become established post-clearing of native vegetation. Safeguard measures that will minimise the likelihood of weed establishment and invasion are described below.

- All vehicles, machinery and equipment entering the site (prior to arrival) are to be thoroughly cleaned inside and out to reduce potential for weed seed spread.
- Prior to commencing work on the site, all vehicles and equipment will be delivered to and inspected as cleaned in a common inspection area. Any additional cleaning prior to commencement of works will be undertaken in the common inspection area.
- Vehicles and equipment working within the construction zone will be inspected daily with any identified weed seeds or segments removed and disposed of appropriately.
- The area of disturbance and immediate surrounds will be continually monitored during and after construction activities to identify and control any weed populations that have established as a result of works. Particular focus will be on eradication of any establishment of noxious weeds in the area of disturbance.
- All weed incursions will be monitored and controlled by a person experienced in weed management.

The EMA project (including the proposal) involves an increase in the level of weed control within the area to be fenced and across the balance of the Mallee Cliffs NP: a comprehensive weed strategy will be developed by the end of 2017, once AWC has collected more information on species' distribution and the threats they represent. As a result, the proposed action will deliver a significant benefit to the environment by reducing the overall level of weeds in the proposal area.

6.2.5 Cumulative impacts

Some of the actions associated with the proposal have the potential to result in either or both positive and negative cumulative impacts; these are identified and discussed throughout this document. Some negative cumulative impacts are likely to occur as a result of the clearing of vegetation and soil disturbance, while positive cumulative impacts will be delivered by feral predator and herbivore removal from the proposed feral-free fenced area, combined with intensive noxious weed and feral animal management in the rest of the project area.

6.3 PHYSICAL AND CHEMICAL IMPACTS DURING CONSTRUCTION AND OPERATION

Physical and chemical impacts during construction and operation				
	Applicable?*	**Impact level** (negligible, low, medium or high; negative or positive; or N/A)	**Reasons** (describe the type, nature and extent of impact, taking into account the receiving environment & proposed safeguards which will limit the impact)	**Safeguards/Mitigation Measures**
1. Is the proposal likely to impact on soil quality or land stability?	☒	Low to medium, Negative	Impacts to soil quality and land stability are anticipated to be low to moderate during the construction phase of the proposal. The highest potential will be during vegetation removal. Temporary negative impacts on soils or land stability would be confined to the fence clearing, track clearing and APZ creation. As detailed in Table 13, about 76 ha of vegetation would be removed (78 ha if an alternative access track was required). This represents a small portion of the total project area (0.14%). All of the work would be undertaken using machinery and with appropriate safeguards, these impacts are expected to be minimised and managed to an appropriate level.	Where possible, ground vegetation should be retained to minimise soil disturbance. All works will follow the guidelines of NPWS field policies and the Department of Conservation and Land Management 'Urban Erosion and Sediment Control Manual'. This will include: 1. Works should not take place during, or within 4 days of heavy rain events (other than work necessary to ensure that soil erosion is minimised). Works should not be scheduled when heavy rainfall is forecast. 2. Sediment controls to be left in situ until the excavated surfaces are stable. 3. Where possible, all foot traffic and light vehicle movements should be confined to existing tracks, the clearing constructed for the fenceline, or the new track network. 4. The site supervisor, through site inductions, would make all personnel aware of risks and responsibilities related to spills of fuel, oil and other chemicals that may be required onsite. Machinery and vehicles should be inspected on a daily basis giving particular attention to the condition of hoses and connections. 5. An emergency spill kit must be kept on site at all times. Staff and contractors using machinery must be made aware of the location of the spill kits and trained in its use. 6. Hay bales would only be used as an erosion control method if they are certified weed free. 7. Longer term the control of feral herbivores and restoration of ecological processes should reduce soil erosion across the project area.

Physical and chemical impacts during construction and operation				
	Applicable?*	**Impact level** (negligible, low, medium or high; negative or positive; or N/A)	**Reasons** (describe the type, nature and extent of impact, taking into account the receiving environment & proposed safeguards which will limit the impact)	**Safeguards/Mitigation Measures**
2. Is the works likely to affect a waterbody, watercourse, wetland or natural drainage system?	☒	Low, Negative	There are no defined watercourses affected by the proposal. However, sediment created as a result of vegetation removal has the potential to be transported in localized runoff. It is also possible that any leaks or spills of petrochemicals associated with machinery could contaminate runoff. With safeguards, these potential impacts are expected to be minimised and managed to an appropriate level (i.e., not significant).	There must be no release of dirty water into drainage lines and/or waterways. Visual monitoring of local water quality (i.e., turbidity, hydrocarbon spills/slicks) must be carried out on a regular basis to identify any potential spills or deficient erosion and sediment controls. Fuels and chemicals must be stored in an impervious bunded area a minimum of 50 m away from: • rivers, creeks or any areas of concentrated water flow • flooded or poorly drained areas • slopes above 10%
3. Is the activity likely to change flood or tidal regimes, or be affected by flooding?	☐	NA	NA	NA
4. Is the activity likely to affect coastal processes and coastal hazards, including those projected by climate change (e.g. sea level rise)?	☐	NA	NA	NA
5. Does the activity involve the use, storage, or transport of hazardous substances or the use or generation of chemicals, which may build up residues in the environment?	☒	Negligible, Negative	There is a potential risk of petrochemical spills from the use of machinery.	The site supervisor, through site inductions, would make all personnel aware of risks and responsibilities related to spills of fuel, oil and other chemicals that may be required onsite. Machinery and vehicles should be inspected on a daily basis giving particular attention to the condition of hoses and connections. An emergency spill kit must be kept on site at all times. Staff and contractors using machinery must be made aware of the location of the spill kits and trained in its use. Visual monitoring of local water quality (i.e., turbidity, hydrocarbon spills/slicks) must be carried out on a regular basis

Physical and chemical impacts during construction and operation				
	Applicable?*	**Impact level** (negligible, low, medium or high; negative or positive; or N/A)	**Reasons** (describe the type, nature and extent of impact, taking into account the receiving environment & proposed safeguards which will limit the impact)	**Safeguards/Mitigation Measures**
				to identify any potential spills or deficient erosion and sediment controls. Fuels and chemicals must be stored in an impervious bunded area a minimum of 50 m away from: • rivers, creeks or any areas of concentrated water flow • flooded or poorly drained areas • slopes above 10%.
6. Does the activity involve the generation or disposal of gaseous, liquid or solid wastes or emissions?	☒	Negligible Negative	Minor negative impacts to air quality may result by the generation of exhaust fumes from machinery during the clearing of vegetation phase. Fine particulate matter such as dust as a result of the vegetation removal will also occur. Emissions would be generated during the operation of the machinery and motor vehicles. Small amounts of rubbish are also likely to be generated by personnel. These impacts would be restricted to the period of construction and during scheduled maintenance. With appropriate safeguards, these potential impacts are expected to be minimised and managed to an appropriate level.	1. All machinery (including vehicles) should be periodically inspected and maintained to ensure minimum levels of emissions. 2. Engines would be switched off, rather than left idling for long periods. 3. Rubbish generated during works would be minimised and where generated, would be disposed of in an appropriate manner.
7. Will the works involve the emission of dust, odours, noise, vibration or radiation in the proximity of residential or urban areas or other sensitive locations?	☒	Negligible Negative	During construction, some dust is likely to be generated by both the clearing operations and general use of motor vehicles and machinery. During operation, some increase in AWC support vehicles could result in the potential for additional dust on public roads. However, no residential, urban areas or other sensitive locations are adjacent to the proposal.	To reduce the potential level of dust, AWC support vehicles should be limited to a maximum speed of 60 km/h on public roads, and 40 km/h on park roads.

