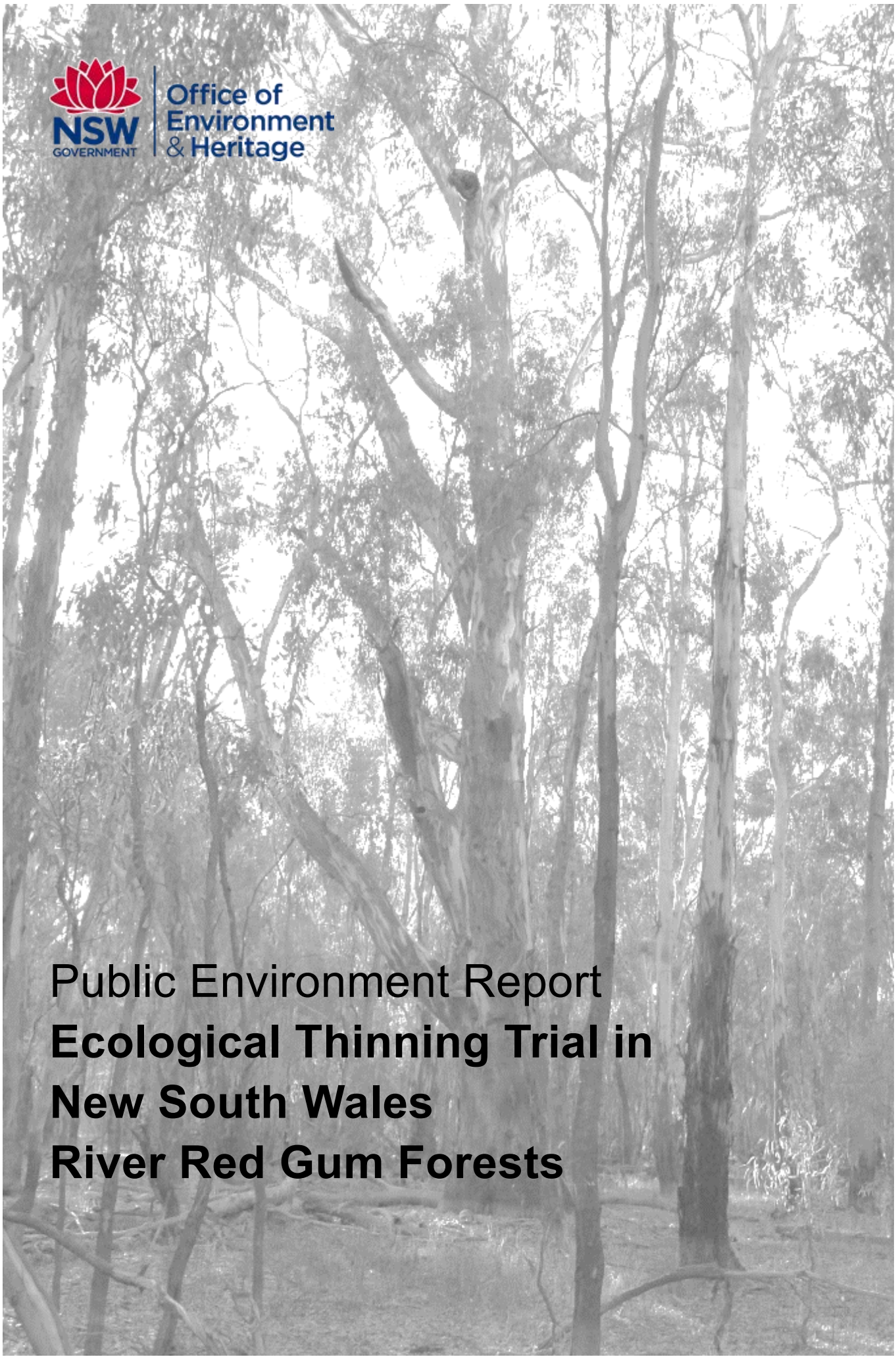

Public Environment Report

Ecological Thinning Trial in New South Wales River Red Gum Forests

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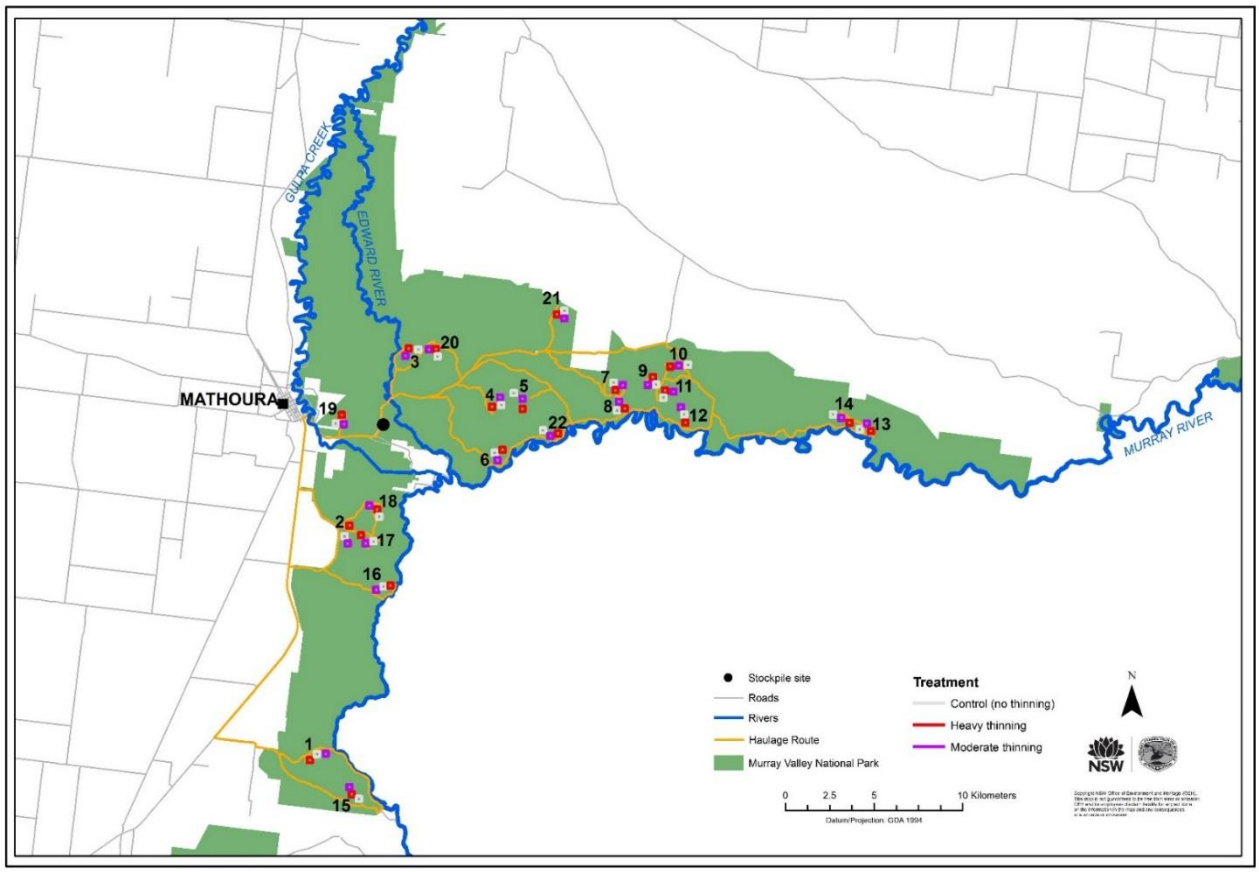
Addendum to Public Environment Report - Ecological Thinning Trial in New South Wales River Red Gum Forests (EPBC2013/6713)

Figures one and two detail the updated site names, locations, haulage routes and haulage distances for the ecological thinning trial.

Figure One: Site Names & Haulage distances (single one-way trip) to stockpile site

Site	Common name	Precinct	Distance (km)
1	Rushy Road	Moira	33
2	Coolamon Crossing	Moira	14
3	Middle Road	Millewa	5
4	Sandhills Road	Millewa	9
5	James Swamp Road	Millewa	13
6	Western Millewa River Road	Millewa	13
7	Glens Road	Millewa	18
8	Millewa River Road	Millewa	18
9	Sams Road	Millewa	24
10	Toupna Crossing Road	Millewa	24
11	Box Plain Road	Millewa	24
12	Millewa River Road East	Millewa	27
13	Seven Mile Creek East	Millewa	35
14	Seven Mile Creek West	Millewa	37
15	Ferry Road	Moira	45
16	Swifts Creek Road	Moira	21
17	Porters Creek Road	Moira	16
18	Poverty Point Road	Moira	17
19	Log Dump Road	Moira	4
20	Gerapna Road	Millewa	7
21	Dudleys Road	Millewa	15
22	Fishermans Bend Road	Millewa	17
		Average distance (km)	20

Figure Two: Site Locations & Haulage Routes



Contents

List of figures

List of acronyms

Acronym	Description
CAMBA	China–Australia Migratory Bird Agreement
CMA	Catchment management authority
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DBH	Diameter at breast height
DBHoB	Diameter at breast height over bark
DEPI	Victorian Department of Environment and Primary Industries, formerly Department of Sustainability and Environment (DSE)
DoE	Commonwealth Department of the Environment, formerly DEWHA and SEWPaC
DEWHA	Department of Environment, Water, Heritage and the Arts (now DoE)
EEC	Endangered ecological community
EMP	Environmental management plan
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
FFG Act	Victorian *Flora and Fauna Guarantee Act 1988*
GBCMA	Goulburn Broken Catchment Management Authority
FCNSW	Forestry Corporation of New South Wales
JAMBA	Japan–Australia Migratory Bird Agreement
MDBC	Murray Darling Basin Commission
NPA	NSW National Parks Association
NPWS	NSW National Parks and Wildlife Service
NRC	NSW Natural Resources Commission
NSW	New South Wales
OEH	NSW Office of Environment and Heritage
PER	Public Environment Report
POM	Plan of management
PV	Parks Victoria
REF	Review of Environmental Factors
ROKAMBA	Republic of Korea–Australia Migratory Bird Agreement
SAC	Scientific advisory committee

SEWPaC	Department of Sustainability, Environment, Water, Populations and Communities (now DoE)
SIMI	Statement of interim management intent
SLATS	Statewide Landcover and Trees Study
TSSC	Threatened Species Scientific Committee
VEAC	Victorian Environmental Assessment Council
VNPA	Victorian National Parks Association

Location of responses to specific requirements in the *Tailored Guidelines for the Content of a Draft Public Environment Report*

Tailored guidelines for the content of a draft PER	**Draft PER section(s)**
1. General information	Section 1
2. Description of the action Content which does not directly align with tailored guidelines:	Section 2
• details of all watercourse crossings and culverts	Section 6.2.1
• water quality monitoring and management programs, including erosion, sediment and runoff controls, water quality testing and other measures to maintain or enhance aquatic habitats in the vicinity of the proposed action	Section 6.3 and Appendix 8
• waste management arrangements, including storage and disposal of fuels, chemicals and other waste products during operations and ongoing management of trial plots	Section 6.2.1
• details of the induction provided to workers, particularly in relation to potential impacts on threatened species and Ramsar values	Section 6.2.3
• coordinates of all works to be undertaken.	Appendix 2
3. Feasible alternatives	Section 3
4. Description of the environment Content which does not directly align with tailored guidelines:	Section 4
• details of surveys.	Section 2.2.3 and Appendix 4
5. Relevant impacts	Section 5 and Appendix 7
6. Proposed safeguards and mitigation measures	Section 6 Appendix 5
7. Other approvals and conditions Content which does not directly align with tailored guidelines:	Section 6.1.1
• a description of the monitoring, enforcement and review procedures that apply, or are proposed to apply, to the action.	Section 6.3, 6.4
8. Consultation	Section 7
9. Scientific review	Section 8, Appendix 1, Appendix 6 and Appendix 9
10. Environmental record of person(s) proposing to take the action	Section 9

Tailored guidelines for the content of a draft PER	Draft PER section(s)
11. Economic and social matters Content which does not directly align with tailored guidelines:	Section 10
• details of any public consultation activities undertaken, and their outcomes.	Section 8
12. Information sources provided in the PER	References
13. Conclusion	Section 11

Executive summary

This Public Environment Report for the Ecological Thinning Trial in New South Wales (NSW) and Victorian River Red Gum Forests (ecological thinning trial) has been prepared in response to a controlled action decision under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Background

Recent studies have described declining health in river red gum forests (Cunningham et al. 2009a, 2009b, 2011; Jurskis et al. 2005; Murray Darling Basin Commission (MDBC) 2006; Pennay 2009). Water regime, including volume, seasonality and timing, is a major factor in maintaining forest health, ecological function and resilience. Considering ongoing river regulation and the likelihood of more frequent and intense droughts under climate change predictions, reducing tree density may be an effective management tool for improving the health of river red gum forests (Horner et al. 2010).

The new Barmah National Park and the Murray Valley National Park, Millewa Group (Barmah–Millewa) were gazetted in NSW and Victoria in 2010. In recommendations supporting the gazettal of these parks, both the Victorian Environmental Assessment Council (VEAC) and the NSW Natural Resources Commission (NRC) stated that an ecological thinning trial be undertaken within an adaptive management framework to address management problems associated with high stem density and canopy dieback in stands of river red gum forests (VEAC 2008; NRC 2009).

According to Cunningham et al (2009c), ecological thinning refers to “the reduction of stem density to improve the ecological health of a forest, with adequate fallen timber retained to improve habitat and structure for animals and plants”.

Objectives of the ecological thinning trial

The proposed ecological thinning trial seeks to address key gaps in knowledge about how to manage this important forest type to:

- promote a diversity of habitats in the landscape for indigenous species, including key habitat features such as hollow-bearing trees, stand structural diversity and coarse woody debris
- prevent further decline in canopy condition (the proportion of canopy that is dead)
- minimise the risk of mass tree death.

The aims of the trial are to determine how ecological thinning affects:

- biodiversity, canopy condition and resilience, and minimises tree mortality (especially of large trees) within stands of river red gum forest
- characteristics of the stands (i.e. hollow availability and structural diversity) and whether these effects depend on water availability and initial stem density
- characteristics of the trees, such as tree diameter growth rate, tree diameter distribution diversity, branch characteristics, and crown shape and health.

Proposed ecological thinning trial activities

The proposed ecological thinning trial involves the thinning of river red gum forests within the Barmah–Millewa. Communities dominated by other eucalypt species, such as Black Box *Eucalyptus largiflorens*, Grey Box *E. microcarpa*, and Yellow Box *E. melliodora,* will not be subject to thinning.

The trial requires two thinning treatments based on spacing of retained trees (7 m and 15 m), and a no thinning control. The trial will consist of 22 sites, with each site consisting of a cluster of three square-shaped 9 hectare plots (300 m × 300 m). Thinning treatments will occur over 396 hectares (44 × 9 ha) of the 66,000 hectare river red gum forests of Barmah–Millewa, with control sites covering an additional 198 hectares (22 × 9 ha). The area subject to treatments constitutes 0.6 per cent of the total area of these forests.

The selection process for the sites and ancillary infrastructure was implemented to ensure chosen sites fulfilled the scientific requirements of the trial while avoiding potential impacts on matters of national environmental significance listed in the EPBC Act.

Specific activities to be conducted in each phase of the trial are:

- establishment phase
  - maintenance of formal access roads
  - establishment of natural surface tracks
  - maintenance of stockpile sites
- treatment phase
  - identification of trees for retention
  - felling
  - transportation and storage of excess felled material
- site monitoring phase
  - conduct periodic flora and fauna surveys to assess outcomes of the trial.

Description of the environment

The river red gum forests of Barmah–Millewa cover an area of approximately 66,000 hectares of Murray River floodplain (including the Edward River) between the towns of Tocumwal, Echuca and Deniliquin. This area is a continuous forest and wetland system.

As part of preparing this PER, the existing ecological conditions of the river red gum forests were established through desktop investigations, field surveys and vegetation mapping. This focused on matters of national environmental significance listed in the EPBC Act.

Based on this, 15 matters of national environmental significance were determined to have a moderate or higher likelihood of occurrence in the trial area (refer to Table ES1).

Risks and potential impacts

A risk assessment was undertaken to identify potential pathways through which the ecological thinning trial may impact the 15 EPBC Act-listed matters of national environmental significance. This included evaluating the initial risk and residual risk (i.e. risk with and without implementation of mitigation and control measures).

- If potential impact pathways presented a 'medium' or higher residual risk to an EPBC Act-listed matter of national environmental significance, then the potential impact of the ecological thinning trial would be considered against the Commonwealth matters of national environmental significance included in the *Environment Protection and Biodiversity Conservation Act 1999*, Significant impact guidelines, 1.1 Significant impact guidelines – matters of national environmental significance (Department of Environment, Water, Heritage and the Arts (DEWHA) 2009a; refer to Table ES1).

Following these assessments, it was determined that the ecological thinning trial would not have a significant impact on any EPBC Act-listed matters of national environmental significance occurring in the trial area.

Management of potential impacts during the trial

An environmental management plan (EMP) has been developed for the proposed ecological thinning trial. It sets out a framework for continuing management, mitigation and monitoring programs to address potential impacts on EPBC Act-listed matters of national environmental significance whilst trial activities are conducted. This includes project delivery standards for each phase of the ecological thinning trial, which cover the relevant management and mitigation measures, environmental monitoring, and contingency plans.

- Based on the risk and impact assessments, and taking into account the mitigation and control measures described in the EMP, no offsetting of ecological thinning trial impacts will be required.

Table ES1: Ecological thinning trial – summary of risk and impact assessments.

Relevant EPBC Act-listed matters of national environmental significance	**Residual risk – project activities with impact pathways with medium or above rating**	**Significant impact assessment**
Fauna: Cattle egret *Ardea ibis*	No impact pathways with medium or above residual risk	No significant impact predicted
Fauna: Eastern great egret *Ardea modesta*	No impact pathways with medium or above residual risk	No significant impact predicted
Fauna: Fork-tailed swift *Apus pacificus*	No impact pathways with medium or above residual risk	No significant impact predicted
Fauna: Rainbow bee-eater *Merops ornatus*	Potential impact associated with felling, and transportation and storage of excess felled material	No significant impact predicted
Fauna: Superb parrot *Polytelis swainsonii*	Potential impact associated with establishment of natural surface tracks, identification of trees for retention, and felling	No significant impact predicted

Relevant EPBC Act-listed matters of national environmental significance	Residual risk – project activities with impact pathways with medium or above rating	Significant impact assessment
Fauna: White-bellied sea eagle *Haliaeetus leucogaster*	No impact pathways with medium or above residual risk	No significant impact predicted
Fauna: White-throated needletail *Hirundapus caudacutus*	No impact pathways with medium or above residual risk	No significant impact predicted
Fauna: Murray hardyhead *Craterocephalus fluviatilis*	No impact pathways with medium or above residual risk	No significant impact predicted
Fauna: South-eastern long-eared bat *Nyctophilus corbeni*	Potential impact associated with identification of trees for retention and felling	No significant impact predicted
Fauna: Koala *Phascolarctos cinereus* (Qld, NSW and the ACT)	Potential impact associated with establishment of natural surface tracks, identification of trees for retention, felling, and transportation and storage of excess felled material	No significant impact predicted
Flora: River swamp wallaby-grass *Amphibromus fluitans*	Potential impact associated with maintenance of formal access roads, establishment of natural surface tracks, felling, and transportation and storage of excess felled material	No significant impact predicted
Flora: Mueller daisy *Brachyscome muelleriodes*	Potential impact associated with maintenance of formal access roads, establishment of natural surface tracks, felling and transportation and storage of excess felled material	No significant impact predicted
Communities: Grey box *Eucalyptus macrocarpa*, grassy woodlands and derived native grasslands of south-eastern Australia	Potential impact associated with maintenance of formal access roads, and transportation and storage of excess felled material	No significant impact predicted
Ramsar sites: Barmah Forest Ramsar site	Potential impact associated with establishment of natural surface tracks, felling and transportation and storage of excess felled material	No significant impact predicted
Ramsar sites: NSW Central Murray Forests Ramsar site	Potential impact associated with establishment of natural surface tracks and felling	No significant impact predicted

1. General information

1.1. Title of the action

The proposed title of the action is the Ecological Thinning Trial in New South Wales and Victorian River Red Gum Forests.

1.2. Proponents

This action is a collaborative project between the New South Wales (NSW) Office of Environment and Heritage (OEH) and the Victorian Department of Environment and Primary Industries (DEPI) (previously the Department of Sustainability and Environment (DSE)).

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1.3. Objectives of the action

It is proposed to undertake an ecological thinning trial within the Barmah–Millewa river red gum *Eucalyptus camaldulensis* forests in order to address key gaps in knowledge about how to manage this type of forest to:

- promote a diversity of habitats in the landscape for indigenous species, including key habitat features such as hollow-bearing trees, stand structural diversity and coarse woody debris
- prevent further decline in canopy condition (the proportion of canopy that is dead)
- minimise the risk of mass tree death.
- The aims of the trial are to determine how ecological thinning affects:
- biodiversity, canopy condition and resilience, and minimises tree mortality (especially of large trees) within stands of river red gum forest
- characteristics of the stands (i.e. hollow availability and structural diversity) and whether these effects depend on water availability and initial stem density
- characteristics of the trees, such as tree diameter growth rate, tree diameter distribution diversity, branch characteristics, and crown shape and health.

