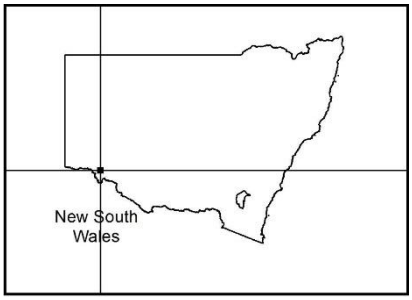
Mallee Cliffs National Park Planning Considerations



Front cover image: Mallee woodland with spinifex understorey. Photo: M Billington, OEH

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ISBN 978-1-925753-45-5
OEH 2018/0172
Mallee Cliffs National Park: Planning considerations, April 2018

Printed on environmentally sustainable paper

How to use this document

This document relates to the matters considered in preparing the *Mallee Cliffs National Park Plan of Management*. Matters that need to be considered when preparing plans of management are set out in Section 72AA(1) of the *National Parks and Wildlife Act 1974*. The legislative and policy framework for plans of management is outlined in Appendix A.

Both the plan of management and this 'planning considerations' document are for use by park managers in developing and monitoring park management priorities. They also serve to inform communities about the values of their parks and what the NSW National Parks and Wildlife Service (NPWS) is doing to care for them.

This document will be updated where appropriate, for example, if we have new information on the values of the park (e.g. new threatened species) or management approaches (e.g. a new pest management technique) or new programs.

Scientific names for common names mentioned in the text are included in Appendix B.

The Mallee Cliffs National Park Planning Considerations document was endorsed by the Minister for the Environment concurrent with adoption of the Mallee Cliffs National Park Plan of Management on 18 December 2017.

Acknowledgments

NPWS acknowledges that Mallee Cliffs National Park is in the traditional Country of the Barkandji People.

This plan of management was prepared by staff of NPWS, part of the Office of Environment and Heritage.

Contacting NPWS

For more information or any inquiries about this plan of management or Mallee Cliffs National Park, contact the NPWS Office at the corner of Sturt Highway and Melaleuca Street, Buronga; or by mail to PO Box 318 Buronga NSW 2739; or by telephone (03) 5021 8900.

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1 Landscape setting and context

Objective: The park retains an important place in the network of conserved lands in western New South Wales

Mallee Cliffs National Park (also referred to as Mallee Cliffs or 'the park' in this document) is located in the south-west corner of New South Wales, 20 kilometres north-east of Buronga. Mildura, a major town in Victoria's Sunraysia district, lies across the Murray River from Buronga (see Figure 1).

Mallee Cliffs protects extensive areas of flat to undulating red sandy plains and sand dunes. The park is significant for protecting mallee and other semi-arid ecosystems of southern Australia which are poorly represented in the reserve system, due largely to clearing of vegetation to make way for dryland farming. In south-west New South Wales, grazing was the main agent of change to mallee vegetation until the last decade or so. Remaining areas of mallee continue to be impacted by clearing for cropping, grazing, inappropriate fire management, mining and soil degradation (Benson et al. 2006).

Mallee Cliffs is 57,969 hectares and was reserved in March 1977 for the purpose of protecting mallee land systems following the purchase of Mallee Cliffs Station, which became available on the expiry of three long-held Western Lands Leases under the *Western Lands Act 1901*. The park is almost completely surrounded by dryland cropping and grazing properties. On part of the park's south-west edge is the **Mallee Cliffs Salt Interception Scheme**, a facility managed by the NSW Department of Primary Industries – Water (see glossary).

The park is in the Murray Darling Depression Bioregion and the South Olary Plain botanical subdivision (Thackway & Cresswell 1995). This area has a warm semi-arid climate, with an annual mean rainfall of 290 millimetres. Evaporation rates greatly exceed rainfall. Average temperatures range from 4 to 32°C, but temperatures in the high 40s are also experienced.

As with many of the bioregions represented in the **NSW Western Division** (see glossary), the level of conservation in the Murray Darling Depression Bioregion is very low at only 5.8% (OEH 2015). Mallee Cliffs is therefore part of an important network of parks which protects native ecosystems that are greatly diminished in extent or degraded by grazing and other land uses in the broader landscape. The other parks include Mutawintji, Sturt, Mungo, Kinchega, Paroo-Darling and Toorale national parks, and Nocoleche and Tarawi nature reserves. Some 300 kilometres to the east, the Yathong – Nombinnie – Round Hill complex of parks incorporates the largest area of mallee within the reserve system in New South Wales, complementing the protection of mallee in Mallee Cliffs, Tarawi Nature Reserve and Mungo National Park.

There are also three small reserves on leasehold land adjoining the park boundary: Wild Dog (to the north of the park), Banya (to the north-west) and Gulthul (south-east) (see Figure 1). These lands were reserved as offsets to clearing of native vegetation and form part of the broader **Southern Mallee Private Reserve** (see glossary). Wild Dog is 2055 hectares, Banya is 1890 hectares and Gulthul is 309 hectares. These reserves on private land complement the broader reserve network. Land may also be set aside for conservation as offsets to clearing of native vegetation under other initiatives from time to time.

2 Protecting the natural environment

Objective: The environment of the park is protected and where necessary restored to be a healthy, stable, representative sample of mallee and belah ecosystems of south-west New South Wales

2.1 Geology, landform and soils

Mallee Cliffs National Park overlies the Murray (Geological) Basin (as distinct from the Murray–Darling Basin which is the surface catchment of the Murray–Darling River system). The Murray Basin originally formed as an extensive area of marine sediments laid down in a shallow arm of the sea during the Cenozoic era (66 million years ago). The sea rose and fell several times during this era, in the Paleocene–Eocene (66–56 million years ago), Oligocene–Miocene (33–23 million years ago), and several times in the Miocence–Pliocene (23–5 million years ago). After each sea recession, silt and clays were deposited forming different geological formations. The sea flooded in from the south-west along the present alignment of the Murray River. The sea last retreated about 2 million years ago leaving a mantle of shallow water sediments (Kingham 1998).

Following the withdrawal of the sea, a succession of cool-dry and warm-moist climatic cycles developed the present cover of deep red sands in the lower Murray–Darling Basin. From about 350,000 to 50,000 years ago there were at least three periods of arid conditions suitable for dune building. These periods of desiccation produced an extensive series of linear sand dunes which appear to be aligned along the anticlockwise pattern of winds circulating around high pressure systems.

The low-relief landform of Mallee Cliffs is characterised by such **aeolian** (see glossary) sand dunes, and sand plains (Lawrie & Stanley 1980). There are no streams, natural water bodies or rock outcrops in the park.

The soils in the sandplains are heavier than the dunefields and composed typically of loam or brown solonised sandy loams, often with limestone nodules at the surface. These alternate with an irregular system of low east–west dunes of red earthy sands and sandy solonised brown soils overlying sandy clays (Morcom & Westbrooke 1990).

2.2 Native plants

Objective: Native plant communities are protected and where necessary restored

Objective: Threatened and rare plant communities and species are protected

Objective: Understanding of the ecology, distribution, threats and management needs of native plant communities is added to and applied in the park

2.2.1 Vegetation communities and threatened species in the park

The native vegetation of Mallee Cliffs is typical of the semi-arid environment of south-west New South Wales. The degree of diversity in this moderately harsh environment is sometimes surprising, as demonstrated by the 293 species of native plants recorded in the park (OEH 2017a). Eleven distinct communities have been identified through surveys and mapping projects (Morcom & Westbrooke 1990; Fox 1991; Scott 1992; Benson et al. 2006).

Two threatened plants occur in the park. Bitter quandong is listed as endangered under the *Biodiversity Conservation Act 2016* (BC Act), and yellow Swainson-pea is listed as

vulnerable under both the BC Act and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (OEH 2017a).

Box 1: Mallee

The dominant vegetation in the park is mallee. The term mallee refers to multi-stemmed mallee eucalypts which form the canopy species of a distinctive ecosystem in the semi-arid zone. The three mallee communities which together make up 76% of the park's vegetation (Benson et al. 2006) are:

- chenopod sandplain mallee woodland/shrubland of the arid and semi-arid (warm) zones
- linear dune mallee mainly of the Murray Darling Depression Bioregion
- deep sand mallee of irregular dunefields of the semi-arid (warm) zone.

The mallee protected in the park is regionally (and possibly nationally) significant due to the widespread clearing of mallee communities which has occurred since the 1880s in Victoria (Mallee CMA 2013), and the degradation of mallee in New South Wales. The mallee vegetation provides habitat essential to the endangered malleefowl and the presence of both mallee and malleefowl were key factors in the decision to create the park.

After mallee, the next dominant plant community in the park is black oak – western rosewood open woodland on deep sandy loams of Murray Darling Depression and Riverina bioregions (Benson et al. 2006). Black oak is commonly known as belah in western New South Wales and is referred to as belah in this plan. As this community occurs on fertile land favoured for cropping, it has consequently been extensively cleared and therefore the 7535 hectares (13% of the park area) conserved at Mallee Cliffs is regionally important.

The next most abundant plant community is corkscrew grass grassland/forbland on sandplains and plains in the semi-arid climate zone, which covers 10% of the park. This community is a derived community, which has resulted from the degradation of native vegetation by a long history of sheep grazing. Prior to reservation, Mallee Cliffs Station was grazed by up to 8500 sheep (Morcom & Westbrooke 1990) for over 100 years. Grazing modified the native plant communities across the majority of the station through the introduction of weeds, trampling of vegetation, browsing of young plants and hardening of soil by hard-hooved sheep. These impacts had the effect of changing the structure and species composition of the native plant communities. Mallee communities were used for grazing to a lesser extent as the structure of the mallee made it difficult for graziers to muster stock and the soil types were unsuitable for ground tanks, but all of the native plant communities occurring in the park were impacted by grazing to some degree.

Corkscrew grass grassland is also known regionally as speargrass grassland and has the highest incidence of non-native plant species of all the vegetation communities in the park. It typically occurs around former ground tanks which were frequented by mobs of sheep on a regular basis. The widespread occurrence of speargrass in the park suggests that the extent of the other plant species and communities may have been greater before grazing (Morcom & Westbrooke 1990). The soils where ground tanks were sited tended to be heavier grey clays, so the original vegetation may have been black box or chenopod shrubland associations. NPWS encourages regeneration of perennial plant species by managing grazing pressure (see Section 2.2.2) and some areas of corkscrew grass grassland are experiencing germination of chenopods and other perennials with time.