6.3.1 Proposed Safeguards

It is recommended that the following safeguards in relation to physical and chemical impacts during construction and operation of the proposal:

- Where possible, ground vegetation should be retained to minimise soil disturbance.
- All works will follow the guidelines of NPWS field policies and the Department of Conservation and Land Management 'Urban Erosion and Sediment Control Manual'.
- Works should not take place during, or within 4 days of heavy rain events (other than work necessary to ensure that soil erosion is minimised). Works should not be scheduled when heavy rainfall is forecast.
- Sediment controls to be left in situ until the excavated surfaces are stable.
- Where possible, all movements (including foot traffic) should be confined to existing tracks or the clearing constructed for the fenceline.
- The site supervisor, through site inductions, would make all personnel aware of risks and responsibilities related to spills of fuel, oil and other chemicals. Machinery should be inspected on a daily basis giving particular attention to the condition of hoses and connections.
- An emergency spill kit must be kept on site at all times. Staff and contractors using machinery must be made aware of the location of the spill kit and trained in its use.
- Hay bales would only be used as an erosion control method if they are certified weed free.
- There must be no release of dirty water into drainage lines and/or waterways.
- Visual monitoring of local water quality (i.e., turbidity, hydrocarbon spills/slicks) must be carried out on a regular basis to identify any potential spills or deficient erosion and sediment controls.
- Fuels and chemicals must be stored in an impervious bunded area a minimum of 50 m away from:
    - rivers, creeks or any areas of concentrated water flow
    - flooded or poorly drained areas
    - slopes above 10%.
- All machinery should be periodically inspected and maintained to ensure minimum levels of emissions.
- Engines would be switched off, rather than left idling for long periods.
- Rubbish generated during works will be minimised and where generated, will be disposed of in an appropriate manner.
- To reduce the potential level of dust, AWC support vehicles should be limited to a maximum speed limit of 60 km/h on public roads and 40 km/h on park roads.

6.4 BIOLOGICAL IMPACTS DURING CONSTRUCTION AND OPERATION

The mitigation measures and safeguards to be put in place are extensive and are detailed in Section 6.4.1, rather than in a column in the following table.

Biological Impacts During Construction and Operation			
	Applicable?*	**Impact level** (negligible, low, medium or high; negative or positive; or N/A)	**Reasons** (describe the type, nature and extent of impact, taking into account the receiving environment & proposed safeguards which will limit the impact)
1. Is any vegetation to be cleared or modified? (includes vegetation of conservation significance or cultural landscape value)	☒	Medium, Negative	The proposal will result in direct impacts to up to 76 ha of vegetation (78 ha if an alternative access track is required). In total, less than 0.14% of the total project area would be directly affected by the clearing of vegetation. The proposed fenceline has been purposely designed taking into consideration the local conditions including vegetation. The fenceline will be between 10 and 11 m wide allowing for a 5 to 5.5 m wide access track on each side of the fence. This maximum width will allow for safe vehicle access on each side of the fence, provides a buffer from any potential tree and branch falls, and acts as a fire break in the event of a wildfire incident. Additional impacts are likely should the SFAZ be implemented. Some indirect minor impacts on vegetation are also likely including edge effects, traffic and soil erosion. Proposed safeguards are likely to prevent the establishment of weeds and spread of weeds. Significant positive impacts on vegetation will arise as a result of the removal of feral herbivores, especially rabbits and goats, and the restoration of ecological processes as a result of reintroduced small mammals.
2. Is the activity likely to have a significant effect on threatened flora species, populations, or their habitats, or critical habitat? (refer to threatened species assessment of significance (5-part test))	☒	Medium, Positive	The activity is not likely to have a significant adverse effect on threatened flora species, populations or their habitats. The proposal would have a positive impact on threatened plants by removing feral predators and herbivores from a significant area (9,570 ha) and reducing the density of feral predators and herbivores across the larger project area (an additional 48,548 ha). The proposal would also have a positive impact by reducing noxious weeds across a large area. There is a low risk that the proposal would have a direct but insignificant negative impact on a small number (up to four) small *Santalum murrayanum* shrubs as a result of the clearing for the fenceline. There will be a significant positive impact on these species as a result of the reintroduction of small mammals that play a role in improving conditions for germination of new plants of such species. Additional assessment under the BC Act and EPBC Act is provided in Appendices 6 and 7.
3. Does the works have the potential to endanger,	☒	Medium, Positive	The proposal would have a positive impact on fauna as a result of the removal of feral predators and the

Biological Impacts During Construction and Operation			
	Applicable?*	**Impact level** (negligible, low, medium or high; negative or positive; or N/A)	**Reasons** (describe the type, nature and extent of impact, taking into account the receiving environment & proposed safeguards which will limit the impact)
displace or disturb fauna (including fauna of conservation significance) or create a barrier to their movement?			effective removal of feral herbivores over a large area (9,570 ha) and increased control of feral animals over a broader area (48,548 ha). In addition, 10 regionally extinct fauna species would be reintroduced. In turn, this would restore important ecological processes. The potential adverse impacts to fauna, including disturbance and displacement, resulting from the proposal would not be significant. They include: 1. Direct impacts as a result of clearing the fenceline, with the potential to affect less mobile fauna occupying soil and vegetation such as reptiles, invertebrates, frogs and small terrestrial mammals. 2. Habitat loss by the removal of vegetation (less than a maximum of 78 ha out of 58,118 ha) and hollow-bearing trees. The loss of hollow-bearing trees is not significant in the context of availability of hollows in the project area. 3. Short term disturbance during the works to any noise-sensitive species. The fence would also create a barrier to movement for a small number of fauna species that cannot pass through the netting on the fence, or fly or glide over it. The potential negative impacts on fauna would not be significant, particularly when the proposed safeguards are taken into account. The positive impacts are significant. Additional assessment for species listed under the BC Act, FM Act and EPBC Act that have the potential to be impacted by the proposal is provided in Appendices 6 and 7.
4. Is the activity likely to have a significant effect on threatened fauna species, populations, or their habitats, or critical habitat (refer to threatened species assessment of significance (5-part test))?	☒	Medium, Positive	The activity is not likely to have a significant adverse effect on threatened fauna species, populations or their habitats. The proposal would result in the removal of some potential habitat and forage for some threatened and migratory biota. However, the nature and extent of the removal of habitat/forage is not significant: see Appendices 7 and 8. See also the safeguards set out in Section 6.4.1 below. The proposal would have a positive impact on threatened fauna as a result of providing a large, feral predator-free area for the 10 locally-extinct species that will be reintroduced as well as extant threatened species. In addition, intensive control of feral animals over a broader area (48,548 ha) will