Various hypotheses regarding the use of ecological thinning are considered by the trial. These are outlined in the Experimental Design and Monitoring Plan established for this ecological thinning trial (see Appendix 1). Should the trial find that ecological thinning is a beneficial tool for river red gum forest management, the method could complement the existing suite of management approaches and be applied to other stands in the future.

1.4. Location

This cross-border project will be undertaken within the Barmah National Park and the Murray Valley National Park, Millewa Group (Barmah–Millewa; refer to Figure 1). Ecological thinning will be confined to these national parks, while some storage of excess felled material will also occur on Barmah Island (Victoria), which is Crown land.

These forests are located on the Murray River floodplain (including the Edward River) approximately 20 kilometres downstream (or west) of Tocumwal (NSW), 20 kilometres upstream (or north) of Echuca (Vic) and approximately 20 kilometres south of Deniliquin (NSW).

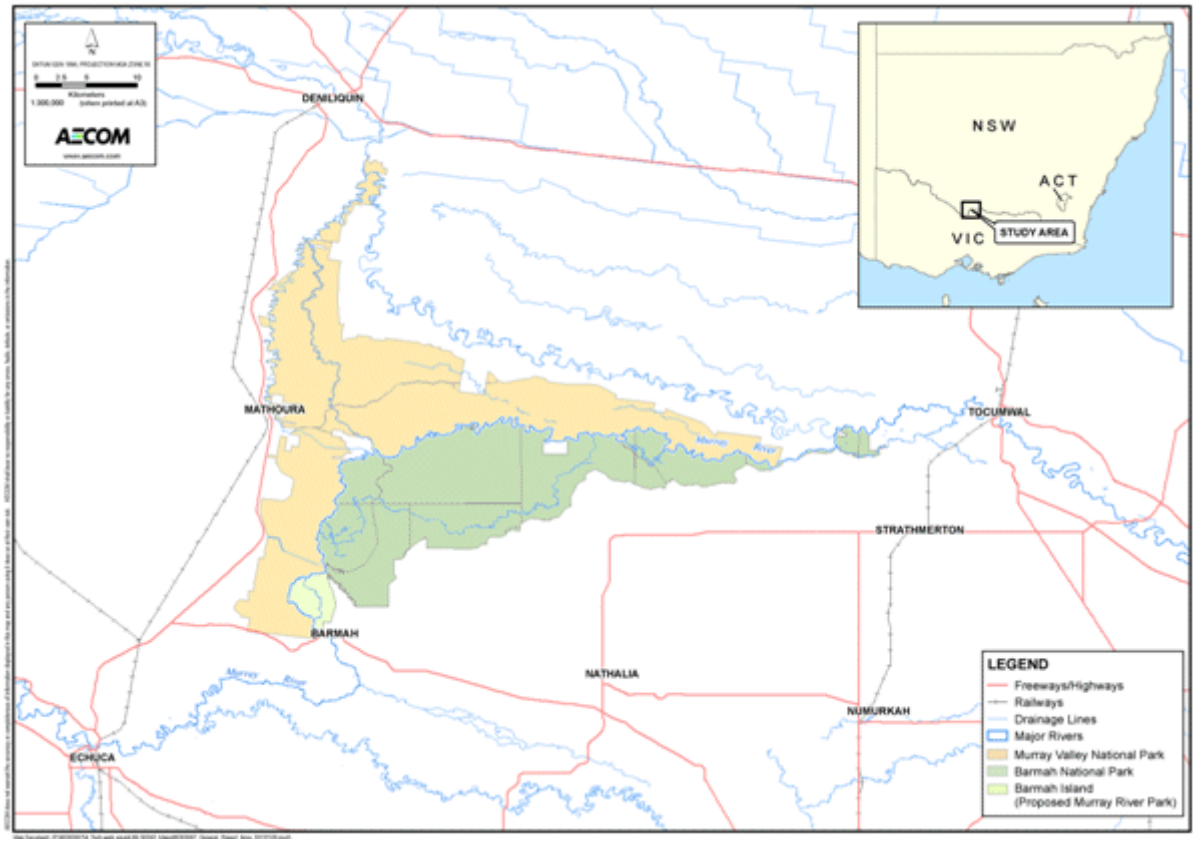

Figure 1: Location of the proposed ecological thinning trial in the Barmah National Park and Murray Valley National Park, Millewa Group (Barmah–Millewa).

1.5. Background to the development of the action

1.5.1. Decline in health of river red gum forests

A number of recent studies have described the declining canopy condition of river red gum forest within the Riverina Bioregion, particularly since 2003 (Cunningham et al. 2009a, 2009b, 2011; Jurskis et al. 2005; Murray Darling Basin Commission (MDBC) 2006; Pennay 2009).

A remote sensing assessment of the health and structure of river red gum forest vegetation communities has been conducted for the Millewa group of forests on the Murray River floodplain. This assessment found the canopy condition of trees within river red gum forest to be poor, with as little as 20 per cent of the river red gums in the forests being in

healthy condition. Seventy-five per cent of the forest was in a state of decline, and a further five per cent was considered to be in poor health (MDBC 2006).

An assessment of the Victorian river red gum forest health in 2006 revealed around 70 per cent of the forests were in some state of dieback (Cunningham et al. 2009a). Likewise, an assessment of NSW river red gum forest and woodland health conducted during October 2009, using categories for multi-temporal Landsat data generated from the Statewide Landcover and Trees Study (SLATS) from 1988 to 2008 showed that expansive areas of river red gum forest had undergone extensive change, with substantial areas displaying declines in foliage cover (Pennay 2009).

Stands of river red gum are intimately associated with the surface flooding regime of the watercourses and related groundwater flow. The species is a large and opportunistic water user, and this is a contributing factor to the maintenance of water tables at depth. Water regime, including volume, seasonality and timing, is a major factor in maintaining forest health, ecological function and resilience in these river red gum forests. A legacy of the recent decadal drought was the large number of incursions by river red gum seedlings, which are normally regulated by summer flooding.

Large-scale natural flooding in 2010–2011 resulted in noticeable improvement in river red gum canopy across Barmah forest (Bruce Wehner pers. comm.). However, the effect is variable and has not been measured quantitatively in 2012–2013 as for other years (e.g. Cunningham et al. 2009b). New research by Monash University is planned for 2014 to re-measure existing crown health plots (Shaun Cunningham pers. comm.).

Considering ongoing river regulation and the likelihood of more frequent and intense droughts under climate change predictions, reducing tree density may be an effective management tool for improving the health of river red gum forests (Horner et al. 2010). Given the declines in condition of stands due to decreased flooding, rainfall and groundwater, thinning river red gum stands (especially small trees) may reduce competition for limited water and space among the remaining trees (see also MacNally et al. 2011). In order to maintain and enhance structural diversity of the river red gum forests across these parks, active intervention in the form of ecological thinning may be required.

1.5.2. Recommendation for an ecological thinning trial

New river red gum parks and reserves totalling more than 200,000 hectares were gazetted in NSW and Victoria in 2010. Included in this was the largest stand of river red gum in Australia at Barmah–Millewa, already recognised as an internationally significant landscape under the Ramsar convention for internationally significant wetlands.

In recommendations supporting the gazettal of these parks, both the Victorian Environmental Assessment Council (VEAC) and the NSW Natural Resources Commission (NRC) stated that an ecological thinning trial be undertaken within an adaptive management framework to address management problems associated with high stem density and canopy dieback in stands of river red gum forests (VEAC 2008; NRC 2009). In response, the Victorian DSE recommended “development of an adaptive management approach based on clearly defined, transparent and scientifically supported ecological objectives” (DSE 2009a, p5).

Following these recommendations, a collaborative NSW and Victorian trial was developed in 2011 for implementation in the Barmah–Millewa to determine the efficacy of using ecological thinning to address conservation concerns in high stem density stands of river red gum. The Barmah and Murray Valley National Parks were chosen because their status as national parks enables a trial to be conducted with appropriate scientific rigour, including long-term monitoring of the potential ecological benefits of the approach. This rigour could not be assured in state forests, which are operated for commercial gain and may be subject to logging during the life of the trial.

Implementation of an ecological thinning trial in western NSW is listed as project number 19 within the 2013/2014 NSW National Parks and Wildlife Service (NPWS) Delivery Plan. Within the project plan, the high-level goal for this project is "to apply collaborative adaptive management approaches to ecological thinning, to manage and improve knowledge about the river red gum ecosystem". The scope and intent of this project is "to carry out ecological thinning and removal of surplus thinning residue from river red gum forests within Murray Valley National Park (NSW) and Barmah National Park (Victoria)".

1.5.3. Rationale for the ecological thinning trial

It is well documented that historical and contemporary timber harvesting operations and associated silvicultural practices have altered the original structure of the river red gum forests and woodlands of the Murray River floodplain (see VEAC 2008; DSE 2009a; NRC 2009; Cunningham et al. 2009d). However, these activities have typically occurred for commercial operations oriented towards utilisation of their timber and not focussed on the improvement of river red gum stand health, or habitat restoration.

Ecological thinning has been described by Cunningham et al (2009c) as "the reduction of stem density to improve the ecological health of a forest, with adequate fallen timber retained to improve habitat and structure for animals and plants". Prior to the establishment of river red gum parks and reserves in Victoria, thinning of river red gum forests to achieve ecological objectives had not been well researched, although river red gum thinning guidelines were established by for the former Department of Sustainability and Environment (DSE) (Water Technology 2009a).

In 2009, Parks Victoria (PV) instigated research to investigate a number of thinning methodologies in Barmah National Park (Pigott 2010) and other river red gum reserves on the Murray River (Water Technology 2012). In addition, application of silvicultural knowledge to undertake thinning for the purpose of meeting ecological objectives has previously been developed by PV in its large-scale ecological thinning trial in box-ironbark forests in Central Victoria. This trial was undertaken in response to a Land Conservation Council (predecessor to VEAC) investigation (Pigott et al. 2010).

The collective knowledge regarding river red gum ecosystems suggests that thinning may increase the growth of remaining trees, increase loads of coarse woody debris, increase litter loads for nutrient input, and provide gaps for sapling recruitment and increased growth of understorey plants (Horner et al. 2010; Mac Nally 2006; Mac Nally et al. 2011; MacNally & Horrocks 2002; Thomson et al. 2011). Results of a long-term trial investigating early thinning of naturally regenerating stands in Barmah forest (Victoria), indicate that 20 (±15 sampling error) hollow-bearing trees per hectare in thinning

treatment areas were recorded after 42 years, while none were found in the control plot (i.e. the unthinned area; Horner et al. 2010).

Before thinning is considered for use for ecological purposes on a large scale in river red gum forests, it must be tested to assess the benefits it may provide to the ecological health of the forests (VEAC 2008). The use of an adaptive management approach will assist in determining the optimum methods for maintaining and enhancing the ecological function of river red gum forests (see Varcoe 2012). Should the trial find that ecological thinning is a beneficial tool for river red gum forest management, the method could potentially be applied on a greater scale.

The proposed ecological thinning trial seeks to investigate the use of ecological thinning to conserve and promote habitat structural diversity, prevent further decline in canopy condition (or reverse decline) and improve the long-term resilience of this ecosystem in a changing climate. In doing this, the trial includes a rigorous, scientifically-based ecological monitoring program to investigate, monitor and understand the impacts, both positive and negative, of the activity on these forests and their associated flora and fauna.

1.6. How the action relates to other known actions

Significant river red gum forests of the Murray River include Perricoota, Koondrook and Campbell's Island State Forests (NSW) and Gunbower National Park/State Forest (Vic). These sites are also recognised under the Ramsar Convention for internationally significant wetlands. The Perricoota and Koondrook State Forests are jointly listed under the NSW Central Murray Forests Ramsar listing, along with the Millewa forests and the Werai forests. These forests were actively harvested for the supply of the river red gum timber industry at the time of their listing.

The other known actions described in this section relate to commercial harvesting of river red gum timber, which differs from ecological thinning in terms of objectives and methodology. Commercial harvesting continues to occur within Perricoota, Koondrook and Gunbower State Forests, as described below.

1.6.1. Perricoota and Koondrook State Forests

The Perricoota and Koondrook section of the NSW Central Murray Forests Ramsar site covers an area of 31,163 hectares. Logging and associated activities conducted in these forests have been assessed under NSW environmental law. The Integrated Forestry Operations Approval for Riverina Red Gum (NSW Government 2010) provides for two possible operations during which river red gum forest thinning may occur within these forests, being:

- Early thinning – operations are carried out for the purposes of producing river red gum residue. Under this program the residue is in addition to the residue produced from high-quality large logging operations. Early thinning methods may be used if the diameter of the dominant and co-dominant trees in each cohort of tree is less than 50 centimetres and the basal area of the remaining dominant and co-dominant trees in that cohort is at least 12 square metres per hectare. During each of the 2009–2010 and 2010–2011 financial years a maximum of 30,000 tonnes of residue were able to be produced from early thinning operations. This figure was reduced to 25,000 tonnes in the 2011–2012 financial year and 20,000 tonnes in the 2012–2013 financial year. Residue is processed into large quantities of firewood and is mostly transported from the region to Melbourne.

- Thinning – may also be carried out on a cohort of trees within the Perricoota and Koondrook forests if the sum of the basal area of the remaining dominant and co-dominant trees is at least 12 square metres per hectare.

In both cases, thinning is undertaken within these forests for commercial benefit and for the purpose of promoting the growth of other trees that have the potential to yield timber for future commercial harvesting operations.

1.6.2. Gunbower State Forest

In Victoria, selective sawlog commercial harvesting continues to occur in the Gunbower State Forest, and previously occurred in parts of the Gunbower National Park prior to its establishment in 2010.

Promotion of the early development of large, open-grown trees was undertaken by thinning dense regrowth stands, usually in two stages (Murray Thorsen, pers. comm.). First, 'non-commercial thinning' was carried out on young stands, whereby only small trees were thinned. Several years later, 'commercial thinning' involved felling larger trees for promotion of more rapid tree growth and more desirable tree form. Usually felled material was deemed 'firewood grade' and not suitable for sawlogs. The primary objective of this latter thinning is to achieve sawlog productive potential in river red gum stands by directing management towards achieving optimal stocking (DNRE 2002).

1.7. Current status of the action

This proposed action was referred to the Commonwealth Minister for the Environment under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 24 December 2012. The delegate of the Minister determined on 6 February 2013 that assessment and approval is required as the action has the potential to have a significant impact on matters of national environmental significance that are protected under Part 3 of the EPBC Act, specifically:

- wetlands of international importance (sections 16 and 17B)
- listed threatened species and communities (sections 18 and 18A)
- listed migratory species.

It was determined that the proposed activity be assessed by a Public Environment Report (PER; this document). The *Tailored guidelines for the content of a draft Public Environment Report* (SEWPaC 2013a), which stipulate the required content of the PER, were issued by the Minister in April 2013.

A period for public comment on this draft PER is now being provided, after which time the PER will be finalised by the proponents taking into account the comments received. The PER will then be provided to the Minister for the Environment and the report published. A decision will be made within 40 business days of receiving the finalised PER from the proponents.

Pending approval of the Commonwealth Minister for the Environment, and subject to appropriate site conditions, the ecological thinning trial is scheduled to commence in January 2015.

1.8. Consequences of not proceeding with the action

Research in river red gum forests in the Riverina has shown that during the recent dry period, tree mortality had increased dramatically in high-density stands (Cunningham et al. 2009a). It is plausible that high-stem-density stands are at increased risk of stand death in the absence of an appropriate flood regime and/or active management (Overton and Doody 2013). Due to competition for water and other resources, growth rates of trees in high-density stands may be negligible and recruitment of new individuals may not be stimulated. Should senescence occur simultaneously in the even-aged cohort of trees, a decline in forest health indicators and potentially total stand death is expected in some cases, altering the vegetation to an open woodland or shrubland community (Overton and Doody 2013).

The reduced frequency, duration and extent of flooding across the Murray River floodplain due to river regulation, as well as land management practices (e.g. timber harvesting, wildfire suppression and domestic livestock grazing), has led to significant changes in stand condition and structure, coarse woody debris levels and understorey/groundlayer composition of river red gum forests (Water Technology 2009a). Ensuring an appropriate water regime is recognised as the key ecological driver for the health of these river red gum forests; however, it is anticipated that even with major programs such as The Living Murray Initiative and other environmental watering programs, large areas of each forest will not receive the desired water regimes that will sustain their key ecological functions.

Considering recent research into climate change scenarios and water use projections (CSIRO 2008; Cunningham et al. 2011; Mac Nally et al. 2011), tree dieback in these areas is considered likely to continue as water availability decreases across south-eastern Australia due to rising temperatures, decreasing annual rainfall and the increasing severity of droughts. The continued degradation of river red gum forests is likely to bring impacts including the increased mortality of stands of trees, the long-term loss of the hollow tree resource and the loss of suitable habitat for native flora and fauna, including threatened species. This is likely to cause a decline in the ecological function and structural diversity across the river red gum forests, and limit their ability to support viable populations for indigenous species in the region. Such declines would also lead to degradation of the forests' aesthetic values.

In not proceeding with this action, the options to manage these river red gum forests and improve tree health and canopy condition would be limited to current approaches. With long-term monitoring in an adaptive management framework, the proposed ecological thinning trial would assist significantly in developing understanding of future management options. Along with improved water management, ecological thinning has the potential to assist in building resilience to climate change for this important forest type (Cunningham et al. 2009b; Horner et al. 2010).

2. Description of the action

Before ecological thinning is considered for use on a large scale in river red gum forests, it must first be tested to assess the benefits it may provide to their ecological health. This section describes the proposed ecological thinning trial, specifically:

- the design of the ecological thinning trial (e.g. scientific methodology)
- planning and site selection phase – development of experimental design, site selection process (including ecological site assessment surveys), precise location of sites
- the specific activities to be undertaken in each phase of the ecological thinning trial, including timing and equipment to be used:
  - **establishment phase** – establishment of supporting infrastructure required to implement the trial (e.g. access roads and stockpile sites
  - **treatment phase** – identification of trees for retention, felling and transportation of excess felled material
  - **site monitoring phase** – monitoring to determine efficacy of the trial.

Control measures to mitigate potential impacts of the ecological thinning trial on matters of national environmental significance are provided in Section **Error! Reference source not ound.** of this Public Environment Report (PER).

2.1. Design of the ecological thinning trial

The design of the ecological thinning trial is fully documented in the Experimental Design and Monitoring Plan (see Appendix 1). A review of the Experimental Design and Monitoring Plan will occur 5 years after the completion of the ecological thinning operations to determine the effectiveness of the surveys.

This proposed action involves the thinning of river red gum forests. Communities dominated by other eucalypt species, such as black box *Eucalyptus largiflorens*, grey box *E. microcarpa*, and yellow box *E. melliodora*, will not be subject to thinning.

The ecological thinning trial requires two thinning treatments, based on spacing of retained trees, and a no thinning control (refer to Table 2.1).

Table 2.1: Ecological thinning treatment levels.

Level	Maximum post-treatment spacing	Final density	Retained basal area*	Habitat trees
Heavy thinning	15 m	Approximately 60 stems/ha	approx. 8–12 m^2/ha*	Retain all suitable habitat trees and trees (>40 cm diameter at breast height (DBH)), i.e. potential habitat, even if it results in clumping of retained trees

Level	Maximum post-treatment spacing	Final density	Retained basal area*	Habitat trees
Moderate thinning	7 m	Approximately 260 stems/ha	approx. 16–20 m^2/ha*	Retain all suitable habitat trees and trees (>40 cm diameter at breast height (DBH)), i.e. potential habitat, even if it results in clumping of retained trees
Control	Unchanged	Unchanged	Unchanged	Retain all suitable habitat trees and trees (>40 cm diameter at breast height (DBH)), i.e. potential habitat, even if it results in clumping of retained trees

*Basal area will not be used to implement treatments; these values are estimates of the basal area likely to be retained given the implementation of spacings. Note: cm = centimetre; ha = hectare; m = metre

The moderate thinning treatment is equivalent to the widest spacings that have been implemented in commercial silvicultural settings in NSW (7.3 m) (FCNSW 1984), and substantially wider than most silvicultural thinning treatments (3–4 m) (Schonau and Coetzee 1989). Trees in low density stands of river red gum forest are known to have crown diameters up to 17 metres (with DBH 78.8 cm; NPWS unpublished data).

The trial will consist of a total of 22 sites located across the river red gum forests (see Section 2.2 and Appendix 2 for specific locations). Each site will consist of a cluster of three 9-hectare plots (square in shape, 300 m × 300 m):

- 1 × heavy thinning treatment
- 1 × moderate thinning plot
- 1 × control plot.

This gives a total of 22 control plots and 44 treatment plots. Therefore, thinning treatments will occur over 396 hectares (44 × 9 ha) of the 66,000 hectare Barmah–Millewa river red gum forests, with control sites covering an additional 198 hectares (22 × 9 ha). The area subject to treatments constitutes 0.6 per cent of the total area of these forests. Plot size and replication was supported by Robinson (2011) as being adequate to test the trial hypothesis.

All coarse woody debris that is present before treatment will be retained. Within NSW, this is a requirement of the Review of Environmental Factors (REF) prepared under the *National Parks and Wildlife Act 1974* (NSW). Mac Nally et al. (2001) found that restoration targets for coarse woody debris in river red gum forests may reasonably be set at 40–50 tonnes per

hectare, with imposition of a high variance in coarse woody debris load densities also likely to aid bird species diversity and abundance. The NSW BioMetric benchmark for coarse woody debris in river red gum forests is 45 tonnes per hectare, where the benchmark represents a stand of a comparable natural ecosystem exhibiting relatively little evidence of modification since post-European settlement (DECC 2008), while the Victorian Environmental Assessment Council has recommended a target of at least 50 tonnes per hectare on average.