The park also contains small samples of less than a hectare of the following communities (Benson et al. 2006):

- sandplain mulga tall open shrubland of the semi-arid and arid climate zones
- black bluebush low open shrubland of the alluvial plains and sandplains of the arid and semi-arid zones

- pearl bluebush low open shrubland of the arid and semi-arid plains
- white cypress pine open woodland of sand plains, prior streams and dunes mainly of the semi-arid (warm) climate zone
- black box grassy open woodland of rarely flooded depressions in south western NSW
- narrow-leaved hopbush - scrub turpentine - senna shrubland of semi-arid and arid sandplains and dunes.

The distribution of these plant communities is largely determined by minor changes in topography and associated soil type. All communities are described in detail in Appendix C.

The white cypress pine open woodland community is in poor condition, lacks an understorey and supports only a few canopy trees in poor health. Despite this, it is significant as a remnant of the Sandhill Pine Woodland in the Riverina, Murray-Darling Depression and NSW South Western Slopes Bioregions Endangered Ecological Community listed under the BC Act (NSW SC 2008).

Mallee with chenopod understorey, Mallee Cliffs National Park. Photo credit: E Foster, OEH.

Belah with chenopod understorey, Mallee Cliffs National Park. Photo credit: R Enke, OEH.

Derived grassland/herbland, Mallee Cliffs National Park. Photo credit: R Enke, OEH.

2.2.2 Restoring native vegetation values in the park

Mallee Cliffs exists as a patch of relatively intact native vegetation in a moderately fragmented landscape in which negative impacts on native vegetation are otherwise high. Clearing for dryland cropping and grazing by sheep, cattle, goats and rabbits have significantly altered the landscape. The occurrence of small patches of relict native plant communities within the park possibly demonstrates relatively long-term ecological change in the south-west of New South Wales.

In addition to bearing the impacts of extensive grazing on native vegetation communities, the park was formed only 2 years after a fire burnt the majority of the mallee communities on Mallee Cliffs Station in the summer of 1974–75.

Restoration of the native vegetation ecosystems has therefore been a major focus of park management since the park was formed. Restoration effort has included the decommissioning of artificial water points, monitoring and control of native and non-native herbivores, weed control and the introduction of a scientifically based fire management regime. These works are briefly discussed here.

Decommissioning of artificial water points – The introduction of artificial sources of water in the semi-arid landscape of western New South Wales for watering stock animals has led to undesirable increases in populations of non-native pest animals, such as goats and pigs, and possibly an increase in some native animals such as kangaroos. These increases have in turn led to significant changes to the native vegetation and habitat values for native animals around the water points. It is now known that ground-dwelling mallee birds decrease in abundance closer to artificial water points due to the decline or loss of low, dense shrub species. Many of these birds are of conservation concern such as striated grasswren, southern scrub-robin and shy heathwren (Harrington 2002).

To combat these types of impacts, 17 of the 18 ground tanks previously using for watering sheep on Mallee Cliffs Station have been decommissioned by severing drainage lines so that water can no longer collect. The single remaining ground tank (known as Pine Tank) was retained as a necessary source of water for park management activities, including pest control and fire management. It is fenced to exclude all large herbivores. (Introduced pests are discussed in detail in Section 2.5).

In recognition of the role that artificial water plays in the semi-arid landscapes in the area, NPWS works in cooperation with neighbouring landholders to address total grazing pressure by both native and non-native herbivores.

Monitoring and control of herbivores – Goats and rabbits have an impact on native vegetation communities, particularly in destroying newly germinated and immature plants, thus reducing the chances of recruitment and growth of vegetation communities. Competition and habitat degradation by feral goats and rabbits are listed as key threatening processes under the BC Act (NSW SC 2004 and NSW SC 2002 respectively). This listing recognises their role in the decline of several threatened plants and animals. NPWS controls these species by regular and ongoing pest control programs (see Section 2.5) and there has been a significant reduction in the number of goats and rabbits in the park since its acquisition (R Enke [OEH], 2017 pers. comm.). NPWS also monitors kangaroos on an occasional basis to determine their impact on park values.

NPWS is also separately monitoring the effect of grazing pressure from native and non-native pest animals on specific vegetation communities through a scientific grazing trial. Exclosures were constructed in mulga in 1994, and white cypress pine, belah–rosewood and bluebush/herbland communities in 2007. Four different grazing treatments were applied to the pine, belah and bluebush/herbland communities:

- total exclusion of all animals
- accessible to rabbits only

- accessible to large herbivores (kangaroos and goats)
- no exclusion (i.e. a control plot).

These exclosures are monitored every 2–3 years to measure species composition, species recruitment, and health and growth of individual plants.

In all four communities, the monitoring has clearly demonstrated the slow rate of change under semi-arid conditions. Responses for individual communities have varied considerably. In the mulga exclosures, significant regeneration has occurred with a prolific number of young mulga plants emerging from multiple germination events. Mulga regeneration is now also occurring outside exclosures as the native ecosystems respond positively to sheep being removed and the control of feral goats and rabbits. By contrast, the heavily depleted white cypress pine community has continued to deteriorate. Isolated white cypress pine trees continue to die within the exclosures under all four treatments, and it is likely that these remnants will not recover at all. For the other plant communities, preliminary results have shown limited change over time. The exclosures will continue to be maintained.

Weed control – There are 33 introduced plant species recorded in the park. While the mallee communities were relatively weed-free at the time the park was reserved, other plant communities, where the greatest grazing pressure had occurred, showed varying degrees of weediness. Over the 40 years since the park was reserved, weediness throughout the park has reduced, particularly with regard to the incidence of African boxthorn, onion weed and Patterson's curse. This is broadly due to the removal of domestic grazing stock.

The *Biosecurity Act 2015* and regulations provide specific legal requirements for the prevention, eradication or containment of state-level priority weeds. These requirements apply equally to both public and privately-owned land. A regional strategic weed management plan prepared under the Biosecurity Act identifies those pest plants that are being prioritised for management action, investment and compliance effort within the Western Local Land Services region (Western LLS 2017). These priorities will be implemented via the relevant NPWS pest management strategy.

Priority weed species identified in the regional pest management strategy for control in the park are: African boxthorn, Patterson's curse, Bathurst burr, onion weed, white horehound, fierce thornapple and Ward's weed (OEH 2013c). African box thorn is identified as a state priority species under the Biosecurity Act (Western LLS 2017). One of the important contributing factors in controlling weeds has been limiting the frequency of vehicles entering the park. Weed spraying is generally confined to management trails.

Fire management – Fire is a sporadic feature of the semi-arid zone, characterised by large infrequent wildfires in years with significantly above-average rainfall when grass fuel loads are high. Fire can also occur at any time in vegetation communities that carry perennial hummock grasses, such as spinifex, so mallee with a spinifex understory is a highly flammable vegetation community. Some semi-arid vegetation communities, such as chenopod shrublands, do not require fire to maintain ecological processes and fire can be detrimental. Fire is therefore managed in the park according to a research-based fire management strategy which is based on fire history and the ecology of individual native plant communities (see Section 2.3).

The *Reintroduction of Locally Extinct Mammals* project commenced in the park in 2017 (see Box 4 and Appendix E). Several of the species to be reintroduced to the park are known for their ability to enhance ecosystem processes in the semi-arid zone, particularly through digging. Digging mammals are thought to improve soil health by mixing organic matter, dispersing soil nutrients, improving water infiltration and spreading micro-organisms (Fleming et al. 2014). The introduction of these 'ecosystem engineers' to the park may add to the restoration efforts described above, provided the carrying capacity is controlled.

In the moderately harsh climate of the semi-arid zone, improvement in the health and condition of native vegetation ecosystems takes time. In 40 years of park management, the elimination of domestic stock and control of feral goats and rabbits has allowed the regeneration of some communities. The removal of artificial water points has considerably reduced grazing pressure by goats, and probably kangaroos. With the exception of the white cypress pine community, it is expected that regeneration of native vegetation communities in the park will continue.

2.3 Fire

Objective: Fire in the park is managed to conserve and maintain semi-arid ecosystems while also protecting park management infrastructure

Objective: The fire regime applied in the park maintains populations of all native plants and animals, particularly malleefowl and other threatened species

Fire is an integral part of the Australian environment. It is a major factor in determining the structure and species composition of the vegetation, and has long-term effects on animal populations. However, inappropriate fire regimes can lead to impacts on, and loss of particular plant and animal species and communities, and high-frequency fires have been listed as a key threatening process under the BC Act (NSW SC 2000b). The primary objectives of NPWS fire management are to protect life, property and community assets from the adverse impacts of fire, while also managing fire regimes in parks to maintain and enhance biodiversity.

Fire frequency, intensity, season of occurrence, the source of fire and its subsequent path are major factors influencing the distribution and composition of plant and animal communities. Through the use of prescribed fire and other fire management techniques, NPWS has considerable potential to influence these factors. A great deal of research is being directed at understanding the effects of fire on plants and animals in mallee ecosystems in order to develop an appropriate fire regime which will not compromise conservation of the park's natural values. Research carried out by NPWS in Tarawi Nature Reserve and Mallee Cliffs as well as the Mallee and Fire Biodiversity Project (La Trobe University n.d.) has contributed significantly to the understanding of fire in mallee ecosystems.

Box 2: Managing fire in the park

Fire history in the park

Aboriginal people are known to have used fire across the Australian continent to promote food animals and other resources by deliberate burning of known habitats, sometimes at a small or very small scale. The Aboriginal fire regimes for semi-arid mallee communities are not known with any surety.

Fire history in south-west New South Wales (DEC 2006) reveals that:

- Large fires can occur in all vegetation communities in years when very high fuel loads are present. This occurs after significantly above-average rainfall which promotes massive growth of speargrass, other ephemeral grasses and herbs.
- Smaller fires can occur at other times, mainly in the mallee spinifex communities.
- Fires occur at very irregular intervals.
- Fire behaviour in mallee communities can be extreme and unpredictable.
- Most fires are ignited by dry lightning storms.