Biological Impacts During Construction and Operation			
	Applicable?*	**Impact level** (negligible, low, medium or high; negative or positive; or N/A)	**Reasons** (describe the type, nature and extent of impact, taking into account the receiving environment & proposed safeguards which will limit the impact)
			benefit extant threatened fauna outside the fenced area. The potential adverse impacts to fauna, including disturbance and displacement, resulting from the proposal would not be significant for extant or reintroduced threatened fauna. They include: • direct impacts as a result of clearing the fenceline, with the potential to affect less mobile fauna occupying soil and vegetation such as reptiles, invertebrates, frogs and small terrestrial mammals; • habitat loss by the removal of vegetation (less than a maximum of 78 ha out of 58,118 ha) and hollow-bearing trees; the loss of hollow-bearing trees is not significant in the context of availability of hollows in the project area; • short-term disturbance during the works to any noise-sensitive species. The fence would also create a barrier to movement for a small number of fauna species that cannot pass through the netting on the fence, or fly or glide over it. The potential negative impacts on fauna would not be significant, particularly when the proposed safeguards are taken into account. The positive impacts are significant.
5. Is the activity likely to impact on an ecological community of conservation significance?	☒	N/A	No direct or indirect impact to an ecological community of conservation significance is anticipated.
6. Is the activity likely to have a significant effect on an endangered ecological community or its habitat? (refer to threatened species assessment of significance (5-part test))	☒	N/A	No threatened ecological communities (TEC) were recorded within the proposed CFAI, although remnants of the Endangered Ecological Community, 'Sandhill Pine Woodland in the Riverina, Murray-Darling Depression and NSW South Slopes Bioregions' in poor condition are reported to remain in Mallee Cliffs NP (Ryan Duffy, OEH, pers. comm. 2017).
7. Is the activity likely to cause a threat to the biological diversity or ecological integrity of an ecological community?	☒	High, Positive	The proposed works would significantly enhance the ecological integrity and biological diversity of the project area by: • removing or reducing the key threat to ecosystem integrity and biological diversity – feral predators and herbivores – as well as other threats such as weeds. • reintroducing 10 threatened mammals that are currently regionally extinct; in addition to enhancing biological diversity in itself, the return of these 10 species would restore a range of

Biological Impacts During Construction and Operation			
	Applicable?*	**Impact level** (negligible, low, medium or high; negative or positive; or N/A)	**Reasons** (describe the type, nature and extent of impact, taking into account the receiving environment & proposed safeguards which will limit the impact)
			ecosystem processes which will enhance ecosystem integrity; The proposal would involve the clearance of 76 ha of vegetation (or 78 ha if an alternative access track is required). However, this will not cause a threat to biological diversity or ecological integrity, especially when the safeguards (Section 6.4.1) and the relatively small scale of this impact in the context of the project area (~58,000 ha) and wider locality are considered
8. Is the work likely to introduce noxious weeds, vermin, feral species or genetically modified organisms into an area?	☒	High, Positive	The works are not likely to introduce noxious weeds or feral animals. Weeds are already established in the study area. The proposal will significantly reduce the extent of weeds through weed control across the project area. There is a risk that construction of the fence, or the use of vehicles in ongoing operations, could result in the introduction and/or spread of weed species. However, this risk is reduced to negligible levels by the safeguards set out below in 6.4.1 and the fact that landscape scale weed control will be implemented across the project area.
9. Is the work likely to affect areas of outstanding biodiversity value?	☐	N/A	No areas of outstanding biodiversity value as listed by the BC Act are present within the study area.
10. Is the work consistent with any applicable recovery plans or threat abatement plans?	☒	High, Positive	Generally, the works are consistent with management plans, recovery plans or actions devised under the Saving Our Species Program in that feral animals such as red fox, feral cat, pig, goat and rabbit would be eradicated from the proposed feral-free fenced area. The works are also consistent with the National Threatened Species Strategy and Recovery Plans prepared under the EPBC Act (e.g. for the mammals to be reintroduced, where recovery plans are available; and for extant species such as Western Pygmy-possum and Malleefowl). They are also consistent with the EPBC Threat Abatement Plans for predation by European red fox and by feral cats.
11. Is the works likely to affect any joint management agreement entered into under the BC Act?	☐	N/A	No Joint Management Agreement under the BC Act is present.

6.4.1 Proposed Safeguards

The following mitigation measures and safeguards have been or will be put in place to avoid or minimise biological impacts of the proposal.

Threatened vegetation communities: The proposed sites of the fence, tracks and operations base have been selected to avoid listed communities.

Area to perimeter ratio to minimise clearing for the fence: While a circular fenced area would have the shortest perimeter, it would be impracticable in terms of the existing road network and would also compromise the structural strength of the fence. Various options were assessed before the proposed location was selected: for instance, square or rectangular designs would not fit well with the existing road network, and would have required more clearing for new access tracks.

Vegetation along fence route: The fence has been located to coincide as far as possible with the distribution of Plant Community Type 165 (i.e. Herbland/open-herbland; Morcom and Westbrooke 1990). This vegetation type is a derived community which has resulted from the loss of woodland overstorey trees and shrubs due to former grazing over the past 100 years. The fence alignment is also sited to minimise impact on PCTs 171/172 (i.e. mallee woodlands with a dense spinifex understorey), passing instead through the more open mallee woodlands (PCT 170) and Black Oak dominated woodlands (PCT 58).

Vegetation along track routes: The proposed track network inside the fence and the alternative access track have been designed taking into account the need to avoid damaging intact vegetation, and makes extensive use of existing vehicle tracks and areas of disturbed and derived vegetation. Routes have been surveyed for threatened plant species.

Vegetation at operations base site: The operations base would be located predominantly within a disturbed and 'derived vegetation' area that has received considerable earlier disturbance. The tree cover is low and shrubs are sparse (see Appendix 3, Figure 39). The vegetation of most of the APZ is derived from one of the most common and widespread vegetation types in the Park (i.e. PCT 58). This proposed site has been mapped as PCT 170 ('Chenopod sandplain mallee woodland/shrubland', Morcom and Westbrooke 1990) but this is in error (see Appendix 3, Figure 39).

Feral predators and feral herbivores: Feral predators and herbivores will be removed from the site of proposed mammal reintroductions. There will also be intensive feral predator control outside of the fenced area. These measure will also reduce threats to the extant fauna.

Adequate area of habitats to support viable populations of species: The proposed fence area is of sufficient size (9,570 ha) to support viable populations of reintroduced species as well as extant species.

Malleefowl mounds: Surveys have been carried out along the proposed fenceline and track routes and in the area of the proposed operations base to identify any nearby Malleefowl mounds. They will be protected by a buffer of at least 50 m.

Pre-clearing surveys: Pre-clearance fauna surveys will be completed by suitably qualified persons. This will generally involve inspections of logs, rocks and leaf litter and fallen timber for frogs, reptiles and mammals. Any such fauna found will be relocated to adjacent habitat. These surveys will occur on the same day as clearing takes place.

Hollow-bearing trees: Removal of hollow-bearing trees will be carried out in accordance with guidelines detailed in Appendix 11.

Vegetation communities within the proposed fenced area: The approach taken has been to ensure that all of the main vegetation types in the Mallee Cliffs NP are well represented

inside the conservation fence. In addition, the habitat preferences of some currently-extant threatened species (e.g. the Malleefowl, Gilbert's Whistler, Red-lored Whistler, and a number of reptiles) are known to include Mallee with spinifex so this vegetation type was given special consideration.