2.2. Planning and site selection

The selection process for the proposed ecological thinning trial sites and ancillary infrastructure was implemented to ensure chosen sites fulfilled the scientific requirements of the trial while avoiding potential impacts on matters of national environmental significance.

This section provides an overview of the process, including application of the following site selection criteria:

- sites must meet specific parameters for water availability, stem density and canopy condition
- sites must not have been subject to logging or fire since 2001
- sites must be located more than 100 metres from the nearest road (to minimise disturbance effects), but near fire trails (to minimise the need for establishment of additional natural surface tracks)
- individuals or key habitat features for threatened species must not have been detected within a treatment plot.

Further detail regarding the site selection process is provided in the Ecological Thinning Trial in NSW and Victorian River Red Gum Reserves Experimental Design and Monitoring Plan (OEH, PV and DSE 2012; see Appendix 1). Names of the chosen sites are provided in Table 2.2 below; precise coordinates are provided in Appendix 2.

Table 2.2: Site names.

Site	Common Name	Precinct
1	Rushy Road	Moira
2	Coolamon Crossing	Moira
3	Middle Road	Millewa
4	Sandhills Road	Millewa
5	James Swamp Road	Millewa
6	Western Millewa River Road	Millewa
7	Glens Road	Millewa
8	Millewa River Road	Millewa
9	Sams Road	Millewa
10	Toupna Crossing Road	Millewa
11	Box Plain Road	Millewa

Site	Common Name	Precinct
12	Millewa River Road East	Millewa
13	Steamer Plain	Barmah
14	War Plain Track	Barmah
15	Forcing Yards Track	Barmah
16	Sand Ridge Track	Barmah
17	Long Plain Track	Barmah
18	Doug's Crossing Track	Barmah
19	Bourke Street	Barmah
20	Sharpe's Plain Track	Barmah
21	Chinaman's Garden Track	Barmah
22	Dinny's Dip Track	Barmah

2.2.1. River red gum site quality, stem density and canopy condition

All ecological thinning trial sites must be located in areas identified as river red gum forest in NSW and Victorian vegetation maps. In order to meet the scientific requirements of the trial design, sites of varying quality, stem density and canopy condition are required.

- 'Site quality' is based on the stand height, and is used as a coarse indicator of the frequency of surface flooding and access to groundwater (Forest Commission of NSW (FCNSW) 1984). Areas meeting the required site quality parameters were identified using existing data from the Statewide Forest Resource Inventory, conducted in the 1990s in Victoria, and NSW in 1954 by FCNSW; these areas are shown in Figure 2.

Identification of areas with appropriate stem density and canopy condition used mapping undertaken by Bowen et al. (2012). Figure 3 shows the stem density across the trial area, while the canopy condition is shown in Figure 4: Ecological thinning trial – canopy condition and location of trial sites.. As stands greater than 400 stems per hectare are more extensive in NSW, 12 of the 22 sites are located in NSW.

Within each site, all three plots have the same mapped stem density, canopy condition and water availability level prior to treatment. Plots within a site will be aligned to ensure consistent average micro topographic relief.

2.2.2. Logging and fire history

All ecological thinning trial sites must not have been harvested for sawlogs or affected by fire since 2001. The harvest history of the river red gum forests since 2001 is shown in Figure 5, while bushfire history shown in Figure 6.

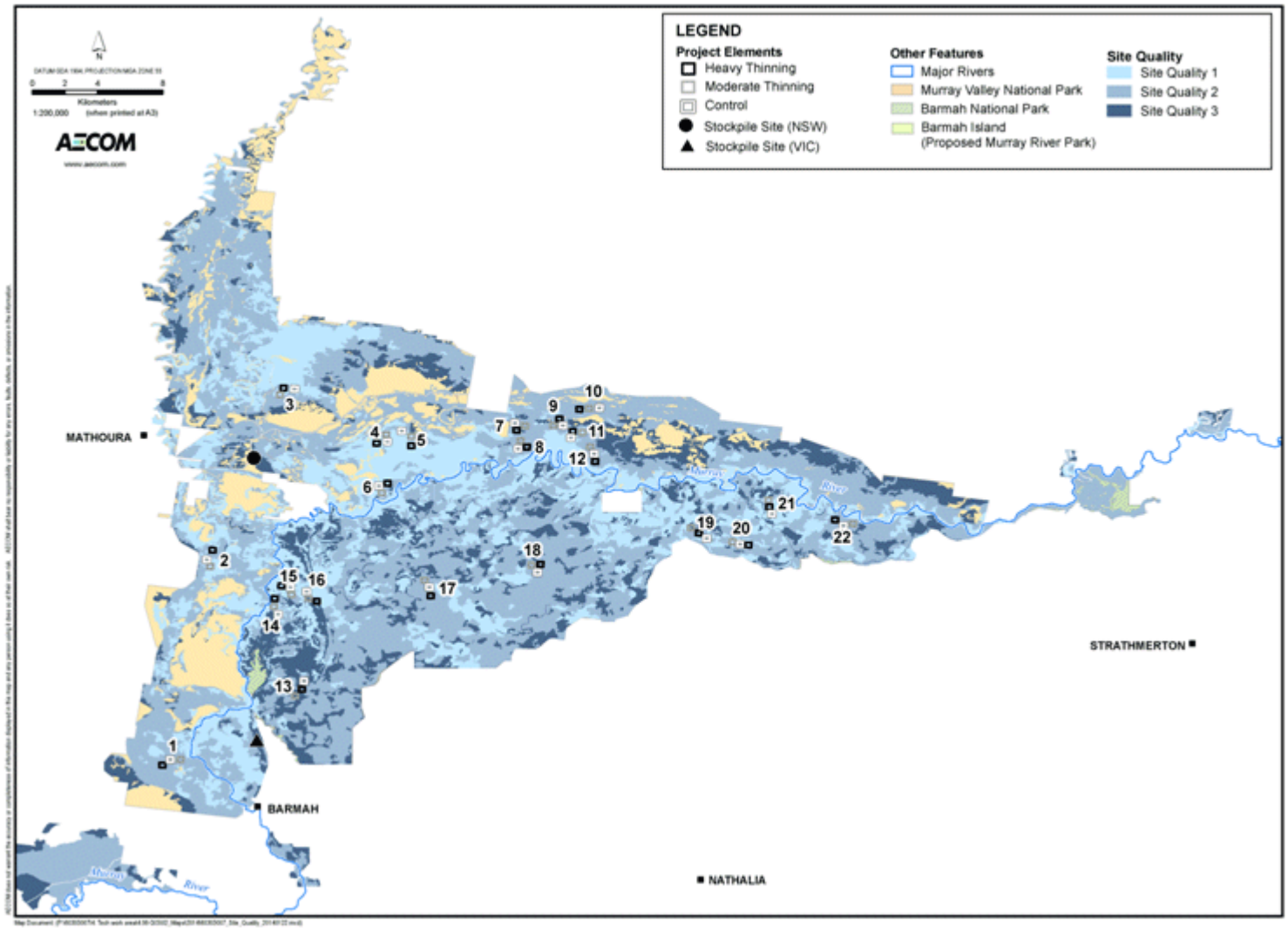

Figure 2: Ecological thinning trial – site quality and location of trial sites.

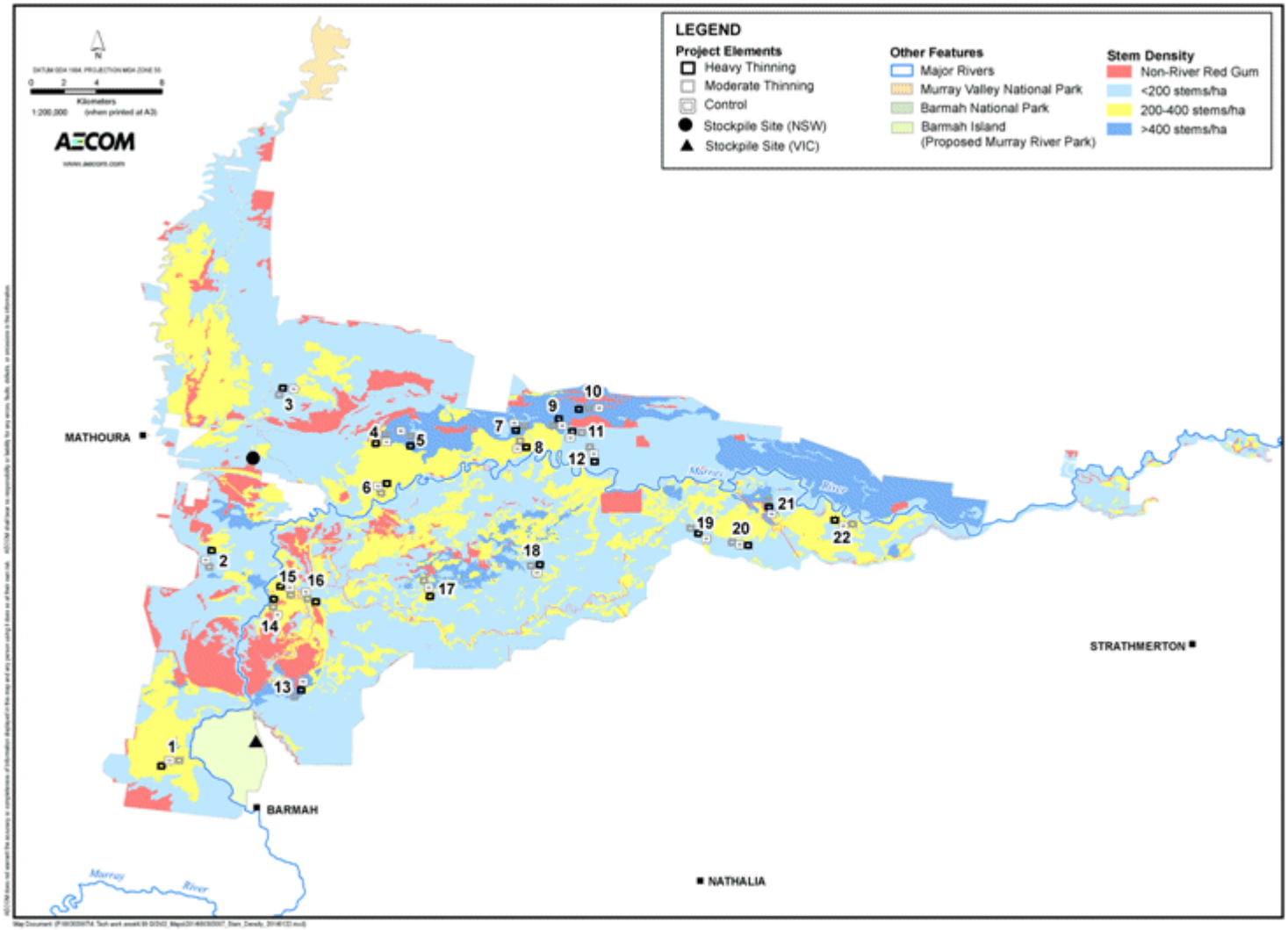

Figure 3: Ecological thinning trial – stem density and location of trial sites.

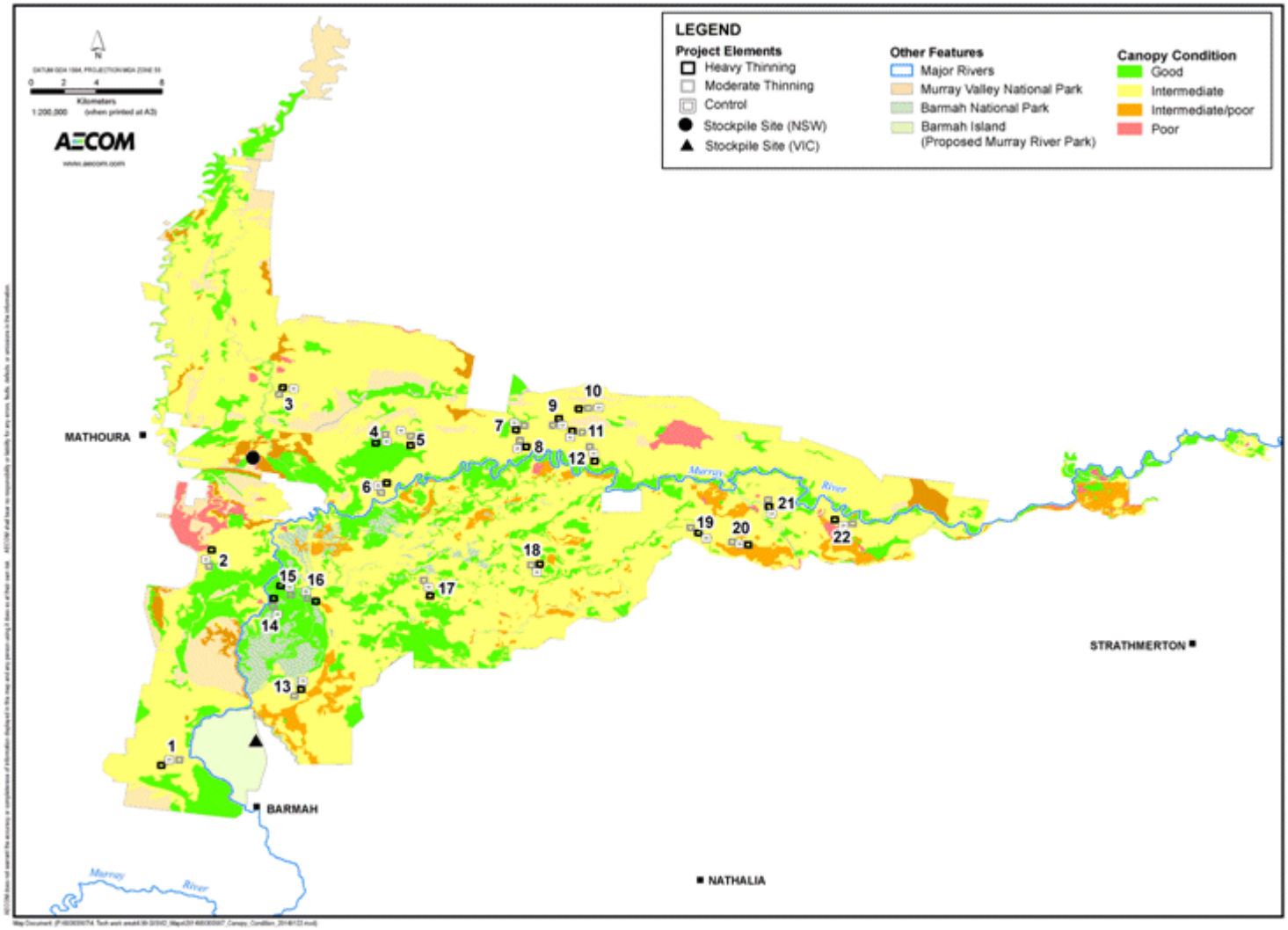

Figure 4: Ecological thinning trial – canopy condition and location of trial sites.

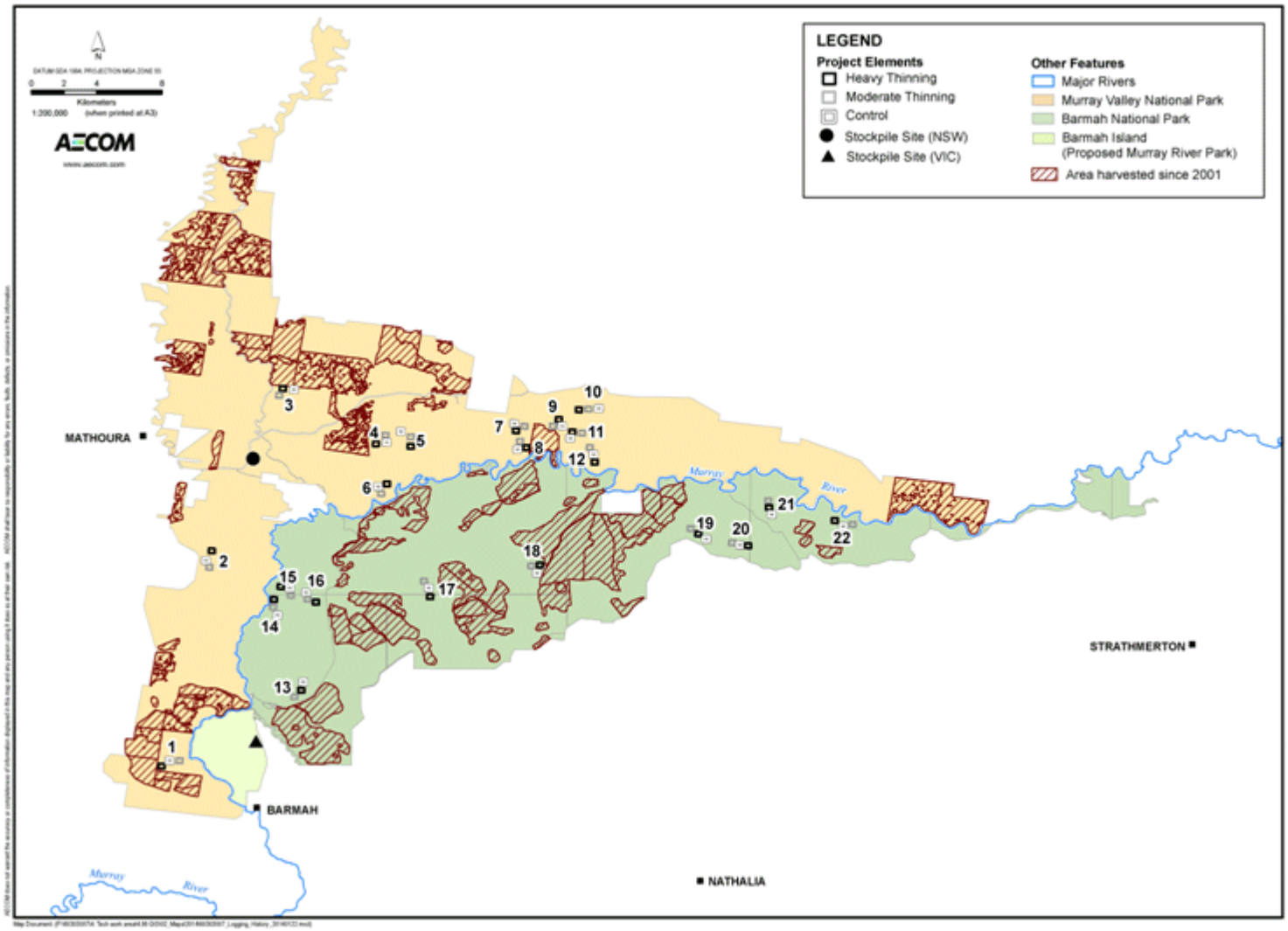

Figure 5: Ecological thinning trial – areas subject to logging since 2001 and location of trial sites.

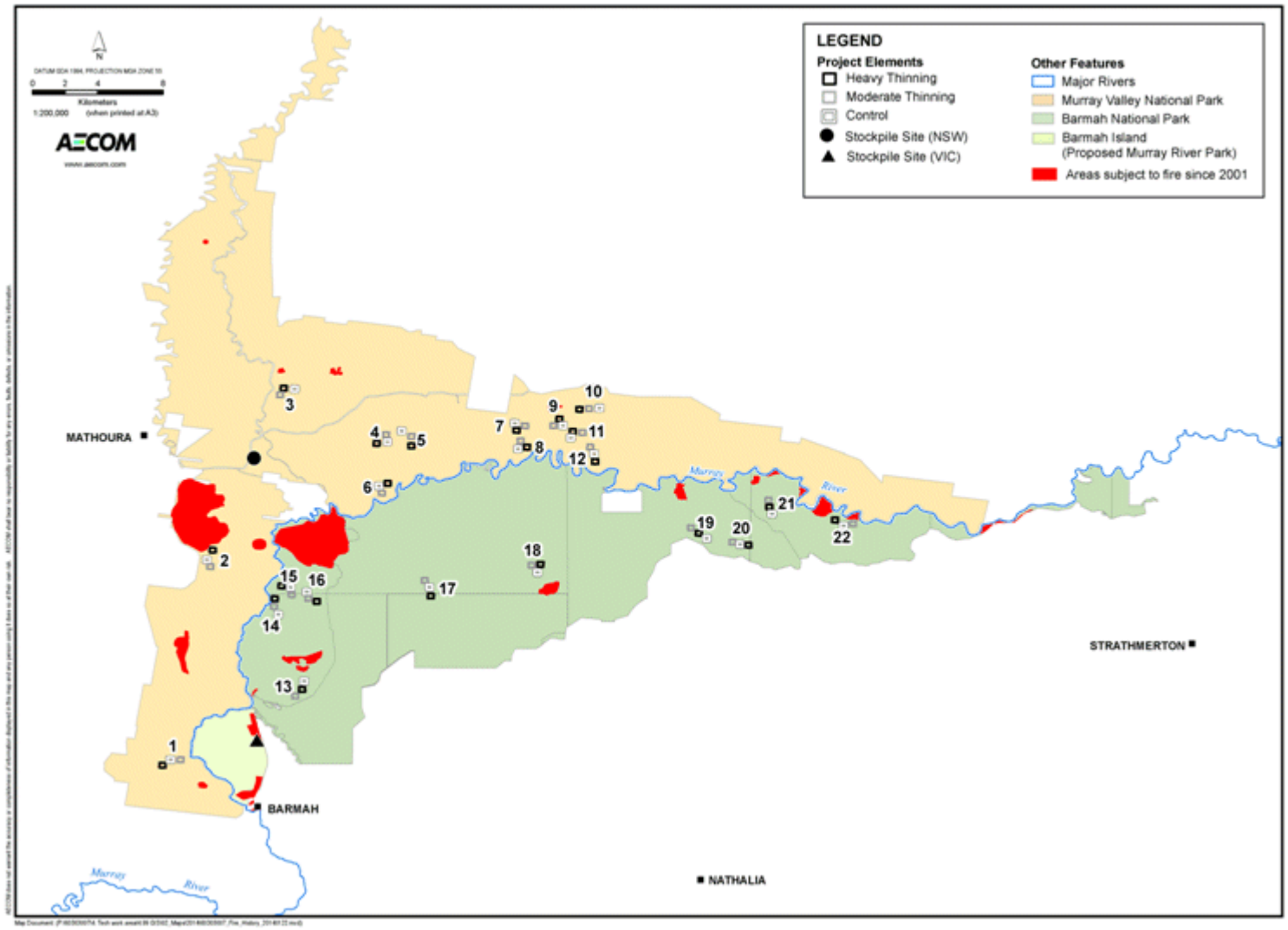

Figure 6: Ecological thinning trial – areas subject to fire since 2001 and location of trial sites.