Details about the fire history in the park prior to its acquisition are not comprehensive. In January 1918 'very large' fires occurred in the region but then no 'large' fires are known to have occurred between 1932 and 1975 (DEC 2006). In 1975 the mallee-dominated vegetation communities of Mallee Cliffs Station were burnt in extensive fires which occurred across the landscape of south-west New South Wales (Watson et al. 2012). Since then, only three wildfires have occurred: in the western corner of the park in 1989, in the north-east corner in 1998, and in the south-east of the park in 2006.

As a result of this fire history, most mallee vegetation in the park is now reaching about 40 years of age, with some small but significant areas that are much older (potentially 100 years) (Clarke et al. 2010).

Fire ecology

Fire affects the functioning of ecosystems in a number of ways including changing vegetation structure, animal habitat and fuel abundance, and altering nutrient and energy flows. Ecosystems and the plants and animals that live in them have evolved to survive with particular fire regimes. Altering fire regimes beyond the adapted thresholds can disrupt the functioning of these ecosystem (OEH 2013a).

In Mallee Cliffs, fire can have both beneficial and undesirable outcomes. For example, fire will benefit plant species which need fire to release seed for recruitment, and the flush in vegetation germination immediately after fire has the potential to produce great resources for animals (including seeding grasses for malleefowl and seed-eating mammals). Conversely, grazing by introduced pests and native herbivores after fire affects the recruitment of palatable plants. Some species can disappear from the landscape if fire kills plants and eliminates seed banks or if suitable habitat for animals is lost.

Mallee ecosystems are fire prone and fire in this landscape is a key driver of ecological change. In mallee vegetation communities, habitat and fuel characteristics such as leaf litter, hollows, canopy cover and height, bark and spinifex cover all increase in the first 35 years after fire. From about 35 years to 100 years after fire these characteristics provide optimum habitat for a large number of species including several threatened species. Maximum fuel loads are also attained by 35 years and they remain high for at least another 65 years (Haslem et al. 2011). Mallee-dominated vegetation communities contain plant species which are generally fire tolerant and some plants might be considered fire dependant, but ongoing research has demonstrated that there is no minimum or maximum fire interval required in these communities.

Fire in remnant tracts of native vegetation, including the mallee, can be problematic because a single fire can burn the entire area once the patch size diminishes below a critical level. This creates a single age cohort and reduces biodiversity values. The overall objective in mallee-dominated vegetation communities is therefore to provide patchiness and multiple age classes whilst maximising the amount of older mallee which has optimum habitat features.

Although fire is an important part of the Australian environment it is important to note that not all vegetation communities require fire to maintain ecosystem process and health. Fire can be detrimental to some semi-arid vegetation communities such as chenopod shrublands. In the park, fire should be avoided in belah–rosewood woodlands which have a chenopod understorey.

Fire regimes for vegetation in the park

Many species of plants and animals are adapted to specific stages of the post-fire vegetation regeneration cycle and, as such, different frequencies of fires will favour different species. The species that are favoured will depend on the plant's life cycle and patterns of seed set. Mallee pine, for example, takes 15 years to form cones but will survive for up to 500 years if it escapes being burnt for the first 50 years of its life. On the other hand, a number of reptiles are most favoured by the 6–25 year post-fire stages because fire promotes the growth of spinifex (Caughley 1985) which is important shelter/habitat for reptiles in the park.

Longer periods between fires will result in greater vegetation variety and it appears desirable that communities in the park should generally not be burnt more often than at least every 20–40 years. Some areas should remain unburnt for as long as possible to provide old-age stands of

vegetation. The most desirable result would be for all post-fire stages to be present in some part of the park to provide habitat diversity.

The fire regimes in the park's fire management strategy (OEH 2013b) reflect requirements for fire intervals for plant communities and habitat requirements for animals where these are known.

The park has 11 vegetation communities which, from a fire management perspective, can be broken up into five broad community types. The vegetation management guidelines and expected fire behaviours for each of these community types are provided in Appendix D.

Bushfire risk management zones

Fire management zones are used to differentiate the fire management intent to meet the needs of park values. The location of the zones will be reviewed and amended in conjunction with development of the *Reintroduction of Locally Extinct Mammals* project (see Box 4).

- Land management zones – Most of the park is presently managed as a land management zone. The objective of this zone is to conserve biodiversity and protect cultural and historic heritage. Fire in this zone is managed consistent with fire thresholds.
- Strategic fire advantage zones – The objective is to provide strategic areas of fire protection advantage which will reduce the speed and intensity of bushfires, and reduce the potential for spot fires. These zones also aid in containing bushfires to existing management boundaries. The overall fuel hazard should be maintained in these zones at high or below, however, adherence to guidelines for biodiversity will take precedence where practical.
- Asset protection zones – The objective of this zone is the protection of human life and property, and highly valued public assets such as built infrastructure. In this zone, these values take precedence over guidelines for the management of biodiversity. Overall fuel hazard should be maintained at moderate or below.

Working with other fire management authorities

NPWS assists in developing fire management practices that contribute to conserving natural and cultural heritage across the landscape, and implements cooperative and coordinated fire management arrangements with other fire authorities, neighbours and the community (OEH 2013b). NPWS maintains cooperative arrangements with surrounding landowners and the Rural Fire Service and is a member of the Lower Western Zone Bush Fire Management Committee.

2.4 Native animals

Objective: Native animal populations are protected and maintained

Objective: Populations of malleefowl and other rare, threatened or isolated animal species are protected and maintained

Objective: The *Reintroduction of Locally Extinct Mammals* project is implemented in the park

Mallee Cliffs provides valuable habitat for a diverse range of animals, especially mallee-dwelling animals. Native animals recorded on Mallee Cliffs include: 129 birds, 50 reptiles and 18 mammals. Highly visible animals common in the semi-arid environment include emus, kangaroos, sand monitors and woodland birds.

Knowledge about the native animals of south-west New South Wales was quite limited until the Western Region Biodiversity Conservation Project was undertaken by NPWS (Mazzer et al. 1998). This project surveyed 51 sites, including sites in Mallee Cliffs National Park, Tarawi Nature Reserve and private land between 1994 and 1996.

The Fire and Wildlife in the Mallee Project carried out by La Trobe University between 2006 and 2008 (La Trobe University n.d.) added significantly to the knowledge of animals, habitat and the role played by fire in mallee ecosystems. A total of 280 sites spread across the mallee in the three states of southern Australia were surveyed, including sites on Mallee Cliffs.

Regular monitoring has been carried out by NPWS since 2001 using fixed pitfall traps which are distributed in different habitat types throughout the park. While this monitoring program was originally set up in response to a single record for the threatened western pygmy possum, to date almost 3000 animals of 46 species have been captured over 11 surveys, thus establishing the habitat values of the park. Importantly, this long-term monitoring has also confirmed that some animal species of the mallee go through 'boom and bust' cycles, according to dry or wet rainfall years or series of years.

Western pygmy possum in mallee shrubland, Mallee Cliffs. Photo credit: R Dayman, OEH

In the semi-arid lands, mallee spinifex communities occur as a patchwork of vegetation and open ground, which varies with age. Over the 40 years or so since fire burnt the majority of the mallee communities in Mallee Cliffs Station in 1974–75, litter and spinifex have been able to build up in the park's mallee communities to create the conditions needed to support a greater diversity of animals. While most of the mallee in the park is middle-aged (40+ years since fire), there are some patches of old-age mallee (over 50 years old) and it is these that form the richest habitat in the park in terms of the diversity of animal species found there. The presence of spinifex in the park is also important as some animals, such as the southern ningaui, are spinifex specialists. The older mallee, particularly the shrub layer that is present, is also important for a number of birds including the southern scrub-robin, Gilbert's whistler and shy heathwren.

Important habitat features in the park include:

- a plentiful layer of ground litter needed by malleefowl to build mounded ground nests
- stripping bark for use by birds and mammals as nesting materials
- old-age trees which contain cracks, spouts and hollows for use by bats and other arboreal mammals

- hollow logs in the belah woodland for use by reptiles
- mixed-age, patchy spinifex hummocks which provide ground cover needed by reptiles and ground mammals.

The variety of habitat in the park also allows animals to take refuge during protracted dry periods and/or fire.

2.4.1 Threatened animals known or likely to occur in the park

A total of 27 threatened species listed under the BC Act have been recorded in the park. Malleefowl and Corben's long-eared bat are also listed under the EPBC Act (see Table 1). The preference of many of the threatened mammals and reptiles for mallee with spinifex understorey underscores the importance of this vegetation type in the park.

Strategies for the recovery of threatened species, populations and ecological communities have been set out in a statewide *Biodiversity Conservation Program* (OEH 2017) (formerly known as the *Threatened Species Priorities Action Statement*). These actions are currently prioritised and implemented through the *Saving our Species* program, which aims to maximise the number of threatened species that can be secured in the wild in New South Wales for 100 years (OEH 2013d). A national recovery plan has been prepared for the endangered malleefowl to consider its management needs in more detail (Benshemesh 2007).

Table 1. Threatened animals in the park

Common name	Scientific name	Status	
		BC Act	EPBC Act
Reptiles			
Jewelled gecko	*Strophurus elderi*	V	
Mallee slender blue-tongue lizard	*Cyclodomorphus melanops elongatus*	E	
Mallee worm-lizard	*Aprasia inaurita*	E	
Western blue-tongued lizard	*Tiliqua occipitalis*	V	
Birds			
Black-chinned honeyeater (eastern subspecies)	*Melithreptus gularis gularis*	V	
Black falcon	*Falco subniger*	V	
Chestnut quail-thrush	*Cinclosoma castanotum*	V	
Dusky woodswallow	*Artamus cyanopterus cyanopterus*	V	
Flame robin	*Petroica phoenicea*	V	
Gilbert's whistler	*Pachycephala inornata*	V	
Hooded robin (south-eastern form)	*Melanodryas cucullata cucullata*	V	
Little eagle	*Hieraaetus morphnoides*	V	
Major Mitchell's cockatoo	*Lophochroa leadbeateri*	V	
Malleefowl	*Leipoa ocellata*	E	V
Pied honeyeater	*Certhionyx variegatus*	V	
Purple-gaped honeyeater	*Lichenostomus cratitius*	V	

Common name	Scientific name	Status	
		BC Act	EPBC Act
Red-tailed black cockatoo (inland species)	*Calyptorhynchus banksii samueli*	V	
Regent parrot (eastern subspecies)	*Polytelis anthopeplus monarchoides*	E	V
Shy heathwren	*Hylacola cautus*	V	
Southern scrub-robin	*Drymodes brunneopygia*	V	
Spotted harrier	*Circus assimilis*	V	
Varied sittella	*Daphoenositta chrysoptera*	V	
White-fronted chat	*Epthianura albifrons*	V	
Mammals			
Corben's long-eared bat	*Nyctophilus corbeni*	V	V
Little pied bat	*Chalinolobus picatus*	V	
Southern ningaui	*Ningaui yvonneae*	V	
Western pygmy possum	*Cercartetus concinnus*	E	

Source: *BioNet Atlas*, accessed 2017 at www.bionet.nsw.gov.au/.