Intensive ongoing monitoring: AWC has developed a detailed draft Ecological Health Monitoring Framework (EHMF) for the Mallee Cliffs EMA project area (see Appendix 12). Under this draft EHMF, AWC ecologists will undertake regular biological surveys to measure a suite of indicators including:

- biodiversity indicators (species such as Malleefowl, etc.);
- threat indicators; and
- indicators related to ecological processes.

The objectives of this monitoring program include to: (a) track the ecological health of the Mallee Cliffs NP over time; (b) monitor the success of endangered mammal reintroductions; and (c) measure the changes in ecological health that occur as a result of the removal of feral animals and the reintroduction of endangered mammals. The last will allow AWC to evaluate the outcomes of the reintroduction project for extant species and ecosystems at sites both inside and outside the fence.

Barrier effects: Population sizes of all potentially-affected medium-sized mammals will be monitored by AWC both inside and outside the fenced area. While populations of medium-sized mammals are expected to increase in the fenced area following the eradication of feral cats and foxes, populations may still be sufficiently small to be subject to loss of genetic diversity over the long term. In these cases, occasional manual dispersal (i.e. capture and release) of individuals across the fence is likely to be sufficient to maintain connectivity between populations.

Populations of reintroduced animals: AWC will monitor key elements of the extant biota (vegetation, fauna) as well as population sizes of reintroduced mammals, to determine empirically the consequences of reintroductions. If monitoring reveals significant impacts of reintroduced mammals on extant biota that are considered to lie outside the bounds of acceptable change, then AWC may seek to reduce impacts of reintroduced mammals by:

- reducing the population size of reintroduced mammals through:
    - release of a proportion of individuals outside the fence (this action is part of the next stage of the EMA project, but would only occur in conjunction with intensive feral predator control outside the fence);
    - translocation of individuals to another reintroduction site (AWC has multiple reintroduction sites for the candidate species);
    - by other means, such as introduction of terrestrial native predators such as the Western Quoll (which is planned for reintroduction at Mallee Cliffs NP);
- reducing impacts of reintroduced mammals on particular plants – e.g. threatened plants – by exclusion fencing within the reintroduction site. This approach has been adopted at Mulligan's Flat, primarily for research purposes.

Fence entanglements or collisions: Should monitoring of the conservation fence confirm that bird strike is an issue, AWC would investigate the possible retrofit of mitigation measures. For example, the incidence of bird strike (grouse and capercaillie) on deer fences in Scotland has been reduced by incorporating wood or plastic into the fences to make them more visible to the birds (Trout and Kortland 2012).

Weed management: All vehicles, machinery and equipment entering the site (prior to arrival) are to be thoroughly cleaned inside and out to reduce potential for weed seed spread.

Prior to commencing work on the site, all vehicles and equipment will be delivered to and inspected as cleaned in a common inspection area. Any additional cleaning prior to commencement of works will be undertaken in the common inspection area.

Vehicles and equipment working within the construction zone will be inspected daily with any identified weed seeds or segments removed and disposed of appropriately.

The area of disturbance and immediate surrounds will be continually monitored during and after construction activities to identify and control any weed populations that have established as a result of works. Particular focus will be on eradication of any establishment of noxious weeds in the area of disturbance.

All weed incursions will be monitored and controlled by a person experienced in weed management.

A comprehensive weed strategy will be developed by the end of 2017, once AWC has collected more information on species' distribution and the threats they represent.

Vehicle impacts: Vehicles associated with the construction of the proposal will remain on existing tracks and within the footprint of the CFAI clearings. Foot traffic will be minimised outside of the clearing footprint.

The implementation of the project in accordance with these measures will not have a significant impact on the environment (see Appendices 6 and 7).

6.5 COMMUNITY IMPACTS DURING CONSTRUCTION AND OPERATION

Community impacts during construction and operation				
	Applicable?*	**Likely impact** (negligible, low, medium or high negative or positive; or N/A)	**Reasons** (describe the type, nature and extent of the impact, the nature of the receiving environment and any proposed safeguards which will limit the impact)	Safeguards/Mitigation Measures
1. Is the activity likely to affect community services or infrastructure?	☒	Negligible, Negative	The proposal would likely result in additional vehicle traffic mostly during construction on roads within Mallee Cliffs NP.	Vehicle speed would be limited to 60 km/h on public roads, and 40 km/h within park, to minimise the potential impact of dust and noise.
2. Does the activity affect sites of importance to local or broader community for their recreational or other values or access to these sites?	☒	Moderate, Positive	Mallee Cliffs NP is currently closed to the public. As part of the proposed project, guided visits to the proposed feral-free fenced area will commence after mammal reintroductions.	No safeguards are considered necessary.

Community impacts during construction and operation				
	Applicable?*	**Likely impact** (negligible, low, medium or high negative or positive; or N/A)	**Reasons** (describe the type, nature and extent of the impact, the nature of the receiving environment and any proposed safeguards which will limit the impact)	Safeguards/Mitigation Measures
3. Is the activity likely to affect economic factors, including employment, industry and property value?	☒	Medium, Positive	The proposal is likely to result in local jobs during construction and an increase in visitors to the local area.	No safeguards are considered necessary.
4. Is the activity likely to have an impact on the safety of the community?	☐	N/A	The proposal is not expected to impact on community safety.	No safeguards are considered necessary.
5. Is the activity likely to cause a bushfire risk?	☒	Negligible, Negative	There is a very low bushfire risk in relation to the proposal. With appropriate safeguards, this risk is reduced to a negligible level.	An assessment of bushfire risk will be undertaken before construction starts. Measures to reduce risk identified in the assessment will be implemented. No campfires or smoking permitted on site.
6. Will the activity affect the visual or scenic landscape?	☒	Negligible, Negative	Due to the nature of the proposal, vegetation will be removed. However, most of this would be in a narrow strip and would not be significant in terms of the large areas of vegetation immediately adjacent that would be retained.	No safeguards are considered necessary.
7. Is the activity likely to cause noise, pollution, visual impacts, loss of privacy, glare or overshadowing to members of the community, particularly adjoining landowners?	☒	Low, Negative	During construction, the proposal may potentially cause some noise and pollution impacts for members of the community, particularly adjoining landowners.	The timeframe of work would be minimised where possible to reduce amount of time adjacent landholders and users of surrounding areas are exposed to potential noise pollution.

6.5.1 Proposed Safeguards

It is recommended that the following safeguards in relation to community impacts during construction and operation of the proposal:

- Vehicle speed would be limited to 60 km/h on public roads and 40 km/h within the park to minimise the potential impact of dust and noise.
- An assessment of bushfire risk would be undertaken before construction starts. Measures to reduce risk identified in the assessment will be implemented.
- No campfires or smoking permitted onsite.
- The timeframe of work would be minimised where possible to reduce amount of time adjacent landholders and users of surrounding areas are exposed to potential noise pollution.

6.6 NATURAL RESOURCE IMPACTS DURING CONSTRUCTION AND OPERATION

Natural resource impacts during construction and operation				
	Applicable?*	**Likely impact** (negligible, low, medium or high negative or positive; or N/A)	**Reasons** (describe the type, nature and extent of the impact, the nature of the receiving environment and any proposed safeguards which will limit the impact)	Safeguards/Mitigation Measures
1. Is the activity likely to result in the degradation of the reserve or any other area reserved for conservation purposes?	☒	High, Positive	The reintroduction of extinct mammals and the eradication and control of feral predators and herbivores is likely to lead to landscape scale restoration of the existing ecosystem including benefits for extant fauna and an improvement in the condition of the project area. Weeds will be intensively controlled in the feral predator-free area and reduced across the balance of the study area. The proposal would result in the permanent removal of up to about 78 ha of native vegetation. This impact is considered relatively minor in the context of the extant area of native vegetation of a similar composition across Mallee Cliffs NP.	No additional safeguards considered necessary noting those safeguards already detailed in this REF.
2. Is the activity likely to affect the use of, or the community's ability to use	☐	N/A	The proposal is unlikely to affect the use of, or the ability of the community's use of natural resources given that it encompasses only a relatively small portion of Mallee Cliffs NP.	No additional safeguards are considered necessary.