2.2.3. Minimising impacts on matters of national environmental significance and native vegetation

In addition to meeting the scientific requirements of the trial, the following criteria were applied to minimise impacts on matters of national environmental significance and native vegetation:

- sites must be located greater than 100 metres from the nearest road (to minimise disturbance effects), but near fire trails (to minimise the need for establishment of additional natural surface tracks)
- no known occurrence of a Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)-listed species or community in heavy or moderate thinning plots.

The following specific activities were undertaken to refine site selection based on known occurrences of EPBC Act-listed species and communities.

Desktop searches

An EPBC Act protected matters search was undertaken on 19 November 2013 (see Appendix 3). This search identified 20 species listed as either vulnerable or endangered that are modelled as potentially occurring within the trial area. Additionally, searches of the Atlas of NSW Wildlife and Victorian Biodiversity Atlas were conducted to identify any records of matters of national environmental significance in the Barmah–Millewa and surrounds.

Field surveys

Experienced field ecologists from National Parks and Wildlife Service (NPWS), PV and suitably qualified ecologists conducted pretreatment site assessment surveys at the 66 proposed treatment and control plots to determine the presence of, or potential habitat for, EPBC Act-listed species and communities. These transverse surveys covered the area within each plot, and also extended 100 metres beyond the boundary of the plots in order to record any adjacent species or habitat feature. The surveys included:

- superb parrot *Polytelis swainsonii*
- koala *Phascolarctos cinereus*
- river swamp wallaby-grass *Amphibromus fluitans*
- Mueller daisy *Brachyscome muelleroides*.

In addition, the following habitat features were assessed:

- nests and roosts of a threatened species
- potential bat tree-roosts
- superb parrot nest trees
- hollow-bearing trees
- glider sap-feed trees
- trees containing raptor nests or colonial waterbird nests
- tree features (e.g. location and abundance of large trees, dead and alive, and tree hollow status)
- evidence of koalas *Phascolarctos cinereus*.

Where an EPBC Act-listed species was identified in a proposed treatment plot, the plot was:

- assigned as the control plot, or
- rejected and an alternative plot selected.

The surveys also considered the occurrence of any EPBC Act-listed ecological communities. Where an EPBC Act-listed community was identified in a proposed treatment plot, this plot was relocated.

Specific findings of desktop and field investigations are outlined in Section 4 of the PER, 'Description of existing environment', with further details of the field surveys provided in Appendix 4.

2.3. Trial activities

2.3.1. Establishment phase

Table 2.3 describes the activities to be undertaken to ensure appropriate supporting infrastructure is in place to implement the ecological thinning trial.

Table 2.3: Activities to be conducted in the establishment phase.

Activity	Description	Equipment and machinery	Responsible parties	Timing	Applicable areas
Maintenance of formal site access roads	Routes to be used for access to sites and transportation of excess coarse woody debris material are shown in Figure 7. Treatment plot locations have been selected to make best use of the existing road network. The network of existing park roads is maintained to provide adequate access for Category 1 fire vehicles (e.g. fire tankers). All existing roads have previously been used for forest management operations, and roads will be maintained as per existing park management practices to ensure that surfaces remain stable. The existing formal network will not require widening or augmentation. Lopping of verge vegetation may be required to enable safe access in some locations.	Tree lopping equipment Other equipment determined as required	PV/NPWS to maintain access roads in accordance with existing park management procedures	As required during trial	Site access roads as shown in Figure 7
Establishment of natural surface tracks	A series of natural surface tracks will be constructed within each site to facilitate access to treatment plots. Tracks will be a maximum of four metres in width, and will be primarily used by cars, trucks and four wheel drives. Establishment of these tracks will require clearance of loose timber and debris, followed by slashing of grass (where this is necessary) to provide a clear, visible access route. Under no circumstances will earthworks be undertaken to establish the tracks (i.e. groundlayer vegetation will not be stripped to expose bare earth).	Tractor with slasher mount (where slashing is required)	Contractor PV/NPWS to be present during track identification and establishment	November 2014–May 2015	All sites – access will be required to treatment and control plots

Activity	Description	Equipment and machinery	Responsible parties	Timing	Applicable areas
	Prior to establishment, natural surface tracks will be located in the field by a representative of NPWS or PV. All proposed routes will be walked and surveyed for threatened flora and fauna, and assessed for cultural heritage significance. Routes for surface tracks will avoid drainage feature crossings as far as practicable, and vegetation clearance will occur only to the minimum extent necessary. Construction of natural surface tracks will occur in a manner consistent with the requirements of park management and fire control policies. These tracks will be open for the treatment phase of the proposed ecological thinning trial only (i.e. they will not be used to for access during ongoing monitoring). Following the treatment phase, these tracks will be closed, stabilised and allowed to revegetate.				
Maintenance of stockpile sites	**NSW** – A single stockpile site for excess coarse woody debris material will be used in Millewa on Crossing Road off the Tocumwal Road. The site is bounded by existing fencing infrastructure, located in the existing road network and strategic firebreaks are already in place. No formal works would be required to establish the site. No native vegetation would be impacted. **Victoria** – A single stockpile site for excess coarse woody debris material will be established in the Barmah Island	NSW – None Vic – None	Contractor	As required during trial	Stockpile sites (as shown in Figure 7)

Activity	Description	Equipment and machinery	Responsible parties	Timing	Applicable areas
	section of the proposed Murray River Park. The proposed site (located within in the Barmah Ramsar site envelope) has previously been used for public firewood collection and suitable for this activity. No formal works would be required to establish the site. No native vegetation would be impacted.				

2.3.2. Treatment phase

Table 2.4 describes the activities to be undertaken at during the treatment phase. An individual, site-specific operational plan will be prepared for each of the 22 sites (see examples in Appendix 5). Subject to the approval of this project by the Commonwealth Minister for the Environment, it is intended for all thinning treatments will be conducted before the end of June 2015. The exact timing of treatments will depend on the PER process and its outcome.

In the event of consistent rainfall and/or flooding, thinning treatments may be deferred until the following summer (after the superb parrot breeding season). Should a change to the timing or methodology of treatment activities phase be required, this would require review and approval as per the change management procedure described in Section 6.3.5 of this PER.

Table 2.4: Activities to be conducted in the treatment phase.

Activity	Description	Equipment and machinery	Responsible parties	Timing	Applicable areas
Identification of trees for retention	Prior to treatment, all trees with visible hollows, all dead trees with DBH >20 cm, and all trees with diameter at breast height over bark (DBHoB) >40 cm will identified by a suitably qualified ecologist and marked for retention. Trees >40 cm DBH are retained because they have the	Spray paint and marking tape	NPWS/PV	Spring 2014– Autumn 2015	All treatment plots

Activity	Description	Equipment and machinery	Responsible parties	Timing	Applicable areas
	characteristics of trees that are of conservation concern (i.e. they are large trees with the potential to develop hollows and they can influence new tree recruitment). For safety reasons, some dead trees may need to be felled, and some dead trees may fall when struck by a felled tree. Spacing between retained trees will be 7 or 15 m, depending on the treatment level of the plot. Smaller trees will be preferentially removed. Clumping of large retained trees will be allowed such that the mean spacing within the plot conforms to the specified treatment levels.				
Felling	Trees not marked for retention will be machine felled using commercial tree harvesting machinery typical of a forest harvesting operation. Following felling, each stump will be painted with glyphosate biactive within five minutes to restrict coppicing. The felling method will aim to minimise damage to retained trees. The felling method and capability of contract machinery and operators has been identified in the 'scope of works' for the thinning operations tenders. Specific prescriptions have been developed to minimise short-term impacts on non-target vegetation, soils, water bodies. Operations will be supervised by NPWS and PV staff.	Commercial tree harvesting machine with GPS tracking Glyphosate biactive Chainsaw	Contractor	Summer 2014–Autumn 2015	All treatment plots
Transportation and storage of excess felled material	Felled trees will be retained within plots where it is required to increase coarse woody debris levels to within the range of 45–50 tonnes per hectare. Coarse woody	Forwarder Tipper truck with 5–10 tonne	Contractor	Summer 2014–Autumn	All treatment plots

Activity	Description	Equipment and machinery	Responsible parties	Timing	Applicable areas
	debris levels will be measured post-thinning and felled trees will be randomly removed from the plot until the 45–50 tonnes per hectare level is reached. No coarse woody debris present before the commencement of felling will be removed. Excess felled material will be removed to trucks using forwarders, which do not drag trees along the ground, thereby minimising impact to soils. Depending on site location and conditions, trees may be removed to temporary 'log landings' prior to loading onto trucks. Native vegetation will not be cleared to establish a log landing. Excess coarse woody debris will be removed in lengths to be determined by the length of the vehicle transporting the material. This destination of this material will vary between Victoria and NSW as follows: • NSW – stockpile site shown in Figure 7 (approximately 4 ha in size – 200 × 200 m) • Victoria – stockpile site located on Barmah Island and shown in Figure 7. Excess felled material will be spread out sensitively in on Crown Land in the vicinity of Corrys and Moira Lakes Roads. This area has been previously used for public firewood collection purposes. During wet weather, haulage will cease where there is runoff from the road surface. Under these conditions, only trucks that have already been loaded or partially loaded will be permitted to travel to the identified	capacity Skel truck approx 40 tonne – gross weight (28 tonne timber weight). B-double not permitted		2015	Site access roads as shown in Figure 7 Stockpile sites

Activity	Description	Equipment and machinery	Responsible parties	Timing	Applicable areas
	stockpile sites with their current load.				

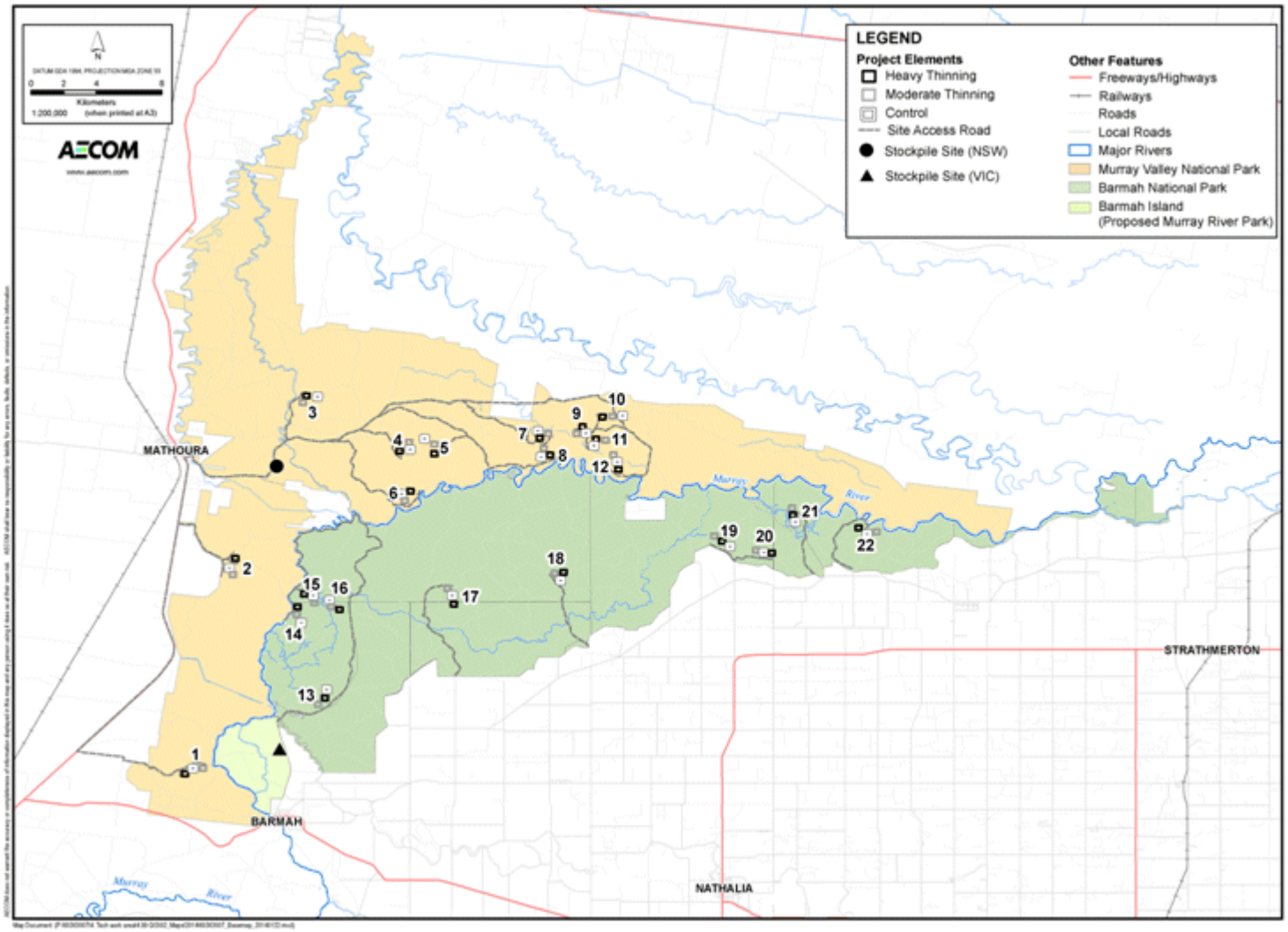

Figure 7: Trial sites, stockpile and access route locations for the proposed ecological thinning trial.

Transportation distances are provided in Table 2.5. Distances for Victorian sites are based on transportation to the edge of the forest.

Table 2.5: Transportation distances (single one-way trip) to stockpile site (NSW) and edge of the forest (Vic).

Site	Common name	Precinct	Distance (km)
1	Rushy Road	Moira	33
2	Coolamon Crossing	Moira	14
3	Middle Road	Millewa	5
4	Sandhills Road	Millewa	9
5	James Swamp Road	Millewa	13
6	Western Millewa River Road	Millewa	13
7	Glens Road	Millewa	18
8	Millewa River Road	Millewa	18
9	Sams Road	Millewa	24
10	Toupna Crossing Road	Millewa	24
11	Box Plain Road	Millewa	24
12	Millewa River Road East	Millewa	27

Average distance (km): 19

Site	Common name	Precinct	Distance (km)
13	Steamer Plain	Barmah	4
14	War Plain Track	Barmah	27
15	Forcing Yards Track	Barmah	25
16	Sand Ridge Track	Barmah	10.5
17	Long Plain Track	Barmah	3
18	Doug's Crossing Track	Barmah	5
19	Bourke Street	Barmah	2
20	Sharpe's Plain Track	Barmah	2
21	Chinaman's Garden Track	Barmah	4.5
22	Dinny's Dip Track	Barmah	5.5

Average distance (km): 9

2.3.3. Site monitoring phase

Post-treatment, annual floristic and bird surveys will be conducted in each treatment and control plot for the first 5 years. Thereafter, all plots will be surveyed at 5-yearly intervals during spring. This monitoring is required to assess the effectiveness of ecological thinning as a potential tool for management of river red gum forests.

Natural surface tracks established during the treatment phase will be closed off immediately after treatment is completed, meaning access to sites for monitoring will occur by foot from existing site access roads. All sites have previously been accessed by foot to conduct pretreatment survey work.

Monitoring will occur under NSW scientific licence number (SL 100124) and NSW animal care and ethics licence number (AEC 090316/01). A research permit from the Department of Environment and Primary Industries will be obtained prior to commencement of any scientific monitoring activities on public land in Victoria.

2.4. Additional development sites

No additional development sites will be required as a result of the ecological thinning trial.

2.5. Supporting infrastructure

Other than the infrastructure described in Section 2.3, no additional supporting infrastructure (e.g. machinery storage areas, work or office sheds, wash down facilities, water, sewage, drainage and electricity facilities) is required to undertake the proposed ecological thinning trial.

3. Feasible alternatives

As noted in Section 1.3, the objective of the proposed ecological thinning trial is to address key gaps in knowledge about how to manage river red gum forests to:

- promote a diversity of habitats in the landscape for indigenous species, including key habitat features such as hollow-bearing trees, stand structural diversity and coarse woody debris
- prevent further decline in canopy condition (the proportion of canopy that is dead)
- minimise the risk of mass tree death.

In addition to the option of taking no action (i.e. conduct no new research), a range of alternative approaches have been considered, including:

- using smaller plot sizes
- using more individual plots
- thinning to 560 trees per hectare
- using chainsaw crews to conduct thinning operations
- use of fire to maintain an open river red gum forest structure
- use of stem-injection of herbicide in selected trees
- not treating cut stumps with herbicide.

Overall, the ecological thinning trial, as described in Section 2, is considered to be the most feasible option because it is the only option that:

- can address the identified knowledge gaps regarding river red gum forest management
- maximises the ability to protect significant ecological features of the stand, such as large, mature hollow-bearing trees
- can be delivered in a safe and cost-effective manner
- could potentially be applied on a broader scale in the event that ecological thinning is found to generate benefits for the health of river red gum forests.

This section outlines the alternatives considered and provides a rationale for why each is not considered feasible.

3.1. Taking no action

Available options for management of river red gum forests will remain limited if a no action is taken.

The NSW Natural Resources Commission (NRC 2009) and the Victorian Environmental Assessment Council (VEAC 2008) river red gum assessments identified there is an urgent need for managers to develop ecologically appropriate and operationally practical techniques to enhance ecosystem health in many river red gum forests that are already suffering severe stress. These techniques include:

- ecological thinning
- ecological burning (or burning to promote certain fire-dependent ecosystems)
- procuring additional volumes of environmental water
- effectively managing environmental water (NRC 2009; VEAC 2008).

Within the river red gum forests, taking no action limits the potential available options to mitigate for stand loss and habitat degradation. Water is a key factor in maintaining the condition and ecological function of river red gum forests, but water availability is forecast to decrease due to the effects of climate change.

Should ecological thinning be found, after this scientific trial, to be a suitable application in conservation management of river red gum forests, then options to manage these areas effectively and efficiently will have been greatly improved.

3.2. Alternative trial approaches deemed to be unfeasible

Alternative approaches to conducting the ecological thinning trial (as described in Section 2), along with the reasons why each alternative approach is not feasible, are detailed in Table 3.1.

Table 3.1: Alternative trial approaches and reasons for not proceeding.