Box 3: Malleefowl

Mallee Cliffs lies in the centre of the identified stronghold for the endangered malleefowl, and park management efforts have focussed on the protection and conservation of this species. The malleefowl population in the park is of regional if not national significance. Other major malleefowl populations are at Yathong – Nombinnie – Round Hill group of parks and Goonoo National Park in central west New South Wales, and at Tarawi Nature Reserve and Scotia Sanctuary near the New South Wales – South Australia border.

The malleefowl is a large and distinctive ground-dwelling bird which has become severely depleted in New South Wales over the last 100–150 years through land clearance and fox predation. In many areas there has been such loss and fragmentation of their habitat that remaining populations are small and isolated (Benshemesh 2007).

Malleefowl, SOS program. Photo credit: M Irvin, OEH

Apart from habitat loss, fragmentation and degradation, malleefowl populations are also threatened by the following factors (OEH n.d.):

- Fire which removes litter for mound construction, shelter from predators, and food sources, especially seeds. Mounds are not usually constructed in an area within 15–20 years after a fire and it may be 40 years before maximum densities are attained.
- Predation mainly by foxes and cats but also by birds of prey which target eggs and chicks.
- Vehicle strike where birds cross roads or feed on spilt grain beside roads.
- Anthropogenic climate change, which in the long-term may alter habitat characteristics preferred by the species such that its capacity to support viable populations is reduced.
- Competition for food and disturbance to nesting mounds by feral goats.
- Disturbance to nesting mounds by feral pigs.
- Sheep grazing of habitat on private land.

Mallee Cliffs is essential to the conservation of malleefowl as one of only a handful of areas where the species is actively managed in New South Wales. These include several conservation reserves, as well as private property and a captive population at Western Plains Zoo. Malleefowl are also being conserved in reserves in Victoria, South Australia and Western Australia. Each of these areas protects a small population of malleefowl and the loss of any of these will result in a substantial reduction in the total population. Small, isolated populations have a greater risk of extinction due to genetic effects and chance events such as drought and fire.

It is not possible to describe the population size of malleefowl at Mallee Cliffs with any accuracy. It has been estimated that the park contains about 300 mounds but the proportion of these that are used for breeding varies considerably each year. Aerial and ground monitoring of 150 mounds has been carried out since 1989 and has determined that, as with other specialists in the semi-arid zone, breeding activity by malleefowl is strongly linked to the age-class of mallee habitat, frequency of fire and the timing (both frequency and season) of rainfall.

Malleefowl nest at Mallee Cliffs. Photo credit: OEH

Old-age mallee with a spinifex understorey is the preferred habitat for malleefowl in the park. Spinifex is less palatable for sheep so the extensive area of mallee with spinifex understorey east of Bulbuc Track was not used for grazing on Mallee Cliffs Station. This extensive area now supports the greatest concentration of malleefowl in the park.

Malleefowl at Mallee Cliffs are managed as an iconic species under the *Saving our Species* program and in accordance with the national recovery plan for malleefowl (Benshemash 2007). Key management actions under the program are control of foxes and other predators, fire management and control of feral goats. NPWS is also continuing to review all aspects of the malleefowl program under an adaptive management approach which takes account of new technologies, such as remote sensing, and changing parameters, such as the emergence of pigs as a pest in the mallee lands.

2.4.2 Restoring native animal values in the park

The loss of many native animal species in Australia over the last 200 years is the result of a combination of factors. Clearing of vegetation, the introduction of hard-hoofed animals, changed fire regimes and the impact of non-native predators have all played a role in the decline and extinction of many native species in Australia.

For the Western Division of New South Wales, however, it was the introduction of sheep and the way they were managed that finally drove so many of the native mammal species to extinction (Lunney 2001). The effects of the rabbit plague, foxes and drought cycles added to the impact of increasing numbers of sheep across the landscape by the mid-1880s, including those marginal parts which formerly provided sufficient refuge for native animals to persist in the harsh conditions of arid Australia.

The introduction of bores and ground tanks across the arid and semi-arid zones to provide water for sheep fundamentally altered the dynamics of native animals and non-native pests. These artificial sources of water enable pest animals to become established in areas that were previously not habitable for most of the time. This has resulted in the persistence of larger and more widespread populations of these species than would otherwise be possible. In a number of cases, the increase in abundance of a species may have significant negative effects on other species (James et al. 1999).

Current estimates indicate that of Australia's native animal assemblage, mammals have been most adversely affected by extinctions. In New South Wales, 59% of all mammal species historically recorded are now endangered or extinct (Lunney et al. 1994). In an effort to address this decline, the *Reintroduction of Locally Extinct Mammals* project will be undertaken in Mallee Cliffs National Park under the *Saving our Species* program (see Box 4). National parks represent a feasible opportunity for this initiative as they are managed to address or exclude the threatening processes which operate on a landscape scale and which have caused the extinction of these species.

Mallee Cliffs is considered suitable for a reintroduction project on the basis that it has been managed for conservation purposes for 40 years and has large areas of suitable habitat available. Since dedication as a national park, emphasis has been placed on the value of Mallee Cliffs National Park as a nature conservation area. For this reason, no infrastructure has been developed in the park and public access has been restricted to education and research purposes.

Similar projects to the one in Mallee Cliffs National Park are being developed in Sturt National Park and Pilliga Outwash parks. The key objectives of the projects are to:

- address the decline in mammal diversity
- improve the overall ecosystem resilience of the parks
- assist in securing a number of threatened species from extinction.

Box 4: *Reintroduction of Locally Extinct Mammals* project

Predation by introduced pests, particularly cats and foxes (see Box 5:), is recognised as playing a major role in the decline of Australia's native animals. Native animals evolved without the responses needed to combat these pests. The removal of introduced predators from within securely fenced exclosures has been proven to be an effective method for ensuring that reintroduced native species establish secure populations. This approach forms the basis of the reintroduction project and it is hoped that, in time, the reintroduced native mammals can also be reintroduced in the broader landscape of the park outside the exclosure.

An area of approximately 9700 hectares has been identified in the south-west quarter of the park as the project area (see Map 1 for an indicative location). Following a concentrated effort to remove all predators and other species with potential to disrupt the project such as emus and kangaroos, the following species are intended to be progressively introduced:

- bridled nailtail wallaby
- brush-tailed bettong
- burrowing bettong [1]
- greater bilby
- greater stick-nest rat
- Mitchell's hopping mouse
- numbat
- red-tailed phascogale
- western barred bandicoot
- western quoll.

These species are no longer found in the park but are known historically to have played an important role in maintaining healthy ecosystems in this environment. Each of these species is also threatened with extinction across its range. Ground dwelling mammals such as bettongs, bilbies and bandicoots are known to have far-reaching, positive effects on entire ecosystems in the semi-arid and arid zones. Turning over soil in their search for food allows better penetration of water into soils and reduces surface runoff, as well as creating the disturbance needed for many plants to germinate. In this sense, such species function as ecological engineers (James et al. 2009; Read et al. 2008) and, with the loss of these species, the important ecosystem services to which they contribute may in turn be threatened (Fleming et al. 2014).

The final selection of species may vary slightly depending on the availability of animals and other factors. The final location and size of the exclosure will be based on the suitability of habitat and the need to minimise disturbance to the park's natural and cultural values.

An initial 10-year contract has been awarded to the Australian Wildlife Conservancy for the project in Mallee Cliffs. In addition to establishing and managing viable populations of locally extinct species in the project area, the contract includes the delivery of park management activities such as pest and weed control, asset maintenance, future visitor management and supporting NPWS in fire management activities across the whole park. At the end of the 10-year period the outcomes of the project will be assessed. This review will help to determine the next steps for the project. Additional detail on the project is included in Section 5.2.

[1] *Bettongia lesueur graii* is an extinct subspecies of burrowing bettong. Therefore, it will be replaced by the remaining extant representative of the species, *Bettongia l. lesueur,* consistent with the national recovery plan for the species.

The management of genetic health and resilience in the populations of each of the species to be introduced is an important and essential component of the project. Animals for reintroduction will be sourced from a number of subpopulations, including wild populations, so as to maximise genetic diversity. Preference will be given to animals from populations in environments that are most similar to the conditions in Mallee Cliffs and that are closest to the park. In the event that suitable animals are not available from wild subpopulations, they may be selected from captive populations.

Reintroduced species will be translocated into the purpose-built exclosure free of introduced predators. In the surrounding area outside the fence, intensive pest control including targeted cat control, will benefit extant threatened species including Malleefowl. This concentrated effort is expected to have benefits for all biodiversity in the park, particularly ground-dwelling and ground-nesting animals. It will also improve knowledge of predator–prey interactions and improve expertise in effective pest control, particularly for cats and foxes. The long-term objective of the program is that once the reintroduced populations become established and the threats to these species are effectively reduced more broadly throughout the park, animals will be released from the exclosure into the surrounding area.

Fencing for the exclosure has been designed to maximise cat, fox and dog exclusion as well as to exclude pest species such as rabbits, pigs and goats (see photo below of a similar exclosure). Special measures include two electrified wires at different heights, rabbit netting along the ground to prevent burrowing in, and floppy overhangs to prevent cats and foxes climbing over the fence. The exclosure will also be equipped with one-way gates to allow small mammals to disperse into the park in the long term. The integrity of the fence will be constantly monitored and maintained in conjunction with ongoing pest management.