Natural resource impacts during construction and operation				
	Applicable?*	**Likely impact** (negligible, low, medium or high negative or positive; or N/A)	**Reasons** (describe the type, nature and extent of the impact, the nature of the receiving environment and any proposed safeguards which will limit the impact)	Safeguards/Mitigation Measures
natural resources?				
3. Is the activity likely to involve the use, wastage, destruction or depletion of natural resources including water, fuels, timber or extractive materials?	☐	NA	NA	NA
4. Does the activity provide for the sustainable and efficient use of water and energy? Where relevant to the proposal, this should include consideration of high efficiency fittings, appliances, insulation, lighting, rainwater tanks, hot water and electricity supply.	☒	Negligible	Water will be required for the operations base. The remote location of the operations base necessitates that the base must be self-sufficient with rainfall harvesting from available roof space, and where rainfall harvesting proves inadequate, the use of a bore to access ground water. The use of a bore will be subject to an assessment of rain harvesting and accessibility of the groundwater table and water quality. It is not anticipated to recycle grey water (typically used on gardens) as gardens will not be established. Due to the location and nature of the site, the operations base will be self-sufficient with the majority of energy sourced from a hybrid power system combining PV panels, battery storage and diesel generation. In addition, gas will be used for cooking and water heating.	Strategies to minimise water use will include: • Selecting low-flow Water Efficiency Labelling and Standards (WELS)-rated fittings and fixtures, where available. • Selecting WELS-rated appliances and equipment where available. • Maximising rainwater capture through design. • Meeting the requirements of the OEH Park Facilities Manual and consideration of the NPWS Sewage Manual. AWC has incorporated the relevant above considerations in its design. As the site will be self-sufficient, AWC will not seek to obtain an accredited rating for water use, however AWC staff will be conscious of minimising water use due to the operations base water supply being limited. The operations base development aims to minimise demand for energy, selecting energy efficient appliances where possible, and

Natural resource impacts during construction and operation				
	Applicable?*	**Likely impact** (negligible, low, medium or high negative or positive; or N/A)	**Reasons** (describe the type, nature and extent of the impact, the nature of the receiving environment and any proposed safeguards which will limit the impact)	Safeguards/Mitigation Measures
				ensuring strategies are in place such as: • Selecting star-rated equipment with a minimum 4-star rating where possible. • Using LED lighting and other low energy lighting where possible. • Applying passive design elements to moderate room temperatures reducing the need for artificial heating and cooling. • Selecting low-energy, high-efficiency inverter air-conditioning systems for limited use. • Houses will aim to achieve a minimum NatHERS 6 star energy rating. • All other buildings (with exception of the workshop) will aim to achieve a NABERS rating of 4 stars. This will be measured through self-assessment. AWC is conscious of minimising energy use as the operations base will be self-sufficient, generating the majority of its energy through the hybrid power system.

6.6.1 Proposed Safeguards

It is recommended that no additional safeguards above those already detailed in this REF are required to mitigate against natural resource impacts.

6.7 CULTURAL HERITAGE IMPACTS DURING CONSTRUCTION AND OPERATION

Aboriginal cultural heritage impacts during construction and operation				
	Applicable?*	**Likely impact** (negligible, low, medium or high negative or positive; or N/A)	**Reasons** (describe the type, nature and extent of the impact, the nature of the receiving environment and any proposed safeguards which will limit the impact)	Safeguards/Mitigation Measures
1. Will the activity disturb the ground surface or any culturally modified trees?	☐	N/A	The planned fenceline, tracks and operations base have been surveyed – the report from the cultural heritage assessment is included in Appendix 10. The planned fenceline and operations base do not impact on the sites identified in the report.	If unexpected archaeological remains or other cultural heritage items are uncovered during the work, the following protocol will be applied: • Works will immediately cease. • Photographs will be taken of the site, along with any other relevant recording data such as GPS coordinates. • The perimeter will be, as far as is practicable, flagged with marking tape and all staff and other personnel working in the area notified of the site and instructed to not disturb the site. • NPWS staff will be advised. • The relevant Local Aboriginal Land Council will be contacted, and engaged to assess the site and provide advice on management. Should the site be of significance, OEH and NPWS will be notified in writing. The site will be added to work plans to ensure no disturbance.
2. Does the activity affect known Aboriginal objects or Aboriginal places? Include all known sources of information on the likely presence of Aboriginal	☒	NA	The cultural heritage assessment report confirms that the planned works will not impact any known sites.	

Aboriginal cultural heritage impacts during construction and operation				
	Applicable?*	**Likely impact** (negligible, low, medium or high negative or positive; or N/A)	**Reasons** (describe the type, nature and extent of the impact, the nature of the receiving environment and any proposed safeguards which will limit the impact)	Safeguards/Mitigation Measures
objects or places, including AHIMS search results.				
3. Is the activity located within, or will it affect, areas : - within 200m of waters* - within a sand dune system* - on a ridge top, ridge line or headland - within 200m below or above a cliff face - within 20m of or in a cave, rock shelter or a cave mouth? *See the Guidelines for Preparing a REF for definitions.	☐	N/A		
4. If Aboriginal objects or landscape features are present, can impacts be avoided?	☒	Negligible	The planned fenceline, tracks and operations base have been surveyed – the report from the cultural heritage assessment is included in Appendix 10. The proposed activities do not impact on any known sites.	
5. If the above steps indicate that there remains a risk of harm or disturbance, has	☐	N/A	A due diligence report (cultural heritage assessment) has been completed and is attached as Appendix 10. This assessment and field survey was undertaken by a	

Aboriginal cultural heritage impacts during construction and operation				
	Applicable?*	**Likely impact** (negligible, low, medium or high negative or positive; or N/A)	**Reasons** (describe the type, nature and extent of the impact, the nature of the receiving environment and any proposed safeguards which will limit the impact)	Safeguards/Mitigation Measures
a desktop assessment and visual inspection^ been undertaken (refer to the Due Diligence Code)? ^ For activities proposed by OEH, at a minimum, this should be undertaken by an OEH employee with Aboriginal Site Awareness training and relevant practical experience, as approved by an Area Manager.			person with appropriate qualifications and experience.	
6. Is the activity likely to affect wild resources or access to these resources, which are used or valued by the Aboriginal community?	☒	Negligible	The planned works will not impact wild resources. The fenced area will limit access to some areas (noting that the fenced area and operations base form only a small part of the EMA project area). Access for traditional owners and custodians will be provided through access agreements.	