Alternative	Description of alternative	Reasons why alternative is not feasible
Use smaller plot sizes	Smaller plot sizes (2–4.5 ha) were considered during planning for the trial.	The 9 hectare plot size was selected to ensure that thinning was applied at an appropriate spatial scale to detect responses in bat and bird fauna groups. The 9 hectare plot size also enables the impact of edge effects to be minimised (i.e. the majority of the monitoring data is collected at least 50 metres from the boundary of the 9 hectare plot). Smaller plot sizes increase risk of impacts from edge effects, and provide decreased opportunities for data collection.
Use of more individual plots	Early iterations of the trial design proposed far greater numbers of smaller and more randomised treatment plots (i.e. greater than 1000).	Consideration was given to the resourcing of the trial, the availability of potential suitable sites and other environmental considerations. While more treatment plots would provide additional statistical power to the trial, this would also: • result in an increase in potential impacts on matters of national environmental significance • present difficulties in locating enough suitable sites • require considerably greater resources to implement. These factors were considered alongside the need to have a rigorous scientific design – advice from a biometrician and the independent Scientific Advisory Committee

Alternative	Description of alternative	Reasons why alternative is not feasible
		was that the trial design is sound and fit for purpose (Robinson 2011; Appendix 6).
Thinning to 560 trees per hectare	Thinning to 560 trees per hectare was considered for the ecological thinning trial. This was considered based on Horner et al (2009), which found that "thinning stands to densities of 560 trees per hectare is likely to optimise carbon storage and growth of hollow-bearing trees".	Results from Horner et al (2009) also showed only 4% of trees contained hollows and hollows were typically small (5–10 cm diameter). Narrow spacings such as those used in Horner et al (2009) and Horner et al (2010) are more likely to maintain tall slender trees (ideal for sawlog production), rather than trees with spreading crowns, which are desired as part of the proposed ecological thinning trial. The principal author has confirmed that the 2009 study was not conducted in conditions representative of the river red gum forests (G Horner pers. comm. 2013), and that he supports the proposed ecological thinning trial using a range of site qualities and tree densities.
Using chainsaw crews to conduct thinning operations	The use of manual thinning using chainsaw crews was considered.	If the ecological thinning is found to provide benefits for river red gum forests, it may be desirable in the future to apply the method on a broader scale. As manual thinning is a slower and more labour-intensive process, it is unlikely to be operationally practical on a broader scale. Mechanical thinning using commercial tree harvesting machinery is the safest. Mechanical thinning will also enable thinning activities to be conducted more rapidly, thereby limiting the duration of short-term impacts such as noise.
Use of fire to maintain an open river red gum forest structure	Fire is currently used by park management agencies to reduce fine fuel loads in eucalypt forests for 'hazard reduction' purposes. Potential exists for fire to be used to maintain forest structure; however, the ecological impacts from burning in river red gum forest has never been scientifically tested (Water	Further research using trial burns is required before broad-scale burning in river red gum forests could be undertaken. If fire was used as the method for this trial, it would not be possible to guarantee that the existing ecological values would be protected. To provide protection for coarse woody debris and hollow-bearing trees, it would be necessary for NPWS and PV staff to establish earthen protection lines around all known trees and patches of shrubby vegetation. Even with

Alternative	Description of alternative	Reasons why alternative is not feasible
	Technology 2009a; Palmer and Cahir 2010).	this control in place, fire may still pose a threat to older trees, which is contrary to the objectives of the trial.
Use of stem-injection of herbicide in selected trees	Stem-injection of herbicide is a relatively low-cost and low-impact technique used in other forest types worldwide to thin small trees in a developing stand. Trees die in situ and eventually collapse, thereby creating coarse woody debris.	Consideration of this method of forest thinning raised a number of feasibility issues: • time taken to generate coarse woody debris through stem collapse or branch dropping is unpredictable and may take years, rather than the immediate effect of tree felling • potential health, safety and training difficulties associated with chemical usage • logistical and scaling issues make this technique unsuitable for thinning larger areas of river red gum forest • stem-injection would result in higher numbers of visibly dead standing trees, which is likely to result in negative public perceptions of the river red gum forests • the number of dead standing trees would pose a safety risk for park management staff and the general public.
Not treating stumps with herbicide	Not treating stumps with herbicide was considered.	Whilst not treating the stumps with glyphosate would both lessen the cost of the trial and eliminate the need to use herbicide, it would also increase the amount of coppicing. Coppice growth could affect several of the hypotheses related to tree populations and forest structure. Thinning trials in river red gum forests for silvicultural purposes were conducted between the 1950s and the 1980s (FCNSW 1984). Plots from these trials were reviewed by Hamilton (1971, 1972, both cited in FCNSW 1984), who concluded that: coppice survived on 75% of stumps and appeared to have a retarding effect of growth of retained trees. Glyphosate biactive will be directly applied to the stump. It becomes inactive on contact with the soil. It has a low toxicity to mammals, fish and amphibians. It is also registered for use in, or close to, waterways or wetlands. (NSW DPI Website). Glyphosate also has very low mobility.

4. Description of the environment

This section describes the general physical conditions of the Barmah–Millewa, as well as surrounding areas with potential to be affected by the proposed ecological thinning trial. In addition, it provides a detailed description of all Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)-listed matters of national environmental significance that are known or likely to be present in the vicinity of the trial.

4.1. General

The river red gum forests of Barmah–Millewa cover an area of approximately 66,000 hectares of Murray River floodplain (including the Edward River) between the towns of Tocumwal, Echuca and Deniliquin. This area is a continuous forest and wetland system protected within the Barmah National Park (Victoria) and the Murray Valley National Park, Millewa Group (NSW) (see Figure 1).

4.1.1. Altitude

The river red gum forests of Barmah–Millewa are located on the Murray River floodplain at approximately 95 metres above sea level.

4.1.2. Rainfall

Barmah–Millewa is located within the Riverina bioregion, which is characterised by a semi-arid climate with hot summers and cool winters. The mean annual rainfall of the Riverina bioregion varies from 238 to 617 millimetres (NRC 2009). Rainfall predominately occurs between May and September, and annual rainfall tends to increase from west to east and from north to south.

The region's low rainfall and relatively high average temperatures result in a mean annual rainfall deficit (evaporation in excess of rainfall) of 1,075 millimetres. The significant rainfall deficit means that floodwater contributions are needed to support the soil moisture requirements of the river red gum forests and associated wetlands (Leslie 2001).

4.1.3. Land systems

Many of the landforms of the Riverina bioregion are dominated by river channels, with floodplains, swamps, lakes and lunettes of Quaternary age (less than 1.8 million years ago) (NPWS 2003). The alluvial fan of the Murray River is more confined than other alluvial fans in the bioregion (i.e. Lachlan and Murrumbidgee Rivers) and has more active anabranch channels where it is forced to flow around the north-south running Cadell Fault near Echuca (DEWHA 2009).

The displacement of the Cadell Fault some 25,000 years ago forced the west-flowing Murray River north through the Edward River system and south through an ancestral channel of the Goulburn River. These major changes in the landscape led to a greater frequency and duration of flooding, which in turn created the river red gum forests and wetlands observed today (Rutherford 1990).

Soils of the area reflect past patterns of sedimentation and the current flooding regime. Sandy soils are found in belts along the older stream channels and their associated natural

levees, dunes and lunettes. Modern river channels consist mostly of sandy soils and saline heavy grey and brown clays towards the outer perimeter of the floodplains on the rarely flooded higher terraces (NPWS 2003).

4.1.4. Hydrology

From its commencement high in the alpine region of south eastern Australia, the Murray River meanders in a shallow channel through the riverine plains, with other rivers including the Kiewa, Ovens and Goulburn, entering upstream of Echuca.

The uplift of the Cadell Fault diverted the Murray River through elevated sandhills, creating what is today known as the Barmah Choke (because of its relatively small flow capacity compared with other sections of the river channel). The Barmah Choke restricts flow, causes the upstream floodplain to be frequently inundated and creates hydrologic conditions suitable for the development of extensive floodplain forests (NRC 2009).

However, the Murray River and many of its tributaries have been significantly altered since European settlement and become highly regulated in order to supply water to irrigation districts and protect urban areas from the impacts of large floods (Overton et al. 2006). The vegetation and ecology of the river red gum forests has evolved over time in response to water availability (NRC 2009).

Groundwater is also an important component of the hydrologic setting of these forests. This includes the linkages between groundwater and surface water. Typically, areas of groundwater dependent river red gum forest access the shallow unsaturated zone. Some stands of forest may well be maintained in good health by interactions with groundwater rather than through direct flooding. Generally the recharge of groundwater systems is largely influenced by stream and flooding conditions (Overton 2009). River regulation on the Murray River has severely impacted the balance of physical and ecological processes that maintain this unique riverine environment. For instance, due to the demands of irrigation there is a need (August to May) to run the river at unnaturally high levels. When this coincides with significant rainfall, irrigators may cancel pre-ordered irrigation supplies. In such an event, Murray River flows have the potential to increase beyond forest channel capacity. This can lead to unnatural summer floods to lower areas of the river red gum forests and negatively impact resident vegetation communities.

4.2. Method for determining presence and extent of EPBC Act-listed matters of national environmental significance

The existing ecological conditions for the river red gum forests have been established through a mixture of desktop investigations, field surveys and vegetation mapping.

4.2.1. Desktop assessment and field surveys

Desktop assessment and field surveys were conducted as part of the site selection process, and are described in Section 0. Table 4.1 to Table 4.4 provide a full listing all EPBC Act-listed matters of national environmental significance identified through the desktop assessment and field surveys. This includes the species specifically noted in the *Tailored Guidelines for the Content of a Draft Public Environment Report – Ecological Thinning Trial in NSW and Victorian River Red Gum Forests* (SEWPaC 2013a). Due to the inland location

of the proposed ecological thinning trial, matters solely listed as 'marine' have been excluded from further consideration.

4.2.2. Understanding vegetation and threatened ecological community extent

The vegetation of Barmah–Millewa has been mapped at varying extents and scales and a number of different products are available for use in park management. Mapping products include the classification of vegetation communities mapped at broad scales based on land system units derived from information on climate, geology, topography, soils and broad vegetation structure (ECC 1997; Keith 2004). Others have mapped or classified communities to more considerable detail and provide an indication of understorey dominance and species composition (Portners 1993; Frood and Ward 2001; Frood 2007; Benson 2010).

To assist with the planning of the proposed ecological thinning trial, mapping of Barmah–Millewa has been undertaken, combining existing mapping and new interpretation of imagery to produce a consistent, seamless map for the forests (Bowen et al. 2012). This mapping was used to identify EPBC Act-listed vegetation communities.

4.2.3. Likelihood of occurrence of matters of national environmental significance

Based on the results of the desktop assessment and site surveys, a likelihood of occurrence assessment has been undertaken (see Table 4.1 to Table 4.4), which evaluates the potential for each EPBC Act-listed matter of national environmental significance to occur within the area of the proposed ecological thinning trial (i.e. the river red gum forests of Barmah–Millewa and any ancillary areas such as haulage routes). This process involved identifying all matters of national environmental significance that have previously been recorded within, or in close proximity to, the river red gum forests. It has also involved those matters of national environmental significance considered likely to occur based on relevant database searches, as well as assessing the availability of suitable habitat within the Barmah–Millewa area to support these matters.

The following likelihood of occurrence categories were assigned to each EPBC Act-listed matter of national environmental significance identified during the desktop assessment.

- **unlikely –** The species has no recent historical records, was not observed in the field, has limited preferred habitat in Barmah–Millewa and is considered unlikely to be present **OR** the vegetation community/the Ramsar wetland does not occur within Barmah–Millewa.
- **low –** Some habitat for the species is present in Barmah–Millewa. The species may infrequently visit on-route for foraging but will not reside, roost or otherwise depend on habitats of river red gum forests for their survival. Migratory and aerial foraging birds may overfly. The species may be locally extinct **OR** the vegetation community is considered unlikely to occur within Barmah–Millewa.
- **moderate –** Infrequent records for the species may occur within the Barmah–Millewa. The river red gum forests may contain some of the preferred habitat, although generally these are in poor or modified condition **OR** the vegetation community is known to have a scattered distribution within Barmah–Millewa.
- **high –** The species has historically been recorded in Barmah–Millewa. The river red gum forests contain significant preferred habitat which is likely to support a population of the

species, including roost sites **OR** the vegetation community is known to occur within Barmah–Millewa.

- **present –** The species' directly observed, recently recorded or preferred habitat is present in the river red gum forests of Barmah–Millewa **OR** the river red gum forests are part of the vegetation community/Ramsar wetland.

This section provides further detail on the EPBC Act matters of national environmental significance with a moderate or higher likelihood of occurrence within the river red gum forests (see Table 4.1 to Table 4.4), and these matters are then considered in the risk assessment (see Section 5).

Table 4.1: Likelihood of occurrence assessment for EPBC Act-listed fauna species.

Common name	Scientific name	EPBC Act status	Habitat preference/description	Habitat present in Barmah–Millewa	Species recorded in Barmah–Millewa (most recent date)	Likelihood of occurrence in trial area (river red gum forests and ancillary areas)
Amphibians - Growling grass frog/southern bell frog	*Litoria raniformis*	Vulnerable	Permanent lakes, swamps, dams and lagoons or very wet areas in woodland and shrubland; often in waterbodies with dense standing (e.g. *Eleocharis, Juncus, Typha, Bolboschoenus*) and floating vegetation (e.g. *Triglochin, Potamogeton*).	Yes	Yes (1982)	Low
Birds - Australasian bittern	*Botaurus poiciloptilus*	Endangered	Well-vegetated waterbodies, including tall reedbeds, sedgelands, lignum swamps, saltmarshes and brackish wetlands, occasionally along drainage channels	Yes	Yes although personal observations in 2013	Low
Birds - Australian painted snipe	*Rostratula australis*	Vulnerable	Lowland shallow freshwater swamps and wetlands with dense emergent vegetation, including lignum swamps; sometimes in flooded saltmarshes.	Yes	Yes (unknown)	Low
Birds - Caspian tern	*Hydroprogne caspia*	Marine, Migratory (CAMBA, JAMBA)	Coastal, sub-coastal and inland saltwater, brackish and fresh waterbodies and waterways, beaches, lakes and sheltered estuaries. Occasionally reservoirs and artificial wetlands.	Yes	Yes (1979) although personal observations in 2011	Low
Birds - Cattle egret	*Ardea ibis*	Marine, Migratory (CAMBA, JAMBA)	Freshwater wetlands and watercourses, pastures and croplands, especially where drainage is poor. Occasionally also tidal flats and estuaries.	Yes	Yes (unknown)	Moderate
Birds - Eastern great	*Ardea modesta*	Marine,	Occur in a wide range of habitat types. Those	Yes	Yes (2011)	Moderate

Common name	Scientific name	EPBC Act status	Habitat preference/description	Habitat present in Barmah–Millewa	Species recorded in Barmah–Millewa (most recent date)	Likelihood of occurrence in trial area (river red gum forests and ancillary areas)
egret	*(Ardea alba)*	Migratory (CAMBA, JAMBA)	relevant to the project area include swamps and marshes, margins of rivers and lakes, damp or flooded grasslands, reservoirs, sewage treatment ponds, drainage and Yarrawonga Main Channels.		although personal observations in 2013	
Birds - Fork-tailed swift	*Apus pacificus*	Marine, Migratory (CAMBA, JAMBA, ROKAMBA)	Aerial over a wide range of habitats, from inland to coast; spring-summer non-breeding migrant	Yes	Yes (unknown)	Moderate
Birds - Glossy ibis	*Plegadis falcinellus*	Marine, migratory (Bonn, CAMBA)	Mainly margins of freshwater wetlands and nearby grasslands and pastures; sometimes estuaries and brackish lakes. Mainly spring–summer breeding migrant to south-eastern Australia.	Yes	Yes (2013)	Low
Birds - Latham's snipe	*Gallinago hardwickii*	Marine, migratory (Bonn, CAMBA, JAMBA, ROKAMBA)	Wet grasslands and pastures, open and wooded swamps; spring–summer non-breeding migrant.	Yes	Yes (1981)	Low
Birds - Malleefowl	*Leipoa ocellata*	Vulnerable, migratory (JAMBA)	Mallee woodlands, scrubland and heathlands, often with sandy substrate. Breed in areas with good leaf litter layer. Occasional forage in open areas, including farmland and clearing amongst mallee.	No	No	Unlikely – no suitable habitat located within 50 km of plot sites
Birds - Osprey	*Pandion*	Marine, migratory	Littoral and coastal habitats of terrestrial wetlands. Mostly found in coastal areas, but occasionally	No	No	Unlikely – considered too far inland for the

Common name	Scientific name	EPBC Act status	Habitat preference/description	Habitat present in Barmah–Millewa	Species recorded in Barmah–Millewa (most recent date)	Likelihood of occurrence in trial area (river red gum forests and ancillary areas)
	haliaetus	(Bonn)	travel inland along major rivers. Require wide areas of open fresh, brackish or saline water for foraging.			known range of the species
Birds - Painted snipe	*Rostratula benghalensis (sensu lato)*	Endangered	Shallow, freshwater wetlands, including temporary and permanent lakes, swamps and claypans.	Yes	No	Low
Birds - Plains wanderer	*Pedionomus torquatus*	Vulnerable	Low, open native grasslands, typically with sward less than 1 metre high, with extensive inter-tussock spaces and high diversity of small herbs; sometimes in unimproved pastures or crops.	No	Yes (1933)	Unlikely
Birds - Rainbow bee-eater	*Merops ornatus*	Marine, migratory (JAMBA)	Summer migrants to Victoria where they occur in many wooded habitats with an annual rainfall of less than 800 mm, especially north of the Great Divide.	Yes	Yes (2013)	High
Birds - Regent honeyeater	*Anthochaera phrygia (Xanthomyza Phrygia)*	Endangered, migratory (JAMBA)	Depends on nectar and insects from box ironbark eucalypt forests. Only breeding habitat lies in northeast Victoria (Chiltern–Albury) and eastern parts of NSW at Capertee Valley and the Bundarra–Barraba region.	Yes	Yes (1978)	Low – dependant on box-ironbark forests
Birds - Superb parrot	*Polytelis swainsonii*	Vulnerable	River red gum, black box and other eucalypt woodlands and timbered watercourses; sometimes in pastures, stubbles, clearings and wooded farmland and often killed on roads when feeding on spilt grain	Yes	Yes (2001) although personal observations in 2013	High
Birds - Swift parrot	*Lathamus*	Endangered,	Winter migrant from Tasmania. Generally prefers	Yes	Yes (1982)	Low – few records and

Common name	Scientific name	EPBC Act status	Habitat preference/description	Habitat present in Barmah–Millewa	Species recorded in Barmah–Millewa (most recent date)	Likelihood of occurrence in trial area (river red gum forests and ancillary areas)
	discolor	marine	Box Ironbark forests and woodlands inland of the Great Dividing Range during winter.			species prefers Box-Ironbark forests
Birds - White-bellied sea eagle	*Haliaeetus leucogaster*	Marine, migratory (CAMBA)	Coastal islands, coastal lakes and along some inland rivers and lakes.	Yes	Yes (2005) although personal observations in 2013 (R Webster)	Moderate
Birds - White-throated needletail	*Hirundapus caudacutus*	Marine, migratory (CAMBA, JAMBA, ROKAMBA)	Aerial, mainly eastern Australia often associated with coastal and mountain regions.	Yes	Yes (unknown)	Moderate
Fish - Macquarie perch	*Macquaria australasica*	Endangered	Deep, rocky holes with considerable cover and flowing water over un-silted cobble and gravel substrate.	Yes	Yes (1951)	Low
Fish - Murray cod	*Maccullochella peelii peelii*	Vulnerable	Small clear, rocky, upland streams with riffle and pool structure on the upper western slopes of the Great Dividing Range to large, meandering, slow flowing, often silty rivers in the alluvial lowland reaches of the Murray Darling Basin.	Yes	Yes (2000)	Low
Fish - Murray hardyhead	*Craterocephalus fluviatilis*	Vulnerable	Occurs in still and slow-flowing waters including billabongs, lakes and margins and backwaters of lowland rivers	Yes	No	Moderate
Fish - Trout cod	*Maccullochella*	Endangered	Large fish typically inhabit deep holes, smaller fish	Yes	Yes (1992)	Low

Common name	Scientific name	EPBC Act status	Habitat preference/description	Habitat present in Barmah–Millewa	Species recorded in Barmah–Millewa (most recent date)	Likelihood of occurrence in trial area (river red gum forests and ancillary areas)
	macquariensis		beneath and amongst boulders and other cover. Often found in fast flowing water over bedrock, boulder and sand substrates and amongst heavy cover in faster water than for Murray cod.			
Mammals - South-eastern long-eared bat	*Nyctophilus corbeni*	Vulnerable	Occurs in a range of inland woodland vegetation types, including box, ironbark and cypress pine woodlands. Also occurs in Buloke, Brigalow and Belah woodland and river red gum forests, often lining watercourses and lakes.	Yes	No	Moderate
Mammals - Brush-tailed rock wallaby	*Petrogale penicillata*	Vulnerable	Occurs in small populations near the Upper Snowy River in Eastern Victoria and Grampians. Inhabits rock piles and cliffs with numerous crevices and ledges in vegetation ranging from rainforest to dry sclerophyll forest	No	No	Unlikely – outside the current known range of the species
Mammals - Koala (combined populations of Qld, NSW and the ACT)	*Phascolarctos cinereus*	Vulnerable	Range extends from north-east Queensland to south-east South Australia. Typically inhabit most temperate, sub-tropical and tropical forest and woodland communities dominated by eucalyptus and <800 metres above sea level	Yes	Yes (unknown) Although personal observations in 2009	High
Mammals - Spot-tailed Quoll	*Dasyurus maculatus maculatus*	Endangered	Coastal heath and scrub, dry and wet sclerophyll forest, rainforest. Generally a forest dependent species requiring large intact areas of vegetation.	No	No	Unlikely – little preferred habitat within plot sites
Reptiles - Pink-tailed worm-lizard	*Aprasia parapulchella*	Vulnerable	Inhabits sloping, open woodland areas with predominantly grassy groundlayers and rocky	No	No	Unlikely – no suitable habitat in Barmah–

Common name	Scientific name	EPBC Act status	Habitat preference/description	Habitat present in Barmah–Millewa	Species recorded in Barmah–Millewa (most recent date)	Likelihood of occurrence in trial area (river red gum forests and ancillary areas)
			outcrops, particularly those dominated by Kangaroo Grass. Vic distribution restricted to isolated population near Bendigo.			Millewa

Table 4.2: Likelihood of occurrence assessment for EPBC Act-listed floral species.