Exclosure fence at Arid Recovery Centre, South Australia. Photo credit: K Moseby, Ecological Horizons Pty Ltd

Extensive environmental monitoring will be conducted regularly, both inside and outside the exclosure to assess reintroduced animals, responses of other native species including threatened species, and responses of other aspects of the ecosystem to the reintroduction of mammal species and threat management. Short-term, medium-term and long-term indicators of success towards establishing viable populations of each of the reintroduced species will be developed. The results of the monitoring will be used to guide ongoing management decisions, evaluate progress towards establishing viable populations and improving the ecological health of the park. Information about the progress of the project will also be made known to the public.

2.5 Pest animals

Objective: Pest animals are controlled and where possible eliminated from the park

Objective: Negative impacts of pest animals on park values are minimised

With the establishment of vast pastoral holdings in the Western Division from the 1840s onwards, introduced animals brought about dramatic changes to native Australian ecosystems. Several of these introduced animals have become major pest species in the semi-arid zone, including foxes, rabbits, goats, feral pigs and feral cats. These species continue to have impacts across a range of park values, including impacts on biodiversity, cultural heritage, ecosystem function, landscape and scenic values.

Pests in the park are managed under a regional pest management strategy (OEH 2013c) which identifies priority pest programs. The overriding objective of the pest management strategy is to minimise adverse impacts of introduced pest species on biodiversity and other park values. The impacts of many introduced animal pests are classified as key threatening processes under the BC Act and some of these, such as foxes, are addressed under a threat abatement plan.

The decommissioning of ground tanks which were on Mallee Cliffs Station at the time of acquisition (as detailed in Section 2.2.2) has improved pest management efforts on the park.

Box 5: Introduced predators

Many small native mammals that once occurred in the Western Division are now extinct, especially those in the critical weight range of 35–500 grams (Dickman et al. 1993). The *Reintroduction of Locally Extinct Mammals* project seeking to re-establish populations of some of these species will commence in the park in 2017 under the *Saving our Species* program (see Box 4). Introduced predators such as foxes and feral cats have played a significant role in the loss of mammals in the arid and semi-arid zones.

Foxes suppress native animal populations, particularly medium- and small-sized ground-dwelling and semi-arboreal mammals, ground-nesting birds and freshwater turtles. Foxes also prey on domestic stock, including lambs and poultry. Predation by the European red fox is a declared key threatening process under both the BC Act and the EPBC Act (NSW SC 1998; DoE 2009). The fox is also a declared pest species in New South Wales under the *Local Land Services Act 2013*.

Foxes are considered a major pest species in Mallee Cliffs because of the significant impact they have on native fauna, particularly malleefowl. Fox control has been carried out in the park using 1080 poison since 1989 using both buried baits and spring-activated baiting devices (known as canid pest ejectors). As opportunistic feeders, both of these methods have proven to be environmentally safe and effective, particularly if done in cooperation with neighbouring land owners. Fox control is coordinated with rabbit control in the park and is ongoing, due to the highly mobile nature of foxes which results in rapid repopulation of treated areas. Fox baiting is also increased in areas where rabbit control has been undertaken to limit prey switching to native animals as rabbit numbers decline.

Together with foxes, **feral cats** are known to have caused the decline of many native species including extinctions of mammals. They are responsible for the failure of many threatened species reintroduction programs that do not have effective exclusion fencing, and continue to pose a serious threat to Australian wildlife (Short et al. 1992 and Priddel & Wheeler 2002, both cited in Moseby & Hill 2011). Cats are notoriously good hunters and can endure the harsh conditions of the semi-arid and arid zones where other predators fail. The way cats move through the landscape is also less predictable than for foxes which tend to use trails and roads. Predation by feral cats has been listed as a key threatening process under both the BC Act and the EPBC Act (NSW SC 2000c and DoE 2009 respectively).

Although 1080 poisoning is effective in reducing cat numbers, cats are not on the list of approved species for control by 1080 poisoning and special permission is required from Local Land Services for such programs. Shooting at night with spotlights was historically used, however this method is not considered cost-effective for the scale of the problem and therefore better methods are needed.

Large-scale control methods for feral cats are not yet available. Preliminary work is being undertaken to develop new types of cat bait such as 'Curiosity' (DoEE n.d.) and specially designed cat-baiting stations. Subject to further research and approvals, effective controls may be suitable for use in the park in the medium- to long-term.

Rabbits accelerate erosion by removing plant cover and are also suspected as being an important cause in the decline of and limited regeneration of many native species in semi-arid habitats including cypress pine, wattles, hakeas and belah/rosewood communities. Rabbits are a major food source of the large predators, notably foxes and eagles, although predation by those animals alone does not significantly reduce rabbit numbers.

Competition and grazing by the feral European rabbit is listed as a key threatening process under both the BC Act and the EPBC Act (NSW SC 2002 and DoE 2009 respectively). They have been implicated in modifying habitat and reducing food resources important for malleefowl.

A combination of rabbit control techniques is used in Mallee Cliffs. This includes baiting using 1080 poison, warren implosion and warren ripping. The biological control of rabbits using caliciviruses first occurred in the park in 1996 and had a dramatic effect in reducing rabbit populations. An extensive program of warren ripping was then carried out. There has been a significant increase in the regeneration of several perennial plant species throughout the park as a result of the decrease in rabbit numbers but rabbits still impact on the recruitment of some species. Rabbit numbers as low as 0.5 per hectare can still prevent the regeneration of some semi-arid plant species (DoEE 2016). Although warren ripping is one of the most effective techniques available, in dune country it can lead to vegetation damage and has the potential to disturb Aboriginal cultural heritage.

Goats are a significant problem in western New South Wales since they can breed rapidly and are highly nomadic. Goats are mobile, able to move many kilometres in a day, and are not impeded by standard stock fencing. Grazing by feral goats can severely impact the regeneration of some plant species.

Competition and habitat degradation by feral goats is a key threatening process under both the BC Act and EPBC Act (NSW SC 2004 and DoE 2009 respectively). The feral goat is identified by the International Union for the Conservation of Nature as one of the 100 worst invasive species in the Global Invasive Species Database (IUCN 2017).

The removal of ready water by decommissioning almost all of the ground tanks and the installation of a goat trap at the one remaining ground tank (Pine Tank), has meant that goat numbers in the park are low and sporadic. Goats are removed from the park by trapping and mustering by licenced contractors. As with other pest control programs, neighbours are also encouraged to carry out goat control on their lands in cooperation with NPWS.

Pigs were only first recorded in the park in 2013 and are considered an emerging pest. As pig numbers are low, control measures have not yet been implemented but will be prioritised as the need arises.

2.6 Climate change

Objective: The resilience of the park to the impacts of climate change is enhanced

Objective: Understanding the impacts of climate change is enhanced and informs management of the park

Human-induced climate change is listed as a key threatening process under the BC Act (NSW SC 2000a) and habitat loss caused by human-induced greenhouse gas emissions is listed under the EPBC Act (TSSC 2001).

The latest information on projected changes to climate are from the NSW and ACT Regional Climate Modelling (NARClim) project (OEH 2014). The climate projections for 2020–2039 are described as 'near future' (or as 2030); and projections for 2060–2079 are described as 'far future'. The snapshot shown in Table 2 is for the Far West Region which includes Mallee Cliffs (OEH 2014).

Table 2. Far West Region climate change snapshot

Projected temperature changes	
Maximum temperatures are projected to **increase** in the near future by 0.3–1.0°C	Maximum temperatures are projected to **increase** in the far future by 1.8–2.7°C
Minimum temperatures are projected to **increase** in the near future by 0.4–0.8°C	Minimum temperatures are projected to **increase** in the far future by 1.4–2.7°C
The number of hot days (i.e. > 35°C) will **increase**	The number of cold nights (i.e. < 2°C) will **decrease**
Projected rainfall changes	
Rainfall is projected to **decrease** in winter and spring	Rainfall is projected to **increase** in summer and autumn
Projected Forest Fire Danger Index changes	
Average fire weather is projected to **increase** in summer and spring	Number of days with severe fire weather is projected to **increase** in summer and spring

Source: OEH 2014.

What is already a harsh, hot climate in western New South Wales is expected to become even hotter under climate change. Conditions along the southern fringe of the region along the Victorian border are a little milder than further north but the region as a whole still experiences more hot days each year on average than the other regions in New South Wales. Mallee Cliffs currently has 30–40 hot days over 35°C and under the projections for climate change, this is expected to increase by 10–20 additional days.

The projected increases in temperature and increased number of hot days will lead to an increase in evaporation in western New South Wales. This is projected to create drier soil conditions throughout the year. Increases in severe fire weather days and length in fire season are expected. Although weather conditions conducive to large intense fires are likely to increase, the amount of fuel available, such as grasses and herbaceous plants, may decrease. However, in areas with available fuel and fire-prone vegetation, such as mallee woodlands and spinifex grasslands, fires are likely to increase.

With regard to rainfall, a slight increase is projected to occur but the modelling of runoff shows significant variation and there are no clear patterns about whether or not droughts are going to be more or less severe (DECCW 2010).

Larger areas will be vulnerable to increased erosion by wind and by heavy downpours during more frequent intense storms. This increases the risk of disturbance and damage to Aboriginal cultural heritage in the landscape. Increased temperatures and the increase in hot days are also likely to exceed the physiological limits of many soil-crust lichens and cryptogams which are present in arid environments (DECCW 2010). Soil crusts form a major component of ground cover in these environments and play an important role in soil stability, nitrogen fixing and soil fertility. Ephemeral wetlands will be under increased pressure to support waterbirds and other native animals through the dry times.

Throughout the region, animal species which are unable to cope with the intensification of extreme temperatures will decline. Species most at risk are those already under pressure because they are unable to migrate or adapt, for example because they have specialised habitat or thermal requirements, small population sizes or slow growth rates. This could include species such as malleefowl, which require sufficient rainfall at the right time of year to build their nests in long-unburnt, mallee communities.

Mallee Cliffs has been managed as a conservation reserve for 40 years to remove or lessen the effect of threatening processes and restore habitat needed by native plants and animals. Park management activities aimed at avoiding fire in old-age mallee and decommissioning artificial sources of water restoring habitat values have helped to build resilience in a region where mallee ecosystems have been greatly reduced. Continuing these measures and promoting the maintenance of a species-sensitive fire regime in the broader landscape will help reduce the severity of the effects of climate change on the park.