Other cultural heritage impacts during construction or operation			
	Applicable?*	**Likely impact**(negligible/ maintenance, minor, major, contentious; or N/A)	**Reasons** (describe the type, nature and extent of the impact, the nature of the receiving environment and any proposed safeguards which will limit the impact)
1. What is the impact on places, buildings, landscapes or moveable heritage items?	☒	Negligible	It is unlikely that the proposal would have a negative impact on items of other cultural heritage. The proposed CFAI is well clear of any known heritage items. However, if unexpected archaeological remains are uncovered during the work, all work must cease in the vicinity of the material/find and advice must be sought from OEH.
2. Is any vegetation of cultural landscape value likely to be affected (e.g. gardens and settings, introduced exotic species, or evidence of broader remnant land uses)?	☒	Negligible	No vegetation that has been identified as having cultural landscape value is likely to be affected. No additional safeguards are considered necessary.

6.7.1 Proposed Safeguards

If unexpected archaeological remains or other cultural heritage items are uncovered during the work, the following protocol will be applied:

- Works will immediately cease.
- Photographs will be taken of the site, along with any other relevant recording data such as GPS coordinates.
- The perimeter will be, as far as is practicable, flagged with marking tape and all staff and other personnel working in the area notified of the site and instructed to not disturb the site.
- NPWS staff will be advised.
- The relevant Local Aboriginal Land Council will be contacted, and engaged to assess the site and provide advice on management.
- Should the site be of significance, OEH and NPWS will be notified in writing. The site will be added to work plans to ensure no disturbance. all work must cease in the vicinity of the material/find and advice must be sought from the OEH.

7 ENVIRONMENTAL MANAGEMENT

The potential impacts of the proposal identified within Section 6 of this REF can be mitigated through appropriate safeguards to reduce these to acceptable levels. The safeguards provided throughout this REF are summarised within Table 16.

Table 16: Summary of environmental safeguards.

Environmental Component	Proposed Safeguards

Physical and Chemical Impacts	• Where possible, ground vegetation should be retained to minimise soil disturbance.
	• All works will follow the guidelines of NPWS field policies and the Department of Conservation and Land Management 'Urban Erosion and Sediment Control Manual'.
	• Works should not take place during, or within 4 days of heavy rain events (other than work necessary to ensure that soil erosion is minimised). Works should not be scheduled when heavy rainfall is forecast.
	• Sediment controls to be left in situ until the excavated surfaces are stable.
	• Where possible, all movements (including foot traffic) should be confined to existing tracks or the clearing constructed for the fenceline.
	• The site supervisor, through site inductions, would make all personnel aware of risks and responsibilities related to spills of fuel, oil and other chemicals. Machinery should be inspected on a daily basis giving particular attention to the condition of hoses and connections.
	• An emergency spill kit must be kept on site at all times. Staff and contractors using machinery must be made aware of the location of the spill kit and trained in its use.
	• Hay bales would only be used as an erosion control method if they are certified weed free.
	• There must be no release of dirty water into drainage lines and/or waterways.
	• Visual monitoring of local water quality (i.e., turbidity, hydrocarbon spills/slicks) must be carried out on a regular basis to identify any potential spills or deficient erosion and sediment controls.
	• Fuels and chemicals must be stored in an impervious bunded area a minimum of 50 m away from:
	  ○ rivers, creeks or any areas of concentrated water flow
	  ○ flooded or poorly drained areas
	  ○ slopes above 10%.
	• All machinery should be periodically inspected and maintained to ensure minimum levels of emissions.
	• Engines would be switched off rather than left idling for long periods.
	• Rubbish generated during works will be minimised and where generated, will be disposed of in an appropriate manner.
	• To reduce the potential level of dust, AWC support vehicles should be limited to a maximum speed limit of 60 km/h on public roads and 40 km/h on park roads.

Biological Impacts	Threatened vegetation communities: The proposed sites of the fence, tracks and operations base have been selected to avoid listed communities.

Environmental Component	Proposed Safeguards
	Area to perimeter ratio to minimise clearing for the fence: While a circular fenced area would have the shortest perimeter, it would be impracticable in terms of the existing road network and would also compromise the structural strength of the fence. Various options were assessed before the proposed location was selected: for instance, square or rectangular designs would not fit well with the existing road network, and would have required more clearing for new access tracks. Vegetation along fence route: The fence has been located to coincide as far as possible with the distribution of Plant Community Type 165 (i.e. Herbland/open herbland; Morcom and Westbrooke 1990). This vegetation type is a derived community which has resulted from the loss of woodland overstorey trees and shrubs due to former grazing over the past 100 years. The fence alignment is also sited to minimise impact on PCTs 171/172 (i.e. mallee woodlands with a dense spinifex understorey), passing instead through the more open mallee woodlands (PCT 170) and Black Oak dominated woodlands (PCT 58). Vegetation along track routes: The proposed track network inside the fence has been designed taking into account the need to avoid damaging intact vegetation, and makes extensive use of existing vehicle tracks and areas of disturbed and derived vegetation. Routes have been surveyed for threatened plant species. Vegetation at operations base site: The operations base would be located predominantly within a disturbed and 'derived vegetation' area that has received considerable earlier disturbance. The tree cover is low and shrubs are sparse (see Appendix 3, Figure 39). The vegetation of most of the APZ is derived from one of the most common and widespread vegetation types in the Park (i.e. PCT 58). This proposed site has been mapped as PCT 170 ('Chenopod sandplain mallee woodland/shrubland', Morcom and Westbrooke 1990) but this is in error (see Appendix 3, Figure 39). Feral predators and feral herbivores: Feral predators and herbivores will be removed from the site of proposed mammal reintroductions. There will also be intensive feral predator control outside of the fenced area. These measure will also reduce threats to the extant fauna. Adequate area of habitats to support viable populations of species: The proposed fence area is of sufficient size (9,570 ha) to support viable populations of reintroduced species as well as extant species. Malleefowl mounds: Surveys have been carried out along the proposed fenceline and track routes and in the area of the proposed operations base to identify any nearby Malleefowl mounds. They will be protected by a buffer of at least 50 m. Pre-clearing surveys: Pre-clearance fauna surveys will be completed by suitably qualified persons. This will generally involve inspections of logs, rocks and leaf litter and fallen timber for frogs, reptiles and mammals. Any such fauna found will be relocated to adjacent habitat. These surveys will occur on the same day as clearing takes place. Hollow-bearing trees: Removal of hollow-bearing trees will be carried out in accordance with guidelines detailed in Appendix 11. Vegetation communities within the proposed fenced area: The approach taken has been to ensure that all of the main vegetation types in the Mallee Cliffs NP are well represented inside the conservation fence. In

Environmental Component	Proposed Safeguards

	addition, the habitat preferences of some currently-extant threatened species (e.g. the Malleefowl, Gilbert's Whistler, Red-lored Whistler, and a number of reptiles) are known to include Mallee with spinifex so this vegetation type was given special consideration.
	
	Intensive ongoing monitoring: AWC has developed a detailed draft Ecological Health Monitoring Framework (EHMF) for the Mallee Cliffs EMA project area (see Appendix 12). Under this draft EHMF, AWC ecologists will undertake regular biological surveys to measure a suite of indicators including:
	
	• biodiversity indicators (species such as Malleefowl, etc.);
	• threat indicators; and
	• indicators related to ecological processes.
	
	The objectives of this monitoring program include to: (a) track the ecological health of the Mallee Cliffs NP over time; (b) monitor the success of endangered mammal reintroductions; and (c) measure the changes in ecological health that occur as a result of the removal of feral animals and the reintroduction of endangered mammals. The last will allow AWC to evaluate the outcomes of the reintroduction project for extant species and ecosystems at sites both inside and outside the fence.
	