Common name	Scientific name	EPBC Act status	Habitat preference/description	Habitat present in Barmah–Millewa	Species recorded in Barmah–Millewa (most recent date)	Likelihood of occurrence in trial area (river red gum forests and ancillary areas)
Plants - River swamp wallaby-grass	*Amphibromus fluitans*	Vulnerable	Permanent swamps; species is virtually aquatic, often with only the flower heads above the water. The wetland habitats must be at least moderately fertile and have some bare ground, conditions which are produced by seasonally fluctuating water levels. Habitats may include swamp margins in mud, dam and tank beds in hard clay and in semi-dry mud of lagoons with *Potamogeton* and *Chamaeraphis* species (DECC. 2005a).	Yes	Yes (2005)	High
Plants - Mueller daisy	*Brachyscome muelleroides*	Vulnerable	Grows in flood-influenced vegetation communities including cane grass swamp grassland of the Riverine Plains (Benson 47), forb-rich speargrass – windmill grass – white top grassland of the Riverina Bioregion (Benson 44) and plains grass grassland on alluvial dark grey clays of central NSW (Benson 45). Distribution is south from	Yes	Yes (1996)	Moderate

Common name	Scientific name	EPBC Act status	Habitat preference/description	Habitat present in Barmah–Millewa	Species recorded in Barmah–Millewa (most recent date)	Likelihood of occurrence in trial area (river red gum forests and ancillary areas)
			Wagga Wagga and east of the Cobb Highway (OEH 2005).			
Plants - Ridged water-milfoil	*Myriophyllum porcatum*	Vulnerable	Found in ephemeral wetlands of the Riverina, Midlands and Murray Darling Depression. Occasionally found in Murray River tributaries in northern Victoria.	Yes	Yes (2008)	Low – little preferred habitat in river red gum forests
Plants - Slender darling-pea	*Swainsona murrayana*	Vulnerable	In the Murray Fans this species is restricted to the Hay Plain, occurring in the vegetation communities: corkscrew grass grassland/forbland on sand plains and plains, curly windmill grass – speagrass – wallaby-grass on alluvial clay, forb-rich speargrass – windmill grass – white top grassland and weeping Myall open woodland. May occur in the Buloke Woodland and Box-Gum Woodland communities.	No	No	Unlikely – little preferred habitat in river red gum forests
Plants - Greencomb spider-orchid	*Caladenia tensa*	Endangered	Plains areas of western Victoria, in cypress-pine/yellow gum woodland, heathy woodland and mallee on sands and sandy loams derived from aeolian sand deposits	No	No	Unlikely – little preferred habitat in river red gum forests
Plants - Western water-starwort	*Callitriche cyclocarpa*	Vulnerable	Aquatic or amphibious plant, but exact habitat largely unknown. Has been collected from river red gum woodlands with an open grassy understorey.	Yes	Yes (1992)	Low – little preferred habitat in river red gum forests
Plants - Winged peppercress	*Lepidus monoplocoides*	Endangered	Winged pepper-cress occurs predominantly in mallee scrub in semi-arid areas. Sites are seasonally moist to water-logged with heavy, fertile soils and a mean annual rainfall of around	Yes	Yes (2001)	Low – little preferred habitat in river red gum forests

Common name	Scientific name	EPBC Act status	Habitat preference/description	Habitat present in Barmah–Millewa	Species recorded in Barmah–Millewa (most recent date)	Likelihood of occurrence in trial area (river red gum forests and ancillary areas)
			300 to 500 mm. The predominant vegetation is usually an open-woodland dominated by buloke and/or eucalypts.			
Plants - Mountain swainson-pea	*Swainsona recta*	Endangered	Grassland and open woodland, often on stony hillsides. Found in grassy understorey of woodlands and open-forests dominated by *Eucalyptus blakelyi*, *E. melliodora, E. rubida* and *E. goniocalyx*. Grows in association with understorey dominants that include *Themeda australis,* Poa tussocks and spear-grasses. Previously recorded in Victoria from low hill country in north and north-east but known only from one recent (1995) collection near Glenrowan.	No	Yes (1979)	Unlikely – little preferred habitat in river red gum forests

Table 4.3: Likelihood of occurrence of EPBC Act-listed ecological communities.

Ecological community	EPBC Act status	Description	Habitat present in Barmah–Millewa	Community recorded within Barmah–Millewa	Likelihood of occurrence in trial area (river red gum forests and ancillary areas)
Buloke woodlands of the Riverina and Murray–Darling Depression Bioregions	Endangered	Characterised by an open woodland with a well-developed ground layer of native vegetation that is typically grassy, but may support subshrubs and herbs. Buloke is a feature of all communities, but slender cypress-pine and grey box may be present	Yes	Yes	Unlikely
Grey box (*Eucalyptus microcarpa*) grassy woodlands and derived native grasslands of south-eastern Australia	Endangered	An open forest with a canopy dominated by eucalypts, and a moderate to sparse understorey and a ground layer of both perennial and native forbs and graminoids. The canopy is dominated by grey box with a mid-layer of *Acacia, Bursaria, Cassinia, Dodonaea,* and *Maireana.* The ground layer is typically comprised of graminoids, forbs and chenopods.	Yes	Yes	Moderate – some community present along transport routes
Natural grasslands of the Murray Valley Plains	Critically endangered	Characterised by perennial tussock grasses with a lack of woody plants. Broad-leaf herbs are common in the inter-tussock space and may dominant the community depending on seasonal conditions. Occasionally, low chenopod shrubs may occur.	Yes	Yes	Unlikely – not identified in any plots nor along any transport routes
Weeping Myall woodlands	Endangered	Weeping Myall are the sole or dominant overstorey species. Trees may occasionally be present in the overstorey. The understorey of this community often includes an open layer of shrubs above an open ground layer of grasses and herbs, but may exist as either a grassy or shrubby woodland.	Yes	Yes	Unlikely – not identified in any plots nor along any identified transport routes.

Ecological community	EPBC Act status	Description	Habitat present in Barmah–Millewa	Community recorded within Barmah–Millewa	Likelihood of occurrence in trial area (river red gum forests and ancillary areas)
White box–yellow box–Blakely's red gum grassy woodland and derived native grassland	Critically endangered	Characterised by a diverse understorey of native tussock grasses, herbs and scattered shrubs. White box, yellow box and Blakely's red gum are, or were, the dominant overstorey species.	Yes	Yes	Unlikely – not identified in any of the plots nor along any transport routes.

Table 4.4: Likelihood of occurrence of Ramsar wetlands.

Ramsar wetland	Description	Likelihood of occurrence in trial area (river red gum forests and ancillary areas)
Banrock Station wetland complex	Floodplain wetland complex typical of the lower Murray river floodplain. Areas of freshwater and areas of secondary salinized floodplain with discrete wetland basins and channels. Dominant vegetation communities within the complex includes river red gum woodland, Black Box woodland, Lignum shrubland and sedgelands. Downstream of Kingston on Murray in the riverland of South Australia, some 600 kilometres from the subject site	Unlikely
Barmah Forest	Predominately river red gum forest and associated floodplain marshes. In conjunction with Millewa forest it is the largest stand of river red gums in Australia. The forest is dependent on seasonal flooding. Trial sites are within Barmah Forest.	Present
Coorong and Lakes Alexandrina and Albert	The Murray river flows into Lake Alexandrina before flowing out to the Southern Ocean. The Coorong is a long, shallow, brackish to hypersaline lagoon separated from the Southern ocean by a dune system, and separated from Lake Alexandrina by barrages that were built in the 1930s. The site supports a number of threatened species and communities, as well as diverse waterbird assemblages. At the very downstream end of the Murray River, >800 kilometres from the study area.	Unlikely

Ramsar wetland	Description	Likelihood of occurrence in trial area (river red gum forests and ancillary areas)
Gunbower Forest	Together with the Koondrook–Perricoota Forest in NSW, Gunbower is the second largest stand of river red gum in Australia. River red gums inhabit the lower-lying areas of the forest, whilst sites less prone to inundation support black box, and consistently dry sites support grey box. Located approximately 60 kilometres west of the study site.	Unlikely
NSW Central Murray forests	Located on the floodplain of the Murray River in south-central NSW. Dominated by river red gum forest and woodland, wet grasslands and marshes. Also supports large areas of box woodland, and sandhill communities. Trial sites are within the NSW Central Murray forests.	Present
Riverland	Located in South Australia, near the town of Renmark. The site incorporates a series of creeks, channels, lagoons, billabongs and swamps. Areas between the waterbodies support extensive stands of river red gum and the site also contains 11 of the 12 vegetation communities known from the Riverina biogeographical region. >550 kilometres downstream of the study site	Unlikely

4.3. Matters of national environmental significance with a moderate or high potential to occur in the river red gum forests

The following section presents further information on those EPBC Act-listed matters of national environmental significance that are considered to have a moderate or high potential to occur within the river red gum forests.

4.3.1. Cattle egret *Ardea ibis*

The cattle egret is listed under the JAMBA and CAMBA Migratory Bird Agreements.

Distribution

Since 1877 the cattle egret has undergone a significant range expansion, and is only a recent colonist of Australia with the first documented occurrence being recorded in 1948 in the Northern Territory (Deignan 1964). Since this time the species has colonised much of Australia.

The species is known to occur on the wetlands of Barmah–Millewa, as shown in Figure 8.

Habitat requirements

In Australia, the species typically prefers lower lying, poorly drained pastures with a tall grass sward. As its name suggests it is often associated with the habitats of farm animals, in particular cattle. It typically in habitats shallow, open and fresh wetlands including swamps with low emergent vegetation and plentiful aquatic fauna. The species roosts either in trees, or amongst dense ground vegetation within close proximity to lakes and swamps.

Breeding

The species is a colonial breeder, and prefers to breed in wooded swamps, particularly the eucalypt/lignum swamps of the Murray–Darling Basin.

Threats

Threats to the continued viability of the species are faced from persistent ecosystem and community stresses that result in a decline in habitat quality. This may include the modification of natural hydrological systems, resulting in altered hydrological regimes, and a reduction in water quality. An increase in competition from unspecified invasive species may also be a threat to the species (DoE 2013a).

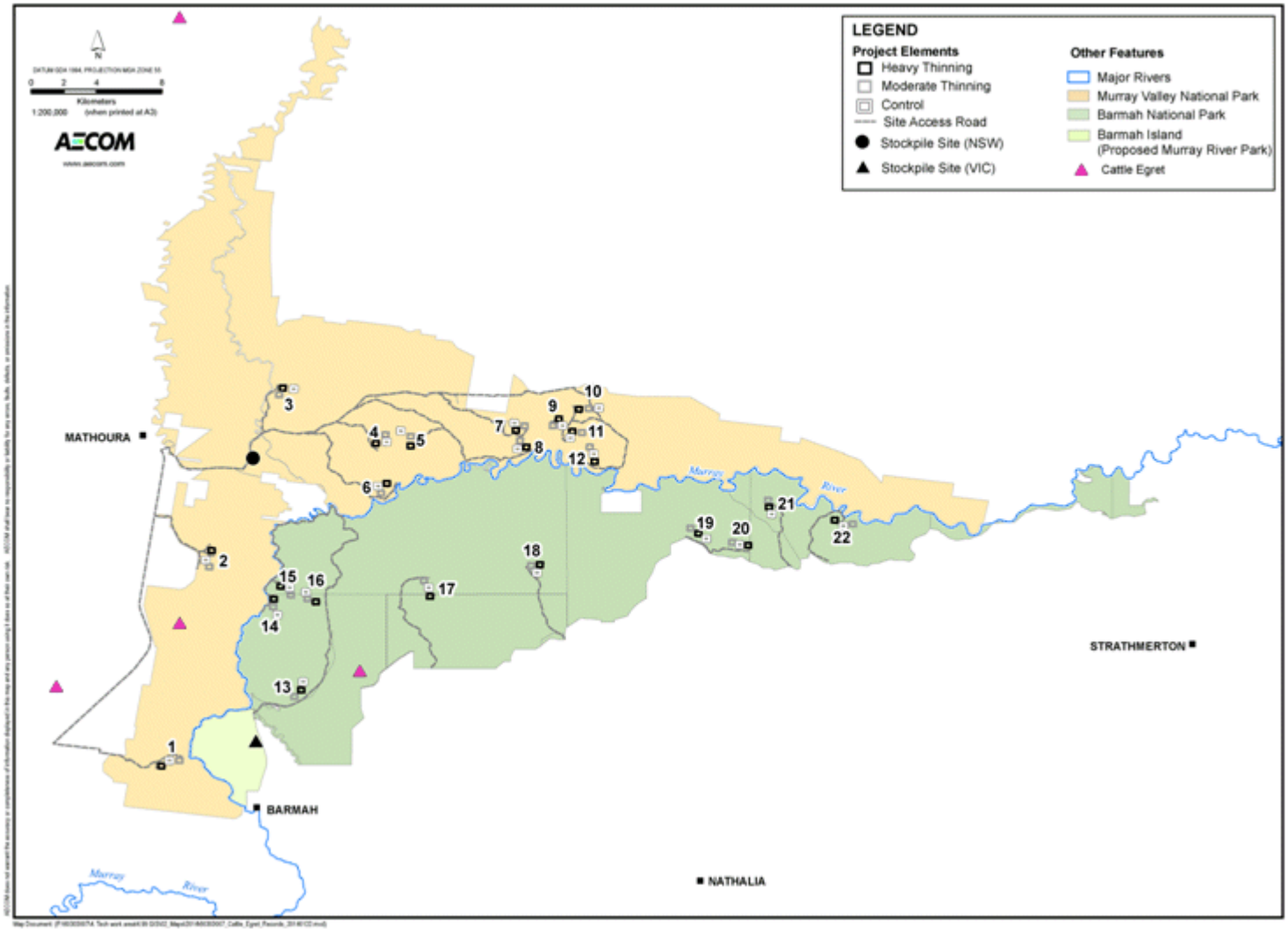

Figure 8: Locations where the cattle egret, *Ardea ibis*, has been recorded within the ecological thinning trial area.

4.3.2. Eastern great egret *Ardea modesta*

The eastern great egret is listed under the JAMBA and CAMBA Migratory Bird Agreements.

Distribution

The eastern great egret occurs across all states and territories of mainland Australia and Tasmania. Breeding colonies are known from the Channel Country of south-western Queensland and north-eastern South Australia, and colonies are also known from the Darling Riverine Plains region of NSW and the Riverina region of NSW and Victoria (Blakers et al. 1984; Marchant and Higgins 1990). Great egrets are a common inhabitant of Barmah–Millewa and have regularly been recorded nesting.

Habitat requirements

The eastern great egret utilises a wide range of wetland habitats, including swamps and marshes, margins of rivers and lakes, damp or flooded grasslands, pasture and agricultural land, reservoirs, sewage ponds, drainage channel, salt pans and salt lakes, estuaries, tidal streams and coastal lagoons (Marchant and Higgins 1990). The species is known to occur on the wetlands of Barmah–Millewa as shown in Figure 9.

Breeding

This species is a colonial nester, utilising a number of wetland sites within the forest. These nesting events occur during natural floods along the Murray River when inundation of the Barmah–Millewa floodplain provides suitable foraging habitat for adults to attain breeding condition and food to raise chicks. Known breeding sites within Barmah–Millewa include St Helena Swamp, Reed Beds South, Duck Lagoon, Porters Plain and Algeboia Plain in NSW, and Black Swamp, Bullock Creek and Top Island in Victoria. The number of pairs nesting within Barmah–Millewa depends on both local and regional climatic conditions.

Threats

Threats to the continued viability of the species are faced from continued habitat degradation as a result of both invasive weed species, and the modification of natural hydrological systems which leads to a direct reduction in preferred habitat through drainage, and/or a reduction in water quality (DoE 2013a b).

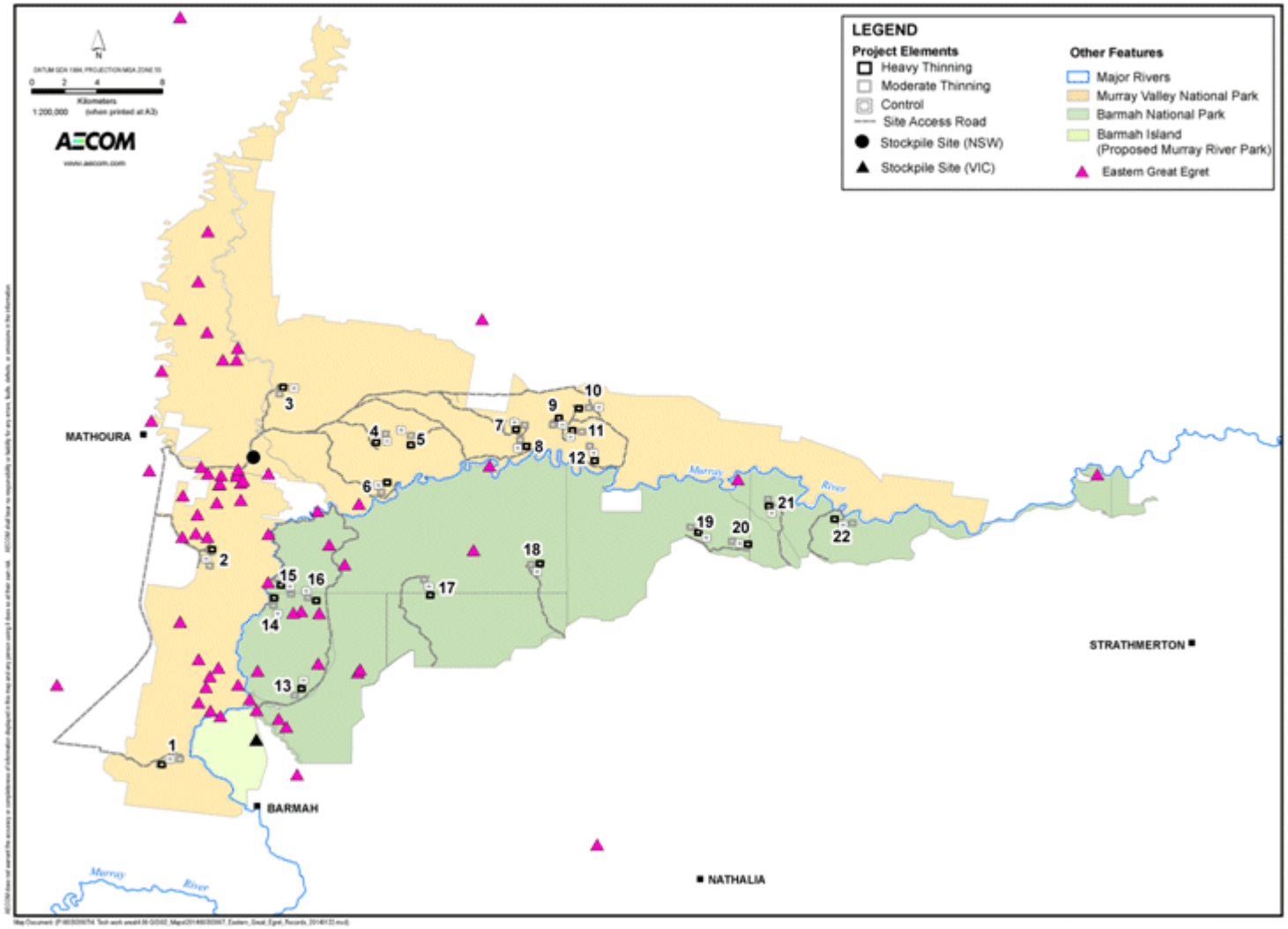

Figure 9: Locations where the eastern great egret, *Ardea modesta*, has been recorded within the ecological thinning trial area.

4.3.3. Fork-tailed swift *Apus pacificus*

The fork-tailed swift is listed under the JAMBA, CAMBA and ROKAMBA Migratory Bird Agreements

Distribution

The fork-tailed swift is a non-breeding visitor to all states and territories of Australia (Higgins 1999).

The species occurs throughout both NSW and Victoria (Blakers et al. 1984; Higgins 1999; Barrett et al. 2003). Breeding occurs outside of Australia in Asia (Chantler 1999; Higgins 1999). There are scattered records of the species moving aerially over Barmah–Millewa.

The fork-tailed swift usually arrives in Australia around October and begins to return to its breeding grounds from mid-April (Higgins 1999).

Habitat requirements

In Australia, the habitat is almost exclusively aerial, from heights less than 1 metre above the ground and higher (Chantler 1999; Higgins 1999). Fork-tailed swifts mostly occur over inland areas over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland and coastal sand-dunes.

Fork-tailed swifts are most likely to roost aerially (Higgins 1999) with few known records of the species roosting in trees (Newell 1930). There are no known records of the species roosting within the river red gum forests of Barmah–Millewa; however, the species has been recorded aerially over the forests as shown in Figure 10.

The species was not recorded during targeted threatened species searches or diurnal bird counts undertaken as part of the ecological thinning trial. It is difficult to conduct systematic surveys due to the species mobility and ability to cover huge distances in a day (DoE 2013c).

Breeding

The species breeds in Siberia between the months of May to August, before beginning their annual migration from Siberia to Australia, where they arrive around October.

Threats

Threats to the continued viability of the species result from increased competition with, or direct predation from, alien species. Furthermore, the species is under threat from the proliferation of shipping related infrastructure, which is leading to increased mortality as a result of direct collisions in shipping lanes and corridors (DoE 2013c).