Long-term conservation of biodiversity under changed climatic conditions depends on the protection, enhancement and connection of remaining habitat across the landscape, incorporating vegetation remnants on both public and private lands. Cooperative arrangements with neighbours are therefore important in controlling pest species and maximising the connectivity of habitats across the landscape. Private land which is added to the Southern Mallee Private Reserve complements the habitat being conserved at Mallee Cliffs but it is unlikely that more comprehensive corridors can be formed to link the park with other vegetated remnants.

2.7 Research into natural values

Objective: Research improves understanding of semi-arid ecosystems including the populations of native plants and animals they support

As an important remnant of mallee woodland, Mallee Cliffs has been the focus of a variety of research to do with mallee ecosystems and the biodiversity they support. Some of the ongoing research programs have collated valuable data for more than 30 years. Together with the data collected from other mallee remnants, this has contributed to the scientific understanding of the natural systems and processes at work.

NPWS encourages environmental research and student field work training projects in the park provided they are of benefit to the park and provided they do not cause undue disturbance to park values and management operations. Past projects have allowed interstate collaborations by several universities to facilitate research into mallee ecosystems across New South Wales, Victoria and South Australia. Preference is given to applied research which will benefit ongoing adaptive management for the park's significant natural values. Long-term research needs to continue in the park to assist in managing fire and to answer questions about the persistence of malleefowl in disjunct populations which are separated by large tracks of cleared farmland.

Monitoring and research into ecosystem restoration and species reintroductions will be conducted in the park by the Australian Wildlife Conservancy as part of the *Reintroduction of Locally Extinct Mammals* project (see Box 4). A research strategy will be developed to

examine key aspects of species reintroductions including: population dynamics, preferred habitat attributes, relationships between reintroduced and resident species, and predator–prey relationships for both native and non-native predators. Pest control methods will also be studied.

3 Looking after our culture and heritage

Objective: Aboriginal and shared histories are protected

Objective: Aboriginal people continue to enjoy connection to Country and are encouraged to participate in park management

3.1 Aboriginal culture and heritage

Both Aboriginal and non-Aboriginal people place values on cultural and natural landscapes. These values may be attached to the landscape as a whole, or to parts of the landscape (e.g. a particular plant, animal or place). All landscapes contain the imprint of human use. On any given area of land, some historical activity will have taken place. Much of the Australian environment has been influenced by past Aboriginal and non-Aboriginal land-use practices, and people continue to influence the land through recreational use, cultural practices, the presence of introduced plants and animals, and in some cases air and water pollution.

Regardless of park boundaries, Aboriginal people have cultural associations and connections to Country across the broader landscape including the use and enjoyment of foods and medicines, caring for the land, passing on cultural knowledge, kinship systems and strengthening social bonds. Aboriginal heritage and connection to nature are inseparable and need to be managed in an integrated manner across the landscape.

Fire was also an integral part of managing Country by Aboriginal people across Australia. Fire was used for hunting, promoting useful species, keeping open paths for travel and for the protection of culturally important places and landscape features.

The park is part of Country for the Barkandji People. The Barkandji Traditional Owners lodged a native title claim over a large area of western New South Wales that included Mallee Cliffs and other NPWS-managed lands. A determination was issued in favour of the Barkandji Traditional Owners on 16 June 2015, but the determination excluded all NPWS-managed lands. NPWS is, however, committed to negotiating an Indigenous land use agreement (ILUA) with the Barkandji native title holders which will address how, and to what extent, the Barkandji People will be involved in management of the parks within the native title area.

> **What is ‘Country’?** To Aboriginal people, the landscape is made up of many features that are interrelated. These include land, water, plants and animals, places and stories, historical and current uses, and people and their interactions with each other and place. These features are central to Aboriginal spirituality and contribute to Aboriginal identity. They are inseparable and make up what is known as ‘Country’.

Limited survey has been carried out for Aboriginal heritage within the area of Mallee Cliffs, and to date only one Aboriginal site, a hearth, has been recorded. However, there is a low likelihood of additional sites being located as there is no permanent water and no source of rock present. It is possible that the mallee sandridge country was visited less frequently by Aboriginal people in the past, compared with the resource-rich Murray River corridor further to the south. An abundance of sites has been recorded along the Murray River, demonstrating that the river supported a large population of Aboriginal people.

NPWS nevertheless recognises the importance of Country for Aboriginal people and will support connection to Country where possible.

While the NSW Government has legal responsibility for the protection of Aboriginal sites and places, NPWS acknowledges the right of Aboriginal people to make decisions about their own heritage. Aboriginal communities will be consulted and involved in the management of Aboriginal sites, places and related issues, and the promotion and presentation of Aboriginal culture and history.

3.2 Shared cultural heritage

History has taken place across the landscape. This includes the history of the first Australians – Aboriginal people – and our shared history since European settlement. Cultural heritage comprises places and items that may have historic, scientific, cultural, social, archaeological, architectural, natural or aesthetic significance. NPWS conserves the significant heritage features of NSW parks and reserves.

South-western New South Wales was settled by Europeans and mobs of sheep from the late 1840s onwards, first along the river systems, and then 'the backblocks'. By the early 1850s squatting licences were being issued for the occupation of river frontage lands near the confluence of the Murray and Darling Rivers.

A map of the Land Board District of Hay published in 1890 (Bowyer-Smith) shows that the western two-thirds of what is now Mallee Cliffs National Park was part of a much larger Mallee Cliffs property which extended to the Murray River. The eastern block of Mallee Cliffs National Park was part of Tapalin property which also had extensive frontage on the Murray River.

Almost all the land in the Western Division is held under Western Lands Leases granted under the Western Lands Act. This act originated from a Royal Commission into the 'condition of the Crown tenants in the Western Division' following severe drought and land degradation on a massive scale. The primary purpose of the leasehold system was to ensure appropriate land administration and land management in what was beginning to be recognised as a fragile environment.

The NSW Government acquired Mallee Cliffs Station for the purpose of making a national park when the three relevant Western Lands Leases expired in 1976. At that time the station had all the infrastructure associated with a country sheep station including homestead and outbuildings (constructed about 1939), woolshed, shearers' huts, sheepyards and ground tanks. All but the meathouse were demolished on the basis that the property lacked a permanent supply of water, there was no legal access to the property and it would not be economically or practically feasible to maintain these facilities as part of a conservation reserve. The majority of Mallee Cliffs had also been burnt out in the bushfire of 1974–75 which destroyed the main part of the boundary fencing and left only a few small island areas unburnt.

The park itself bears evidence of the history of pastoral use in the form of altered vegetation and decommissioned ground tanks. The meat house is the only building remaining from the original station complex but the foundations of other buildings are still extant.

4 Public use of the park

Objective: Public access will continue to be limited to natural and cultural resource conservation activities, environmental education and research

Objective: Visitor safety is maintained for all authorised users of the park

Up until 2017 Mallee Cliffs has been managed with an emphasis on the restoration of mallee ecosystems including malleefowl and other threatened species. The primary purpose of the park has been nature conservation and access by the public has been limited mostly to researchers and bird watching groups who visit a few times a year.

Historically, recreation was excluded from Mallee Cliffs due to the absence of a permanent water supply and a lack of secure legal access. However, other national parks in the region have well-developed visitor infrastructure and provide a range of interesting experiences for visitors including Mungo, Kinchega and Yanga national parks in New South Wales, and Hattah-Kulkyne, Murray-Sunset and Wyperfeld national parks in Victoria.

Up until 2017, access into the park was via private roads over adjoining private land under an informal agreement between neighbouring property owners and NPWS. In order to facilitate the establishment of the *Reintroduction of Locally Extinct Mammals* (as described in Box 4), secure legal access to the park will need to be negotiated with park neighbours.

Public access to Mallee Cliffs will continue to be limited to: natural and cultural resource conservation activities, environmental education and research. In order to protect visitors and park values alike, particularly during periods of high fire risk, park visitation will be via authorised access.

The *Reintroduction of Locally Extinct Mammals* project commenced in the park in 2017. A visitor strategy will be developed to manage access to the project area and is expected to provide rare opportunities for visitors such as scientists, school groups, educational tours and community groups to observe threatened species in the reintroduction area on guided tours. Under this strategy, limited numbers of visitors associated with the project will be allowed to stay on the park within the project's operations base.

5 Park infrastructure

Objective: All infrastructure needed to manage the park is sited, constructed and maintained to adequately service management needs and have minimal environmental impacts

Objective: Non-NPWS uses and activities have minimal impact on park values

Objective: Infrastructure is constructed in the park to support the *Reintroduction of Locally Extinct Mammals* project

5.1 Existing NPWS infrastructure

A network of **management trails** is maintained in Mallee Cliffs for fire management, pest animal and weed control, monitoring and research, and emergency access (see Figure 1).

The only **ground tank** maintained in Mallee Cliffs for fire management and pest animal control is Pine Tank in the eastern section of the park. The tank is fenced and a goat trap installed to prevent access to the tank by large native and non-native herbivores. Water for fire management purposes is stored in an enclosed tank. Additional water for fire management is sourced from the neighbouring **Mallee Cliffs Salt Interception Scheme** (see glossary).

Boundary fencing surrounds the park and is maintained in accordance with fencing agreements with neighbouring landowners.

Several small **fenced exclosures** of 1–2 hectares have been constructed as part of NPWS research into the effects of grazing by native and non-native pest animals (see Section 2.2.2).

5.2 Proposed fencing and other infrastructure for the *Reintroduction of Locally Extinct Mammals* project

Establishment of the *Reintroduction of Locally Extinct Mammals* project (as detailed in Box 4) will include construction of infrastructure to support operations and to engage visitors with the project. New infrastructure will include:

- secure pest-proof fencing around the project area
- management trails connecting to and within the project area
- accommodation and supporting facilities for Australian Wildlife Conservancy staff, researchers and visitors
- office, workshop, power system, repeater antenna and fuel storage.

All houses and other accommodation facilities will be fitted with water tanks and will be reliant on rainwater for their domestic supply. An additional supply for fire/pest management purposes will also be harvested and stored on site. A groundwater bore may also be constructed.

A detailed environmental impact assessment will be undertaken prior to any works being carried out in the park for this project. The outcomes of the assessment will determine the final location of the project's outer boundary, the operations base and location of infrastructure within this area, and the alignment of additional management trails.