	Barrier effects: Population sizes of all potentially-affected medium-sized mammals will be monitored by AWC both inside and outside the fenced area. While populations of medium-sized mammals are expected to increase in the fenced area following the eradication of feral cats and foxes, populations may still be sufficiently small to be subject to loss of genetic diversity over the long term. In these cases, occasional manual dispersal (i.e. capture and release) of individuals across the fence is likely to be sufficient to maintain connectivity between populations.
	
	Populations of reintroduced animals: AWC will monitor key elements of the extant biota (vegetation, fauna) as well as population sizes of reintroduced mammals, to determine empirically the consequences of reintroductions. If monitoring reveals significant impacts of reintroduced mammals on extant biota that are considered to lie outside the bounds of acceptable change, then AWC may seek to reduce impacts of reintroduced mammals by:
	
	• reducing the population size of reintroduced mammals through:
	  ○ release of a proportion of individuals outside the fence (this action is part of the next stage of the EMA project, but would only occur in conjunction with intensive feral predator control outside the fence);
	  ○ translocation of individuals to another reintroduction site (AWC has multiple reintroduction sites for the candidate species);
	  ○ by other means, such as introduction of terrestrial native predators such as the Western Quoll (which is planned for reintroduction at Mallee Cliffs NP);
	• reducing impacts of reintroduced mammals on particular plants – e.g. threatened plants – by exclusion fencing within the reintroduction site. This approach has been adopted at Mulligan's Flat, primarily for research purposes.
	
	Fence entanglements or collisions: Should monitoring of the conservation fence confirm that bird strike is an issue, AWC would investigate the possible retrofit of mitigation measures. For example, the incidence of bird

Environmental Component	Proposed Safeguards
	strike (grouse and capercaillie) on deer fences in Scotland has been reduced by incorporating wood or plastic into the fences to make them more visible to the birds (Trout and Kortland 2012). Weed management: All vehicles, machinery and equipment entering the site (prior to arrival) are to be thoroughly cleaned inside and out to reduce potential for weed seed spread. Prior to commencing work on the site, all vehicles and equipment will be delivered to and inspected as cleaned in a common inspection area. Any additional cleaning prior to commencement of works will be undertaken in the common inspection area. Vehicles and equipment working within the construction zone will be inspected daily with any identified weed seeds or segments removed and disposed of appropriately. The area of disturbance and immediate surrounds will be continually monitored during and after construction activities to identify and control any weed populations that have established as a result of works. Particular focus will be on eradication of any establishment of noxious weeds in the area of disturbance. All weed incursions will be monitored and controlled by a person experienced in weed management. A comprehensive weed strategy will be developed by the end of 2017, once AWC has collected more information on species' distribution and the threats they represent. Vehicle impacts: Vehicles associated with the construction of the proposal will remain on existing tracks and within the footprint of the CFAI clearings. Foot traffic will be minimised outside of the clearing footprint.
Community Impacts	• Vehicle speed would be limited to 60 km/h on public roads and 40 km/h within park to minimise the potential impact of dust and noise. • Where possible, AWC should seek persons residing locally for employment opportunities. • An assessment of bushfire risk would be undertaken before construction starts. Measures to reduce risk identified in the assessment will be implemented. • No campfires or smoking onsite of any kind are permitted. • The timeframe of work would be minimised where possible to reduce amount of time adjacent landholders and users of surrounding areas are exposed to potential noise pollution.
Natural Resource Impacts	Strategies to minimise water use will include: • Selecting low-flow Water Efficiency Labelling and Standards (WELS)-rated fittings and fixtures, where available. • Selecting WELS-rated appliances and equipment where available. • Maximising rainwater capture through design. • Meeting the requirements of the OEH Park Facilities Manual and consideration of the NPWS Sewage Manual. AWC has incorporated the relevant above considerations in its design. As the site will be self-sufficient, AWC will not seek to obtain an accredited rating for water use, however AWC staff will be conscious of minimising water use due to the operations base water supply being limited.

Environmental Component	Proposed Safeguards
	The operations base development aims to minimise demand for energy, selecting energy efficient appliances where possible, and ensuring strategies are in place such as: • Selecting star-rated equipment with a minimum 4-star rating where possible. • Using LED lighting and other low energy lighting where possible. • Applying passive design elements to moderate room temperatures reducing the need for artificial heating and cooling. • Selecting low-energy, high-efficiency inverter air-conditioning systems for limited use. • Houses will aim to achieve a minimum NatHERS 6 star energy rating. All other buildings (with exception of the workshop) will aim to achieve a NABERS rating of 4 stars. This will be measured through self-assessment.
Aboriginal Cultural Heritage Impacts	A survey for Aboriginal cultural heritage has been carried out. The proposal will not impact on any known sites or items. If unexpected archaeological remains or other cultural heritage items are uncovered during the work, the following protocol will be applied: • Works will immediately cease. • Photographs will be taken of the site, along with any other relevant recording data such as GPS coordinates. • The perimeter will be, as far as is practicable, flagged with marking tape and all staff and other personnel working in the area notified of the site and instructed to not disturb the site. • NPWS staff will be advised. • The relevant Local Aboriginal Land Council will be contacted, and engaged to assess the site and provide advice on management. • Should the site be of significance, OEH and NPWS will be notified in writing. The site will be added to work plans to ensure no disturbance.
Other Cultural Heritage Impacts	The proposal will not impact on any known sites or items. If unexpected archaeological remains or other cultural heritage items are uncovered during the work, the following protocol will be applied: • Works will immediately cease. • Photographs will be taken of the site, along with any other relevant recording data such as GPS coordinates. • The perimeter will be, as far as is practicable, flagged with marking tape and all staff and other personnel working in the area notified of the site and instructed to not disturb the site. • NPWS staff will be advised. • Should the site be of significance, OEH and NPWS will be notified in writing. The site will be added to work plans to ensure no disturbance.

8 SUMMARY OF IMPACTS

This section of the REF summarises the impacts identified and considers the cumulative impacts of the works in accordance with OEH guidelines. It considers the document *Is an EIS required?: best practice guidelines for part 5 of the Environmental Planning and Assessment Act 1979* (NSW Government, Department of Planning 1995), and assists in deciding whether the proposal is likely to have significant environmental impacts. Table 17 summarises the impacts and considers the cumulative impacts of the works based on the classification of individual impacts as negligible, low, medium or high, and either negative or positive.

Table 17: Summary of the significance of impacts associated with the proposal.

Category of Impact	Significance of impacts		
	Extent of impact	Nature of impact	Environmentally sensitive features
Physical and Chemical	Medium (-)	Medium (-)	Low (-)
Biological	High (+)	High (+)	Low (-)
Community	Low (+)	Low (+)	N/A
Natural Resources	Medium (+)	Medium (+)	Low (+)
Cultural Heritage	Negligible (-)	Negligible (-)	Negligible (-)
Works as a whole	Medium positive impact	Medium positive impact	Negligible impact

Based on the summary present in Table 17, an Environmental Impact Statement (EIS) is not required. This REF includes a range of impact amelioration measures designed specifically to mitigate any adverse effect of the proposal on threatened biota. This REF assumes that the amelioration measures detailed would be fully implemented should the proposal be approved.