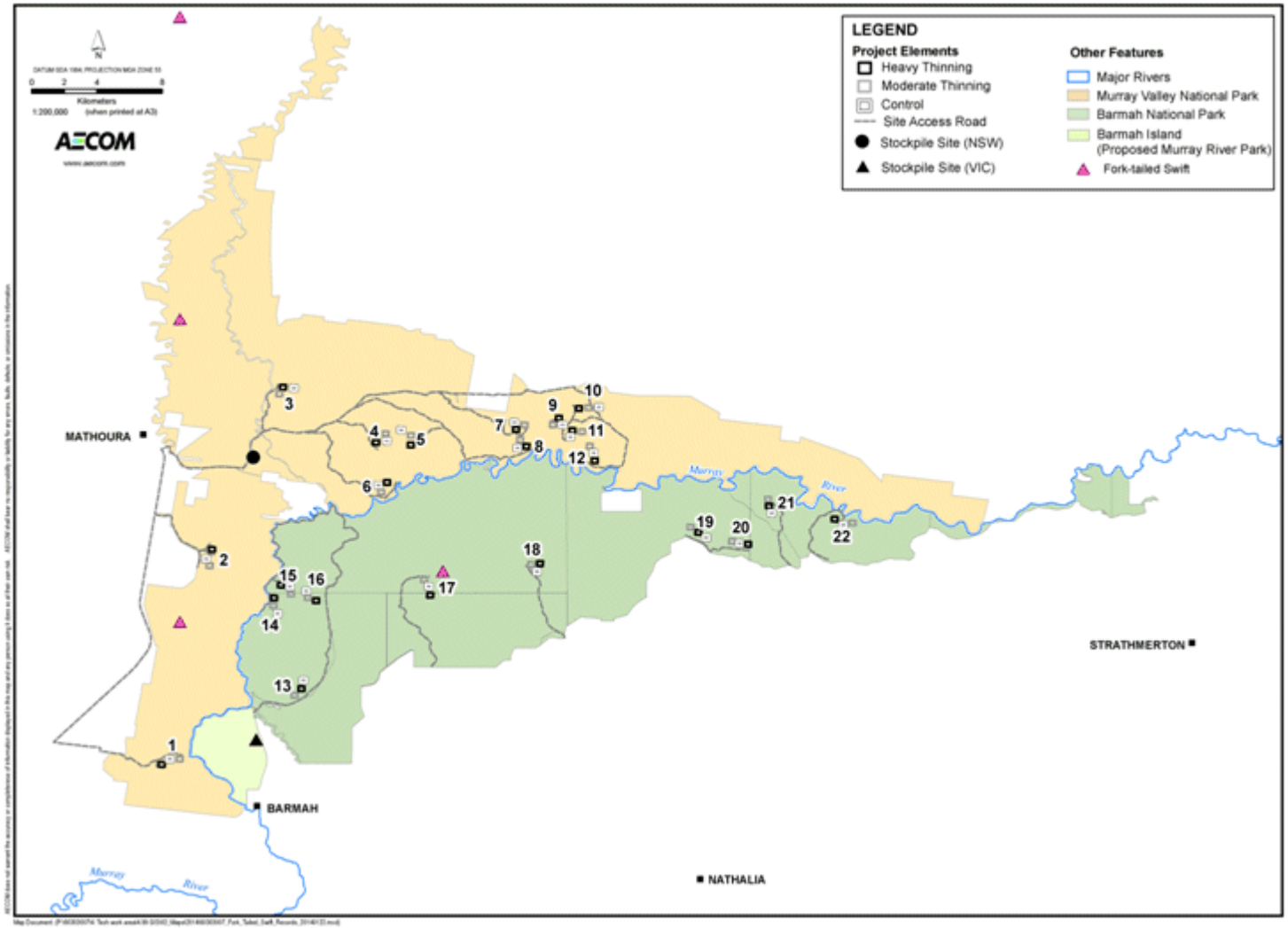

Figure 10: Locations where the fork-tailed swift, *Apus pacificus*, has been recorded within the ecological thinning trial area.

4.3.4. Rainbow bee-eater *Merops ornatus*

The rainbow bee-eater is listed under the JAMBA Migratory Bird Agreement

Distribution

The rainbow bee-eater is found throughout mainland Australia where its status is considered secure (Blakers et al. 1984; Higgins 1999; Barrett et al. 2003). The species is also known from eastern Indonesia, New Guinea, and in the Solomon Islands. In Australia this species is widespread, except in desert areas, and breeds throughout most of its range, although southern birds move north to breed (Higgins 1999). This species is not considered globally threatened.

Habitat requirements

The rainbow bee-eater occurs most often in open forests, woodlands and shrublands, as well as cleared areas, usually near water (Higgins 1999). Along the Murray River this species is known to occur within riparian and floodplain vegetation communities (Disher 2000; Tzaros 2001). Steep waterway banks, sandhills and former sand quarries are used to build nesting tunnels.

Targeted threatened species searches associated with the proposed ecological thinning trial did not detect the species at any of the proposed plots; however most of these surveys were undertaken outside of the species breeding period when they utilise these areas. This species is however known to occur within the river red gum forests of Barmah–Millewa as shown in Figure 11.

Breeding

In Australia, the breeding season extends from August to January. The nest is located within an enlarged chamber at the end of a long burrow or tunnel that is excavated into flat or sloping ground in the banks of rivers, creeks and dams and in roadside cuttings etc. Eggs are laid onto bare ground in clutches of between two and eight and are incubated by both sexes.

Threats

The cane toad is the major known threat to this species, and is impacting upon the viability of the species by feeding on the eggs and nestlings of the birds, and by occupying the nesting burrows, displacing birds from their habitat. In the past, the species was hunted as it was perceived to be a noxious pest. Its feathers were also favoured for use in the millinery trade (DoE 2013d).

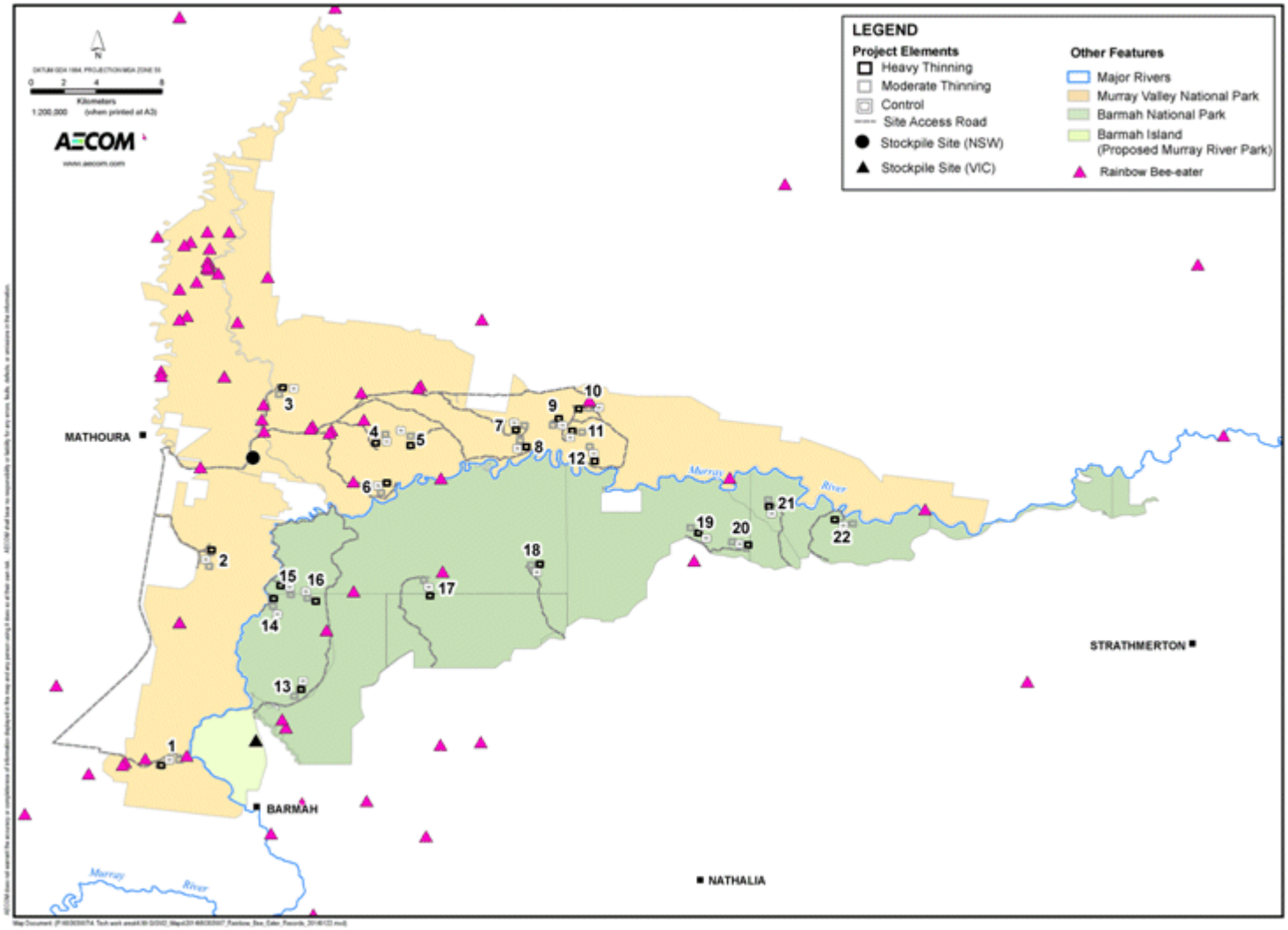

Figure 11: Locations where the rainbow bee-eater, *Merops ornatus*, has been recorded within the ecological thinning trial area

4.3.5. Superb parrot *Polytelis swainsonii*

The superb parrot is listed as vulnerable under the EPBC Act.

It is a medium sized parrot with an adult length of 40 centimetres. It is a dimorphic species females being predominately green with a blue face whilst males are predominately green with a bright yellow face and red collar (DoE 2013e).

Distribution

The superb parrot occurs mainly inland of the Great Dividing Range on the slopes and plains, from northern Victoria to northern NSW (Blakers et al. 1984). Within NSW, superb parrots occur east of a line linking Mathoura, Booroorban, Goolgowi, Yalgogrin and Narromine, and from Tottenham, through Quambone to Baradine and Wee Waa. The range extends east to Canberra and Bathurst, south to the Murray River near Cobram, and north to Coonabarabran and Narrabri (Blakers et al. 1984; Webster 1988; Higgins 1999; Barrett et al. 2003; Baker–Gabb 2011). In Victoria they occur mainly between Cobram and Echuca, centred on the Barmah forest (DSE 2003c). There are 461 known records of this species within Barmah–Millewa as shown in Figure 12.

Habitat requirements

Superb parrots feed on a range of plant species, mostly on the ground, but also in trees and shrubs. Their diet includes seeds of ringed wallaby-grass *Austrodanthonia caespitosa*, barley-grasses *Critesion* spp., wheat *Triticum aestivum*, oats *Avena sativa*, numerous wattle species (e.g. gold-dust wattle *Acacia acinacea*, silver wattle *A. dealbata* and Deane's wattle *A. deanei*), flowers, fruits and nectar of a variety of *Eucalyptus* species, fruit of box mistletoe *Amyema miquelii*, grey mistletoe *A. quandang,* dwarf cherry *Exocarpos strictus* and lerps taken from eucalypt foliage (Keartland 1903; Webster 1988, 1991, 1998).

Breeding

The Riverina (NSW and Victoria) and south-west slopes of NSW bioregions contain the majority of the breeding population (Webster and Logie 2008). In this region there are three main breeding areas, one of which is centred on Barmah–Millewa along the Murray and Edward Rivers (Blakers et al. 1984; Webster 1988; Baker–Gabb 2011).

During the breeding season superb parrots nest in the river red gum forests where large, mature living trees with many hollow branches and located typically close to a watercourse are used for nesting (Webster 1998, 1993, 1997). Foraging occurs in the nearby box-gum or box-pine woodlands, as well as cropping land (Webster 1998; Webster and Logie 2008). During the winter non-breeding period the species disperses further to the boree, box/white cypress pine woodlands or black box woodlands of the plains and sandhills between the Murrumbidgee and Murray Rivers (Webster 1998).

Threats

The clearing and degradation of box woodlands throughout the range of the species is the major threat to the species. It requires corridors of vegetation through the landscape to encourage dispersal. The species requires a specific combination of nesting and foraging habitat, and if either of these are impacted, breeding in the area will cease.

The felling of nest trees and the removal of river red gum forests is reducing the availability of suitable nesting hollows for the species (DoE 2013e).

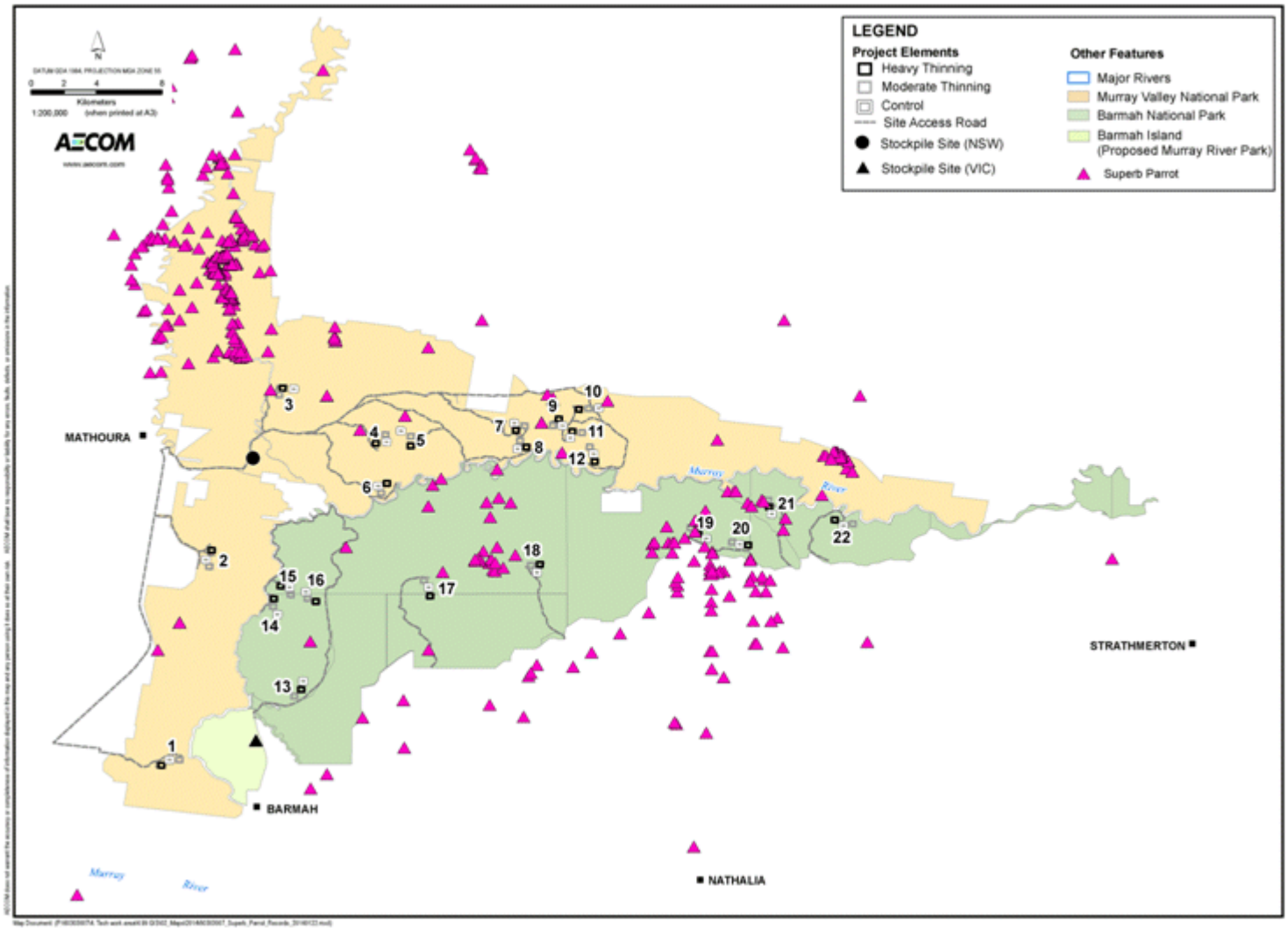

Figure 12: Locations where the superb parrot, *Polytelis swainsonii*, has been recorded within the ecological thinning trial area

4.3.6. White-bellied sea eagle *Haliaeetus leucogaster*

The white-bellied sea eagle is listed under the CAMBA Migratory Bird Agreement

Distribution

The white-bellied sea eagle is found along the coastline of mainland Australia and Tasmania. Its range also extends inland along some of the larger waterways, especially in eastern Australia (Marchant and Higgins 1993; Barrett et al. 2003). This species is well known from the Murray River corridor.

Habitat requirements

The habitats occupied by the white-bellied sea eagle are characterised by the presence of large areas of open water (larger rivers, swamps and lakes) and a variety of wooded terrestrial habitats (Marchant and Higgins 1993). Examples of this are found in the species occurrence in the Barmah–Millewa where nest sites are located at the edge of defined wetlands s such as Barmah Lake, Reedy Lake (Vic), and Moira Lake, St Helena Swamp and Reed Beds Swamp/Duck Lagoon (NSW) as shown in Figure 13.

Breeding

The species nests high up in dead trees or in dead limbs of live trees (Marchant and Higgins 1993; OEH 2012j).

Threats

Threats to the species includes the removal of large trees that could be used as nest sites, disturbance during nesting and reduction in water quality that increases turbidity in feeding areas (OEH 2012j).

The loss of habitat to land development, and the disturbance of nesting sites by humans are the major threats to this species. The species is sensitive to disturbance, particularly during the breeding season, and is known to abandon the nest and young if disturbance occurs. The species is also at risk of ingesting poison by preying on rabbits and similar prey that have been poisoned on agricultural lands.

The white-bellied sea eagle requires large areas of open water if it is to persist in inland areas of Australia. Degradation and modification of these systems will impact on the distribution of the species (DoE 2013f).

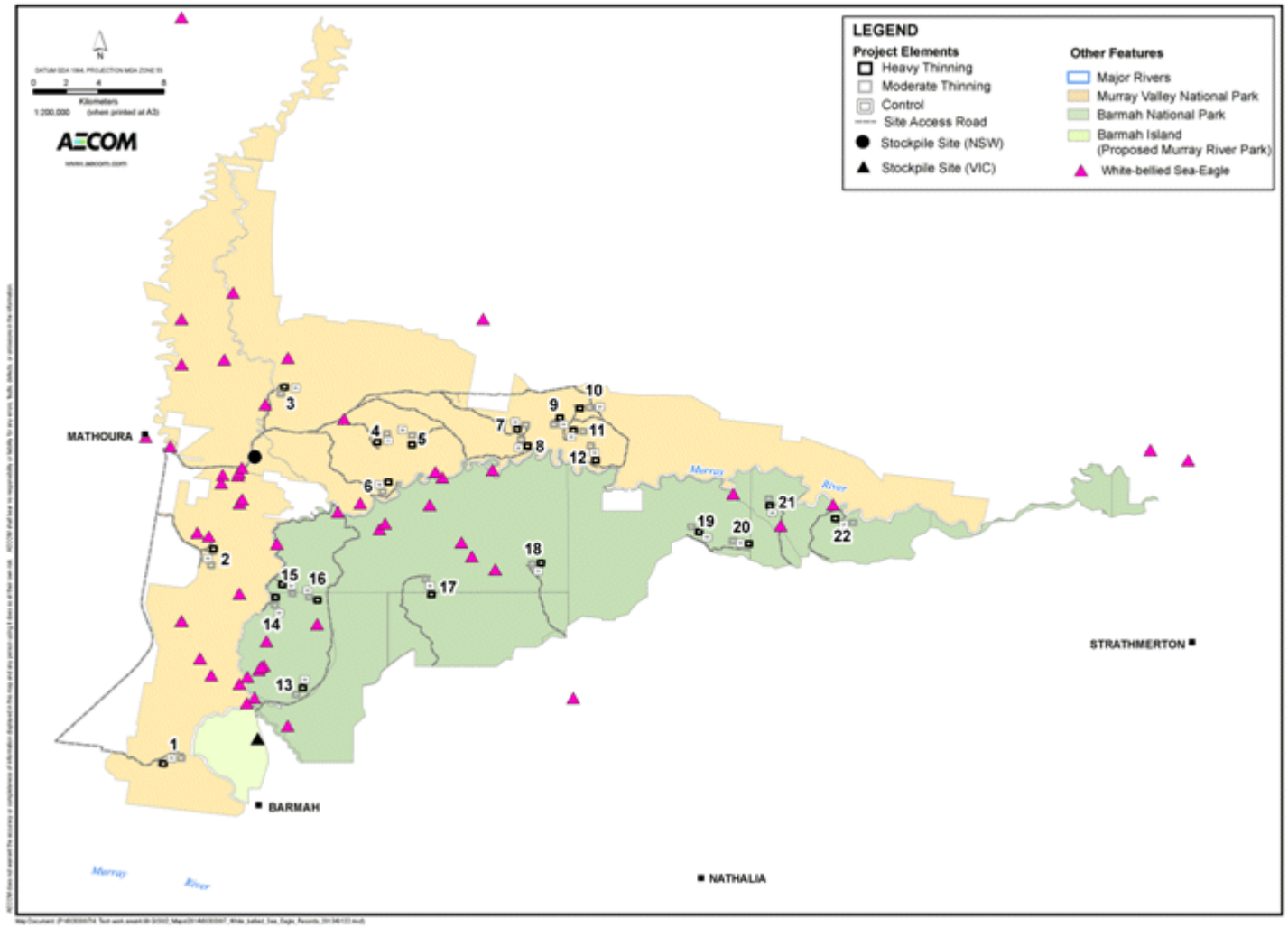

Figure 13: Locations where the white-bellied sea eagle, *Haliaeetus leucogaster*, has been recorded within the ecological thinning trial area.

4.3.7. White-throated needletail *Hirundapus caudacutus*

White throated needle-tail is listed under the JAMBA, CAMBA and ROKAMBA Migratory Bird Agreements.

Distribution

White-throated needletail is widespread in eastern and south-eastern Australia (Higgins 1999; Barrett et al. 2003).The species occurs throughout both NSW and Victoria (Blakers et al. 1984; Higgins 1999; Barrett et al. 2003). Breeding occurs outside of Australia in Asia (Chantler 1999; Higgins 1999). There are two records of the species moving aerially over Barmah–Millewa.

Habitat requirements

In Australia, the habitat is almost exclusively aerial, from heights less than 1 metre above the ground and higher (Chantler 1999; Higgins 1999). White-throated needletails are recorded more frequently over timbered areas including open forest and rainforest as well as woodlands, although they have been recorded over most habitats (Higgins 1999).