Factors to be considered in siting all infrastructure and management trails include:

- the need to minimise the footprint of environmental disturbance
- the need to minimise impacts on malleefowl habitat and habitat needed by other threatened species while including a diversity of habitat within the exclosure for the reintroduced species
- effective asset protection
- cost-effective service provision
- location of existing management trails
- potential impacts on existing park management activities
- operation and workability of the overall project
- aesthetics, design and visual impact on park landscape values.

Appendix A Legislation and policy

The following laws and policies apply to how we manage our parks:

NSW legislation

- *National Parks and Wildlife Act 1974* (NPW Act) and NPW Regulation
- *Biodiversity Conservation Act 2016*
- *Environmental Planning and Assessment Act 1979* (EPA Act)
- *Heritage Act 1977*
- *Biosecurity Act 2015*
- *Local Land Services Act 2013*
- *Rural Fires Act 1997*

Other NSW laws may also apply to park management:

- *Crown Lands Act 1989*
- *Western Lands Act 1901*

Commonwealth legislation

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- *Murray-Darling Basin Plan*

NPWS policies and strategies

These NPWS policies and strategies may also apply to park management:

- Boundary Fencing Policy
- Staff Housing Policy
- Aboriginal Partnerships Policy
- Cultural Fire Management Policy.
- Regional pest management strategies
- Saving our Species Program

Other laws, policies and strategies may also apply; please contact NPWS for advice.

Appendix B Scientific names

The following tables lists scientific names of common names mentioned in the text.
Key:
V = vulnerable species
E = endangered species
X = presumed extinct species
JAMBA = Japan and Australia Migratory Bird Agreement
KTP = key threatening process
SP = state priority species under the Biosecurity Act
RP = regional priority species under the Local Land Services regional strategic weed management plan

Native animals

Common name	Scientific name	Status	
		BC Act	EPBC Act
Reptiles			
Jewelled gecko	*Strophurus elderi*	V	
Mallee slender blue-tongue lizard	*Cyclodomorphus melanops elongatus*	E	
Mallee worm-lizard	*Aprasia inaurita*	E	
Sand monitor	*Varanus gouldii*		
Western blue-tongued lizard	*Tiliqua occipitalis*	V	
Birds			
Black-chinned honeyeater (eastern subspecies)	*Melithreptus gularis gularis*	V	
Black falcon	*Falco subniger*	V	
Chestnut quail-thrush	*Cinclosoma castanotum*	V	
Dusky woodswallow	*Artamus cyanopterus cyanopterus*	V	
Emu	*Dromaius novaehollandiae*		
Flame robin	*Petroica phoenicea*	V	
Gilbert's whistler	*Pachycephala inornata*	V	
Hooded robin (south-eastern form)	*Melanodryas cucullata cucullata*	V	
Little eagle	*Hieraaetus morphnoides*	V	
Major Mitchell's cockatoo	*Lophochroa leadbeateri*	V	
Malleefowl	*Leipoa ocellata*	E	V
Pied honeyeater	*Certhionyx variegatus*	V	
Purple-gaped honeyeater	*Lichenostomus cratitius*	V	
Red-tailed black cockatoo (inland species)	*Calyptorhynchus banksii samueli*	V	
Regent parrot (eastern subspecies)	*Polytelis anthopeplus monarchoides*	E	V

Common name	Scientific name	Status	
		BC Act	EPBC Act
Shy heathwren	*Hylacola cautus*	V	
Southern scrub-robin	*Drymodes brunneopygia*	V	
Spotted harrier	*Circus assimilis*	V	
Striated grasswren	*Amytornis striatus*		
Varied sittella	*Daphoenositta chrysoptera*	V	
White-fronted chat	*Epthianura albifrons*	V	
Mammals			
Bridled nailtail wallaby	*Onychogalea fraenata*	X	E
Brush-tailed bettong	*Bettongia penicillata*	X	E
Burrowing bettong	*Bettongia lesueur graii*	X	X
Burrowing bettong	*Bettongia lesueur lesueur*		V
Corben's long-eared bat	*Nyctophilus corbeni*	V	V
Greater bilby	*Macrotis lagotis*	X	V
Greater stick-nest rat	*Leporillus conditor*	X	V
Little pied bat	*Chalinolobus picatus*	V	
Mitchell's hopping mouse	*Notomys mitchellii*	X	
Numbat	*Myrmecobius fasciatus*	X	V
Red-tailed phascogale	*Phascogale calura*	X	E
Southern ningaui	*Ningaui yvonneae*	V	
Western pygmy possum	*Cercartetus concinnus*	E	
Western barred bandicoot	*Perameles bougainville bougainville*	X	E
Western quoll	*Dasyurus geoffroii*	X	V

Native plants

Common name	Scientific name	Status	
		BC Act	EPBC Act
Belah (also known as black oak)	*Casuarina pauper*		
Bitter quandong	*Santalum murrayanum*	E	
Black bluebush	*Maireana pyramidata*		
Black box	*Eucalyptus largiflorens*		
Cypress pine	*Callitris* spp.		
Mallee pine	*Callitris verrucosa*		
Mulga (also known as sandplain mulga)	*Acacia aneura*		
Narrow-leaved hopbush	*Dodonaea viscosa* subsp. *angustissima*		

Common name	Scientific name	Status	
		BC Act	EPBC Act
Pearl bluebush	*Maireana sedifolia*		
Scrub turpentine	*Eremophila sturtii*		
Senna	*Senna artemisioides* subsp. *filifolia*		
Spinifex (also known as porcupine grass)	*Triodia scariosa*		
Wattle	*Acacia* spp.		
Western rosewood	*Alectryon oleifolius*		
White cypress pine	*Callitris glaucophylla*		
Yellow Swainson-pea	*Swainsona pyrophila*	V	V

Weeds and pest animals

Common name	Scientific name	Status
Weeds		
African boxthorn	*Lycium ferocissimum*	WONS, SP.
Bathurst burr	*Xanthium spinosum*	
Onion weed	*Asphodelus fistulosus*	
Patterson's curse	*Echium plantagineum*	
Speargrass (also known as corkscrew grass)	*Austrostipa scabra*	
Ward's weed	*Carrichtera annua*	
White horehound	*Marrubium vulgare*	
Fierce thornapple	*Datura ferox*	
Pest animals		
Cat	*Felis catus*	KTP
European red fox	*Vulpes vulpes*	KTP
Goat	*Capra hircus*	KTP
Pig	*Sus scrofa*	KTP
Rabbit	*Oryctolagus cuniculus*	KTP
Sheep	*Ovis aries*	

Appendix C Plant communities in the park

Community name/VIS ID (Benson et al. 2006)	Veg Community Types (Keith 2004)	% of park	1990 Morcom & Westbrooke	Description
Chenopod sandplain mallee woodland/shrubland of the arid and semi-arid (warm) zones / 170	Sand Plain Mallee Woodlands	60	1 *Eucalyptus gracilis/E. dumosa/E. socialis* open-scrub	This mallee community is the most extensive plant community in the park. It is found on sandy loams and solonised brown soils of the calcareous sandplains. The dominant eucalypts are snap and rattle (*Eucalyptus gracilis*), white mallee (*E. dumosa*) and red mallee (*E. socialis*). In addition, narrow-leaf red mallee (*E. foecunda*) and glossy-leaved red mallee (*E. oleosa*) occur but less frequently. The community is characterised by a diverse understorey which includes narrow-leaf hop-bush (*Dodonea viscosa* ssp *angustissima*), *Senna artemisioides, Zygophyllum spp., Eremophila glabra, Westringia rigida, Grevillea huegelii* and *Chenopodium curvispicatum*. This community is comparatively weed free but fire prone.
Linear Dune Mallee mainly of the Murray-Darling Basin Bioregion/171	Dune Mallee Woodlands	16	2 *Eucalyptus gracilis/E. dumosa/E. socialis* open-scrub with Triodia understorey	These mallee communities occur on low dune ridges where shallow sands overlie sandy clays. They are recognised as separate communities because of the dominance of the spinifex (*Triodia scariosa*) understorey. On deep red sands, the communities also have a rich shrub understorey other than spinifex. Understorey species include narrow-leaf hop-bush, *Eremophila glabra, Myoporum platycarpum, Senna artemisioides, Baeckea crassifolia, Acacia wilhelmiana, A. microcarpa* and *Pittosporum phylliraeoides.* Several species are restricted to these communities including desert heath-myrtle (*Baeckea crassifolia*) and broom ballart *(Exocarpos sparteus*), are recorded at only a few localities in NSW.
Deep sand mallee of irregular dunefields of the semi-arid (warm) zone/172	Dune Mallee Woodlands			

Community name/VIS ID (Benson et al. 2006)	Veg Community Types (Keith 2004)	% of park	1990 Morcom & Westbrooke	Description
				Because of its dense structure, mallee communities were not as heavily grazed and therefore they are the least modified communities in the park. The communities are comparatively weed free, but very fire prone.
Black Oak - Western Rosewood open woodland on deep sandy loams of Murray-Darling Depression and Riverina Bioregions/58	Semi-arid Sand Plain Woodlands	13	3 *Casuarina cristata* subsp. *pauper* low open woodland	This community occurs on calcareous plains of loamy solonised brown soils of inter-dune areas. Belah (the common name given to black oak in western NSW), typically occurs with rosewood (*Alectryon oleifolius*), although monospecific stands of either species may occur. This community is also often characterised by an understorey of tall and low shrubs including Mueller's daisy bush (*Olearia muelleri*), gallweed (*Zygophyllum apiculatum*), bladder saltbush (*Atriplex vesicaria*) and leafless ballart (*Exocarpos aphyllus*). Narrow-leaf hop-bush, silver cassia (*Senna artemisioides*), false sandalwood (*Myoporum platycarpum*), wait-a-while (*Acacia colletioides)* and black bluebush (*Maireana pyramidata*) often dominate the understorey. In the north of the park there is an unusual occurrence of wilga (*Geijera parviflora*), a species which is regarded as uncommon in the area. This community was utilised for grazing and has been moderately invaded by non-native species. Belah woodland does not readily carry fire and these communities were not severely burnt during the fires in 1975 and 1977.
Sandplain Mulga tall open shrubland of the semi-arid and arid climate zones/119	Sand Plain Mulga Shrublands	<1	6 Mulga (*Acacia aneura*) open-woodland	Only one small patch of mulga occurs in the north of the park within an extensive area of belah woodland. The understorey of the community is dominated by species associated with the herbland community. Mulga is rare in south-west New South Wales due to extensive clearing