8.1 Clause 228 Checklist

In addition to the requirements of the guidance in the book *Is an EIS required?: best practice guidelines for part 5 of the Environmental Planning and Assessment Act 1979* (NSW Government, Department of Planning 1995), the following factors, listed in clause 228(2) of the *Environmental Planning and Assessment Regulation 2000*, have been considered to assess the likely impacts of the proposal on the natural and built environment (Table 18).

Table 18: Clause 228 Checklist.

CLAUSE 228 CHECKLIST		IMPACT
a	any environmental impact on a community	
The reintroduction of extinct mammals and the eradication and control of feral predators and herbivores is likely to lead to landscape scale restoration of the existing ecosystem including benefits for extant fauna and an improvement in the condition of the project area. Weeds will be removed from the feral-free area and reduced across the balance of the study area. There are broader benefits for the local community such as a new visitor attraction. The potential negative impacts as a result of clearing are minor - approximately 76 ha (or 78 ha if an alternative access track is needed) of habitat will be cleared within an area of 58,118 ha (less than 0.14%). The narrow, linear nature of most of this clearing (11 m or less wide) further reduces the likelihood of any significant impact. Safeguards are identified to address any issues (potential direct and indirect impacts) arising from the fence acting as a barrier and the potential impacts of reintroduced mammals on other species.		Medium positive impact
b	any transformation of a locality	
See (a) above. The project area would be positively transformed through the removal and control of feral animals and weeds, the reintroduction of regionally extinct mammals and the restoration of ecological processes. Any negative impacts (transformation) associated with the establishment of the fence are not significant.		Medium positive impact.
c	any environmental impact on the ecosystems of the locality	
See (a) above. The project would deliver substantial benefits for the integrity of ecosystems within the project area by removing and controlling invasive plant and animal species and restoring ecological processes. There will be a loss of 76 ha (or 78 ha if an alternative track is required) of vegetation and the construction of a fence which acts as a barrier to a small number of species. Safeguards detailed in this REF have been developed to minimise direct and indirect impacts.		High positive impact.
d	any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality	
See (a) above.		High positive impact.

CLAUSE 228 CHECKLIST		IMPACT
The project would deliver a significant increase in the recreational, scientific and environmental quality/value of the project area. The level of scientific research and monitoring will increase; an important new recreational/visitor attraction will be established and ecosystem integrity will be improved. The clearing of 76 ha (or 78 ha if an alternative track is required) of vegetation, in a narrow, linear strip, will have limited aesthetic impact. .		
e	any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations	
The planned fenceline, tracks and operations base have been surveyed and no direct or indirect impacts on anthropological, archaeological, historical or other cultural values were identified.		
f	any impact on the habitat of protected fauna (within the meaning of the *National Parks and Wildlife Act 1974*)	
See (a) above. The project would deliver substantial positive benefits for the habitat of protected fauna by: - removing and controlling feral predators and feral herbivores, and reducing the impact of weeds, across the project area - restoring ecosystem processes including through the reintroduction of regionally extinct mammals. Approximately 76 ha of habitat (or 78 ha if an alternative access track is required) will be cleared within a project area of 58,118 ha (less than 0.14%). Taking into account the narrow, linear nature of most of this clearing (11 or less metres wide), the adverse impact on habitat will not be significant.		High positive impact
g	any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air	
The project would deliver substantial positive benefits for animals, plants and other forms of life by: - removing and controlling feral predators and feral herbivores, and reducing the impact of weeds, across the project area; - restoring ecosystem processes including through the reintroduction of regionally extinct mammals. Approximately 76 ha (or 78 ha if an alternative track is required) of habitat will be cleared within a project area of 58,118 ha (less than 0.14%). Taking into account the narrow, linear nature of most of this clearing (11 or less metres wide), the impact on animals and plants will not be significant and will not endanger any species.		High positive impact

CLAUSE 228 CHECKLIST		IMPACT
Safeguards are identified to address any issues (potential direct and indirect impacts) arising from the fence acting as a barrier and the potential impacts of reintroduced mammals on other species.		
h	any long-term effects on the environment	
See above paragraphs. The project would deliver a substantial, positive long-term benefit for the environment.		High positive impact
i	any degradation of the quality of the environment	
See above paragraphs. Overall, the proposal is expected to help restore a range of ecological processes and ecosystem health.		Medium positive impact
j	any risk to the safety of the environment	
There will likely be some chemicals or fuel used on site during the construction works and operation of the project. However, given the safety measures in place, it is unlikely that there will be a material risk to the environment.		Minor short term negative impact
k	any reduction in the range of beneficial uses of the environment	
The Mallee Cliffs NP is currently closed to the public. The proposed project will result in a visitor program of guided tours in the proposed feral-free fenced area which will create beneficial use of the environment.		Medium positive impact
l	any pollution of the environment	
There is a low risk of pollution of the environment. However, measures described in Section 7 would mitigate this potential impact.		Minor, short-term negative
m	any environmental problems associated with the disposal of waste	
Waste generated on the site, general, chemical or vegetative, will be disposed of in an appropriate manner and where relevant will follow the guidelines for the disposal of waste in accordance with the EPA approved methods.		Nil Mitigation measures implemented to address any potential impacts.
n	any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply	
The proposal would not increase demands on resources in short supply.		Nil
o	any cumulative environmental effect with other existing or likely future activities	
See the above paragraphs. The project would deliver substantial long-term benefits. There are no material cumulative effects associated with or relevant to other existing or likely future activities. This REF has taken into account the state of the existing environment as well as other known proposals in the region.		Nil
p	any impact on coastal processes and coastal hazards, including those under projected climate change conditions	

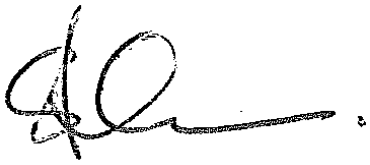
CLAUSE 228 CHECKLIST	IMPACT
This proposal would not impact on coastal process and coastal hazards.	Nil

9 CONCLUSION

This REF has been completed under Part 5 of the EP&A Act, and describes the level of impact that the proposal may have. This REF addresses the duty of the OEH with respect to considering the environmental impact of the proposal under section 111 of the EP&A Act and section 228 of the *Environmental Planning and Assessment Regulation* 2000.

In conclusion, this REF provides a true and fair review of the proposal in relation to its potential effects on the environment. It addresses, to the fullest extent possible, all of the factors listed in Clause 228 of the *Environmental Planning and Assessment Regulation* 2000.

The potential impacts of the proposal identified within the REF can be mitigated through appropriate safeguards to reduce these to acceptable levels. A detailed assessment of the anticipated direct and indirect impacts in accordance with s5A of the EP&A Act, the BC Act, and EPBC Act has been undertaken in this REF. A range of impact amelioration measures designed specifically to mitigate any adverse effect of the proposal on threatened biota are also included. This REF assumes that the amelioration measures detailed would be fully implemented should the proposal be approved.



Mr Steve Sass

Director/ Principal Ecologist, EnviroKey Pty. Ltd

B. App. Sci (Env. Sci) (Hons) (CEnvP), GradCert.CaptVertMgt (CSU)

Certified Environmental Practitioner, Environment Institute of Australia & New Zealand

Practicing Member, Ecological Consultants Association of New South Wales

OEH Accredited Biobanking Assessor (accreditation no. 0143)

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