Community name/VIS ID (Benson et al. 2006)	Veg Community Types (Keith 2004)	% of park	1990 Morcom & Westbrooke	Description
				for agriculture and is at the southern edge of its range at Mallee Cliffs (Benson et al. 2006).
Black Bluebush low open shrubland of the alluvial plains and sandplains of the arid and semi-arid zones/153	Aeolian Chenopod Shrublands	<1	9 *Maireana pyramidata* low open-shrubland	Black bluebush (*Maireana pyramidata)* occurs in small patches. Like pearl bluebush (*Maireana sedifolia*), this community was preferred by stock and was probably once more common in the park.
Pearl Bluebush low open shrubland of the arid and semi-arid plains/154	Aeolian Chenopod Shrublands	<1	8 *Maireana sedifolia* low open-shrubland	Two small areas of pearl bluebush occur in the park on soils with a high clay content and where pools of water accumulate following rain. This species was preferred by stock and was probably once more common on the park.
White Cypress Pine open woodland of sand plains, prior streams and dunes mainly of the semi-arid (warm) climate zone /28	Riverine Sandhill Woodlands	<1	4 *Callitris glaucophylla* low open-woodland	White cypress pine (*Callitris glaucophylla*) occurs as scattered individual plants within the belah community and is the dominant species in a few small areas. Many individual trees have died since the park was formed and little of the native understorey remains. It is likely that persistent overgrazing by sheep and rabbits has resulted in a lack of recruitment over time. White cypress was also favoured for fencing timber and suffered from fire. Given the isolated occurrence of white cypress in the park and their current state of health, the true composition of the community is unlikely to be restored.
Black Box grassy open woodland of rarely flooded depressions in south western NSW /16	Inland Floodplain Woodlands	<1	5 *Eucalyptus largiflorens* open-woodland	A small patch of black box (*Eucalyptus largiflorens*) occurs in the north west section of the park on heavy soils. The understorey consists mainly of non-native grasses and herbs.
Narrow-leaved Hopbush - Scrub Turpentine - Senna shrubland of semi-arid and arid sandplains and dunes /143	Sand Plain Mulga Shrublands	<1	7 *Dodonaea viscosa* subsp. *angustissima* shrubland	In the park, narrow-leaf hop-bush is generally associated with mallee open scrub communities. However, In a number of sites, it occurs as a monospecific tall shrub community. The species is an early coloniser following clearing and disturbance of vegetation including overgrazing. The incidence of this community, therefore,

Community name/VIS ID (Benson et al. 2006)	Veg Community Types (Keith 2004)	% of park	1990 Morcom & Westbrooke	Description
				probably reflects past grazing and clearing. Hop bush is considered by landholders as a major woody weed in the south-west corner of the state.
Corkscrew grass grassland/forbland on sandplains and plains in the semi-arid (warm) climate zone /165	Riverine Plain Grasslands	10	10 Herbland/open herbland	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 community typically occurs around the major watering points which were provided on the former property. Because the watering points were sited in areas of occluded drainage where the soils tended to be heavier grey clays, the original vegetation may have been black box, mulga, cypress pine or chenopod shrub steppe associations. The relative dominance of species in this community may vary dramatically with the extent and season of rainfall. This community is the most heavily invaded by non-native plant species.

Appendix D Vegetation management guidelines by community type for fire

Vegetation Formation	Vegetation Community	Vegetation management guidelines	Fire Behaviour
Grasslands	Open grassland-herbland	An interval between fire events less than 15 years should be avoided. Fire will only carry in this community when there are high ephemeral fuel loads (extreme fuel loads have only occurred a few times in the last 100 years).	This vegetation community will not carry fire unless there are high ephemeral fuel loads. Moderate to high intensity fires may occur when fuel loads are high.
Semi-arid woodlands (shrubby subformation)	Mallee – Spinifex	Recent research suggests that a minimum of 15 years is required before fuel loads are sufficient for fire to carry and that there is no maximum age threshold. Under ephemeral fuel conditions fires may burn more frequently due to increased fuel loads.	Fire intensity in mallee communities ranges from moderate to extreme and is largely influenced by presence of spinifex, ephemeral growth and/or weather conditions.
Semi-arid woodlands (shrubby subformation)	Mallee-shrubland	Recent research suggests that a minimum of 15 years is required before fuel loads are sufficient for fire to carry and that there is no maximum age threshold. Under ephemeral fuel conditions fires may burn more frequently due to increased fuel loads.	Fire intensity in mallee communities ranges from moderate to extreme and is largely influenced by presence of spinifex, Ephemeral growth and/or weather conditions.
Semi-arid woodlands (shrubby subformation)	Belah-rosewood	Fire should be avoided. The understorey is dominated by chenopod species.	This vegetation community will not carry fire unless there are high ephemeral fuel loads. Moderate to high intensity fires may occur when fuel loads are high.
Semi-arid woodlands (shrubby subformation)	Mixed open shrubland/ woodland	An interval between fire events less than 15 years should be avoided. Fire will only carry in this community when there are high ephemeral fuel loads (extreme fuel loads have only occurred a few times in the last 100 years).	This vegetation community will not carry fire unless there are high ephemeral fuel loads. Moderate to high intensity fires may occur when fuel loads are high.

OFH – Overall fuel hazard - A rating system that includes leaf litter, grasses, shrubs, bark type and bark condition.

Ephemeral conditions – occur after consecutive years of high rainfall which leads to a build up of fine fuels such as grasses and herbs. This has the potential to create a continuous fuel loading across all of the vegetation communities listed above.

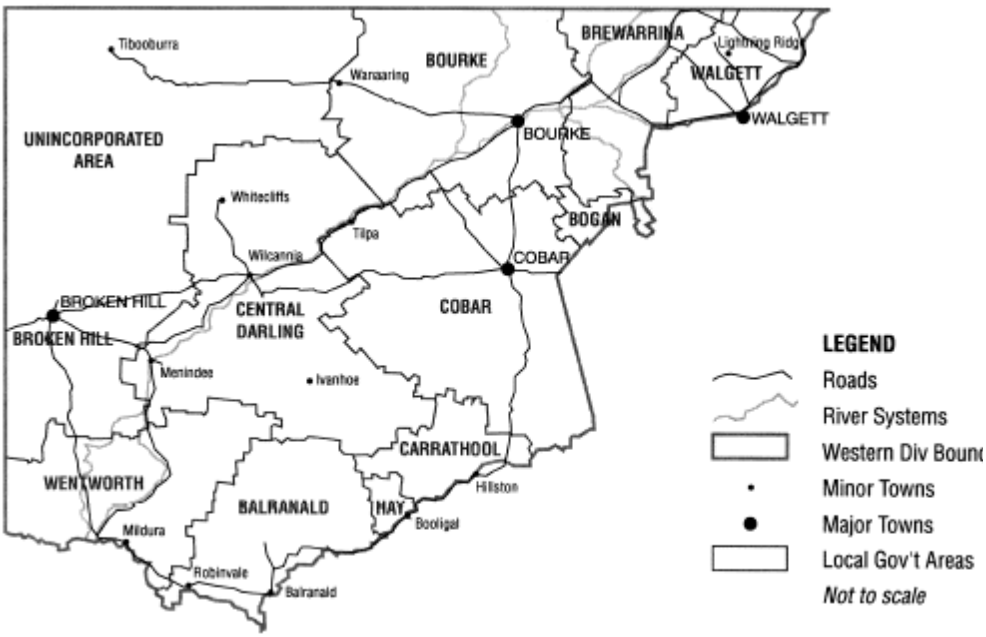
Source: OEH (2013b)

Glossary

The terms listed in this glossary have a particular meaning in this plan of management.

Term	Definition here
Aeolian	Wind-blown or wind-borne
Asset protection zone	Area where the overall fuel hazard is maintained at moderate or below, mostly by mechanical means (e.g. mowing or slashing). The objective of an asset protection zone is to protect human life and property, and this objective takes precedence over biodiversity conservation in these zones.
Mallee Cliffs Salt Interception Scheme	The **Mallee Cliffs Salt Interception Scheme** was constructed in 1994 adjoining the south-west boundary of the park in the vicinity of (former) Todds Tank. This facility is part of a network of 18 salt interception schemes constructed along the Murray River, which extract groundwater from regional aquifers with high salt levels as part of a basin-wide strategy to protect the river from the impacts of rising salinity (MDBA n.d.). At each of these schemes, salt-laden groundwater is pumped to a series of evaporation tanks from where salt is extracted by natural (solar) evaporation and harvested for a number of industrial and domestic uses. The Mallee Cliffs Salt Interception Scheme is managed by the NSW Department of Industries – Water on behalf of the Murray Darling Basin Authority.
Southern Mallee Private Reserves	These are reserves on leasehold land in the Southern Mallee Planning Group Region. The tenure of these parcels remains Western Lands Leasehold but the lease conditions have been altered to ensure conservation in perpetuity. The conditions are to prohibit grazing and actively manage the areas for conservation. These reserves and conditions were agreed to by leaseholders, the former NSW Department of Land and Water Conservation and the Western Lands Commission. The reserves are to offset clearing of other areas of vegetation for cropping by the leaseholders. The Southern Mallee Planning Group was set up under the previous Native Vegetation Conservation Act and the clearing was approved under the *Environmental Planning & Assessment Act 1979*. The Southern Mallee Plan specifically includes the development of a Comprehensive Adequate and Representative reserve system within the overall framework of the plan. This plan also sets targets for representation of each vegetation type in reserves. http://data.environment.nsw.gov.au/dataset/southern-mallee-private-reservesb3c4b

Western Division of New South Wales (map from Ferraro and Burnside 2001 cited in Hope et al. 2012)



The Western Division is an administrative area declared in 1884 over about 31 million hectares. Most of this area is under perpetual leasehold from the Crown and administered through the *Western Lands Act 1901*. The Western Division is a useful descriptor for common land use, issues and environmental considerations.

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