White-throated needletails have been recorded roosting in trees in forests and woodlands, both among dense foliage in the canopy or in hollows (Day 1993; Tarburton 1993; Higgins 1999).

There are no known records of the species roosting within the river red gum forests of Barmah–Millewa; however, the species has been recorded over the forests as shown in Figure 14.

The species was not recorded during targeted threatened species searches or diurnal bird counts undertaken as part of the ecological thinning trial. It is difficult to conduct systematic surveys due to the species mobility and ability to cover huge distances in a day (DoE 2013g).

Breeding

The species breeds in eastern Siberia, north-eastern China and Japan between May and July, before migrating to Australia for the non-breeding season.

Threats

There are apparently few threats to the species in Australia. It is known to impact overhead wires, windows, and lighthouses; however, this is rare, and only impacts a few individuals (DoE 2013g).

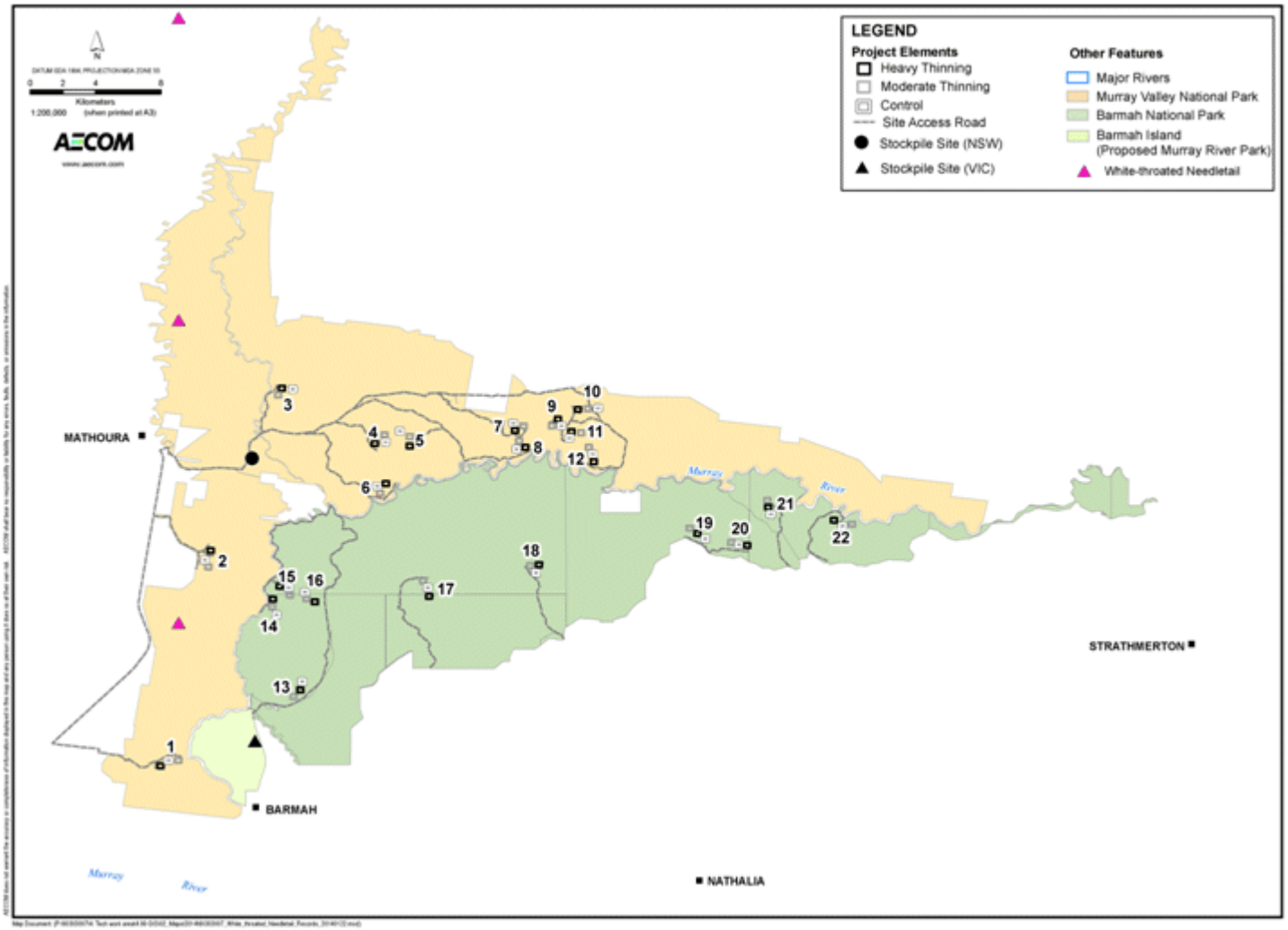

Figure 14: Locations where the white-throated needletail, *Hirundapus caudacutus*, has been recorded within the ecological thinning trial area.

4.3.8. Murray hardyhead *Craterocephalus fluviatilis*

The Murray hardyhead is listed as endangered under the EPBC Act.

Distribution

The Murray hardyhead is endemic to inland parts of south-eastern Australia where it was once widespread and abundant in the Murray and Murrumbidgee River systems of southern NSW and northern Victoria (NSW DPI 2005a). In NSW the species is thought to be locally extinct, having not been recorded for more than 30 years (FSC 2008) while in Victoria the species has been recorded from near Mildura (Raadick and Fairbrother 1999) and in the Swan Hill–Kerang district (Hardie 2000).

Habitat requirements

Murray hardyheads live along the edges of slow-flowing lowland rivers and in lakes, billabongs and backwaters. They are often found amongst aquatic weeds, in both freshwater and quite saline waters.

Breeding

Spawning occurs during the warmer months from October to February. The eggs are randomly dispersed amongst aquatic vegetation (NSW DPI 2005a).

Threats

The lack of water is a major threat to the remaining populations of the species. For suitable habitat that remains, increased salinity river regulation, high nutrient levels, and the impact of introduced aggressive fish species will continue to pose a threat (DPI 2005).

4.3.9. South-eastern long-eared bat *Nyctophilus corbeni*

The south-eastern long-eared bat is listed as vulnerable under the EPBC Act.

Distribution

The species is limited in its distribution in Australia to the Murray–Darling basin, where it is scattered and rarely recorded. It is distributed throughout inland NSW; however, there are limited records from Victoria. Records do indicate populations in the river red gum forests along the Murray River.

Habitat requirements

The species occurs in a range of inland woodland vegetation types, dominated by species such as river red gum, box ironbark, and cypress pine. These woodlands are often lining watercourses and lakes. The species is most common in vegetation types that support a distinct canopy, and a dense clustered shrub layer.

Breeding

Very little information is known of the species' reproductive biology.

Threats

A lack of data on the decline of the population makes the determination of threats to the species difficult. It is clear however that past tree clearing is likely to be a major factor in the decline. Habitat loss and fragmentation associated with agriculture, mining activities and forestry are the main reasons behind the decline in the quality and extent of habitat (DoE 2013h).

4.3.10. Koala *Phascolarctos cinereus* (combined populations of Qld, NSW and the ACT)

The combined koala populations of NSW, Queensland and the ACT are listed as vulnerable under the EPBC Act.

The koala is an arboreal marsupial with a stocky build, large round ears and sharp claws adapted for climbing. Their fur is silver to grey brown with variation in colouration based on population location (DoE 2013i).

Distribution

The koala was common and widespread in forests and woodlands along the east coast of Australia from northern Queensland to south-east Southern Australia. Its distribution is strongly linked to the presence and abundance of eucalypt (and some non-eucalypt) food plants (Krockenberger et al. 2012; OEH 2012f).

In NSW the koala mainly occurs on the central and north coasts, with some populations to the west of the Great Dividing Range (OEH 2012f). The status of the koala in the south west of NSW and northern Victoria is poorly known (DECC 2008c). In Victoria an active translocation program of chlamydia-free populations of koalas from French Island and Sandy Point was undertaken by the Victorian Department of Fisheries and Wildlife in parts of the Murray Valley, including Barmah State Park, Ulupna Island and near Cobram during the 1980s (I. Davidson pers. comm. 2013).

Translocations from Sandy Point (HMAS Cerberus Naval Base, Western Port) were initiated in 1985 to alleviate overbrowsing by the koala population which had expanded rapidly following its introduction from French Island in 1973 (Martin, unpublished). It is likely that all records of koalas in the Murray Valley upstream of Echuca are from these translocations as no credible sightings were known prior to 1985 (I. Davidson pers. comm. 2013). Such introduction efforts have been described as being undertaken to attempt to re-establish wild populations.

In NSW, scattered populations are known to occur along the Murray River. Koalas are most well-known from the Barooga area where they may be commonly encountered. Known records in the area extend along the Murray River to Tooleybuc (Swan Hill area) and along the Edward River approximately 10 kilometres north west of Moulamein.

Habitat requirements

Koalas have been recorded across their range to feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species (OEH 2012f). Where they occur along the Murray River, river red gum is considered a primary food tree species (DECC 2008c). The species of eucalypt and the

extent of tree cover are the most important habitat characteristics for the koala. Soil fertility and water regime may also be important (Krockenberger et al. 2012).

Breeding

Births occur between October and May each year, with female koalas producing a single offspring each year. The newly born koala remains in the pouch for 6–8 months before gaining independence from 12 months of age.

Threats

The main threats to the species are from continued fragmentation and degradation of habitat, the potential for vehicle strike, disease, and direct predation from domestic dogs. Incidences of prolonged drought and/or extreme heat are known to increase mortality. Degradation of habitat, increased predation, vehicle strike and disease are all artefacts of human influence on the habitat of the species.

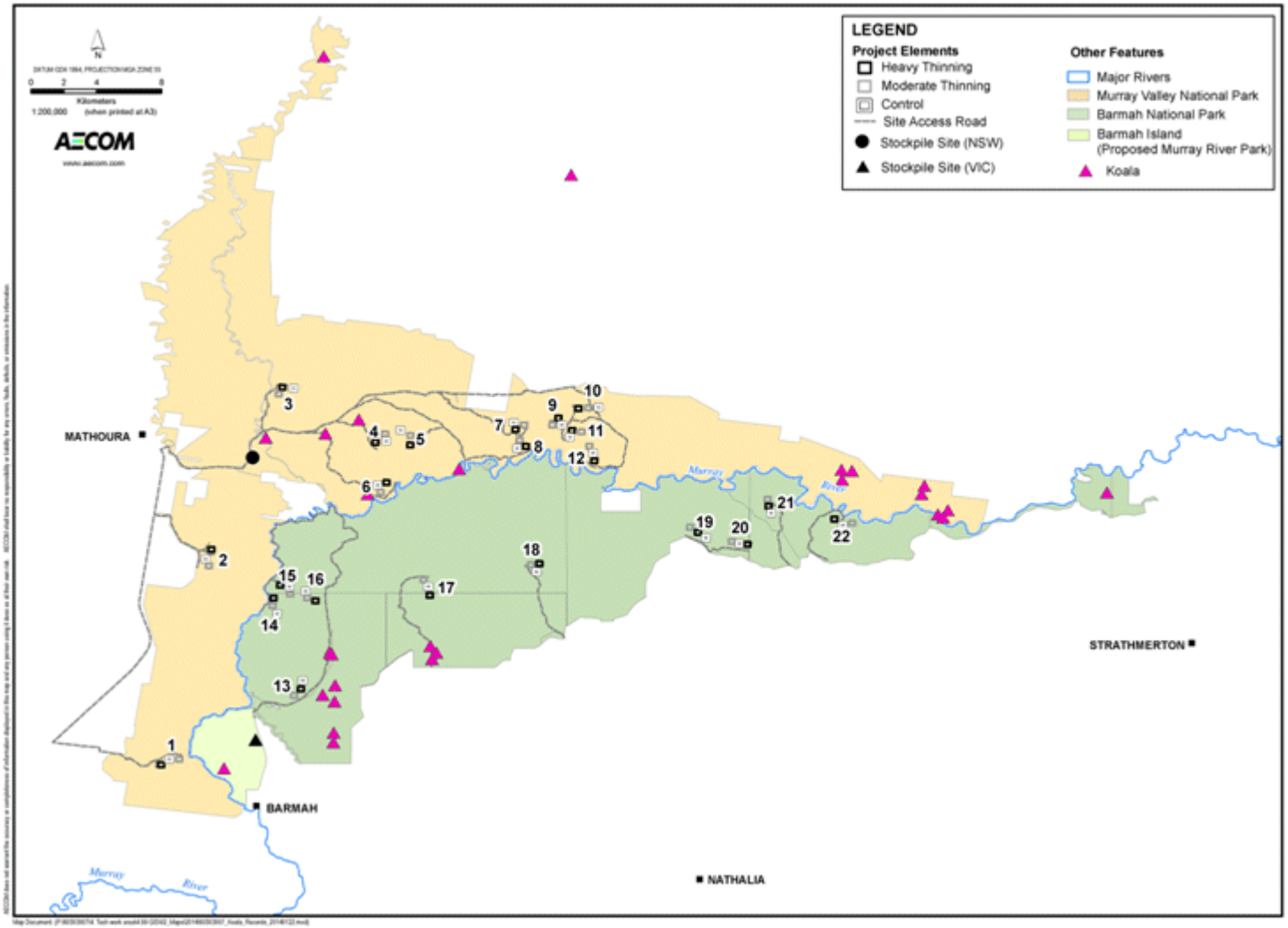

Figure 15: Locations where the koala, *Phascolarctos cinereus*, has been recorded within the ecological thinning trial area.

4.3.11. River swamp wallaby-grass *Amphibromus fluitans*

River swamp wallaby-grass is listed as vulnerable under the EPBC Act. It is an aquatic perennial grass growing to 120 centimetres high. The seed head (inflorescence) is commonly the only part of the plant above water level. Lead blade is rough to touch with deep ribs. The seed is two toothed with a straight bristle rising hallway up its back (DoE 2013j).

Distribution

River swamp wallaby-grass is found in southern NSW across the Murray catchment. Around the eastern parts of the catchment this species is recorded from lagoons beside the Murray River near Cooks Lagoon (Shire of Greater Hume), Mungabareena Reserve (part of the Murray river floodplain), in eastern Albury, at Ettamogah and at Charles Sturt University's campus at Thurgoona. Further west along the Murray River the species is known from Reed Beds Swamp near Mathoura (OEH 2012g).

The species is also known from Victoria and Tasmania (OEH 2012g). In northern Victoria numerous populations exist near the Murray River and its tributaries including the Ovens and Broken Rivers (TSSC 2008). There are 146 known locations from which this species has been recorded within Barmah–Millewa (Figure 16).

Habitat requirements

Habitats where river swamp wallaby-grass grows in south-western NSW include swamp margins in mud, dam and tank beds in hard clay and in semi-dry mud of lagoons with *Potamogeton* and *Chamaeraphis* species. This species needs wetlands which are periodically flooded to maintain wet conditions, at least moderately fertile and which have some bare ground. These conditions are produced by seasonally fluctuating water levels (OEH 2012g).

Threats

The main threats to the species result from expanding pastoral development, alterations to water regimes, and the invasion of habitat by exotic grasses and weeds. This species is also very palatable to stock, and also at risk of trampling as stock seek access to water sources (DoE 2013j).

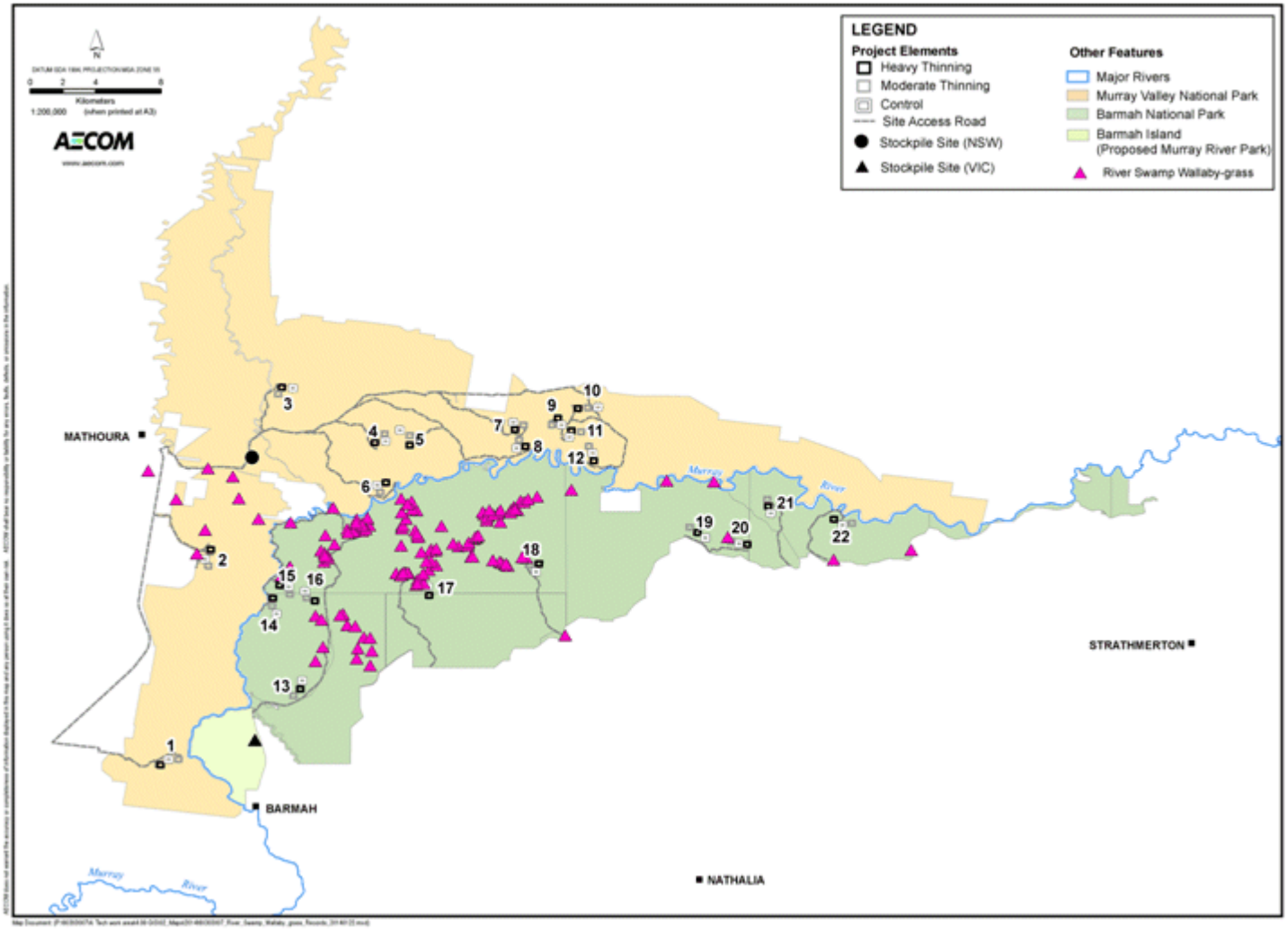

Figure 16: Locations where river swamp wallaby-grass, *Amphibromus fluitans*, has been recorded within the ecological thinning trial area.

4.3.12. Mueller daisy *Brachyscome muelleriodes*

The Mueller daisy is listed as vulnerable under the EPBC Act, listed as vulnerable under the NSW *Threatened Species Conservation Act 1995* and listed under the Victorian *Flora and Fauna Guarantee Act 1988*. Mueller daisy is a small annual herb commonly growing to 7 centimetres tall but sometimes as high as 20 centimetres. The species has several slender, grass-like leaves to 7 centimetres in length originating from the base of the stem. From September to November a singular daisy-like flower with white petals and a yellow centre is produced (Lucas 2010).

Distribution

In NSW the Mueller daisy formerly occurred along the Murrumbidgee River from Wagga Wagga and Narrandera and along the Murray where it is known from Tocumwal. Between these two rivers the species was also known from Walbundrie, on the Billabong Creek (OEH 2013b). Today it occurs in only a single known location near Morundah (Lucas 2010). In Victoria the species occurs only along the Murray River from near Tocumwal to the Ovens River.

In Barmah Forest the species was recorded in 1995 from Grinters Ridge where it was described to be abundant; however, at this time the population status at Tram Swamp and Hammys Plain were unknown. Previous to this, approximately 750 plants were recorded at Sandy Crossing in 1980, and the status of populations at Ulupna Island (1993) and Forcing Yards (1979) within Barmah forest were also unknown (Lucas 2010). There are three known locations from which this species has been recorded within the Barmah forest only. No records are currently known for this species from within Millewa Forest (Figure 17).

Targeted threatened species searches and floristic surveys associated with the proposed ecological thinning trial did not detect the species at any of the proposed plots.

Habitat requirements

Mueller daisy occurs in seasonally damp situation such as shallow depressions and around the margins of swamp, lagoons and claypans, on heavy cracking clays to lighter clay loam soils, in grassland, grassy woodland and open forest habitats (Lucas 2010). NSW populations of the Mueller daisy come from damp areas on the margins of claypans in moist grassland with *Pycnosorus globosus*, *Agrostis avenacea* and *Austrodanthonia duttoniana*. The species is also recorded from the margins of lagoons in mud or water, and in association with *Calotis anthemoides* (OEH 2013b). In comparison, Victorian collections have generally come from open positions on the Murray River floodplain, swampy river red gum forests and damp depressions, including from the Barmah forest (OEH 2013b).

Threats

Habitat degradation associated with agricultural activities is the major threat to the Mueller daisy. Grazing pressure, and restricted geographical distributions that encourages increased competition from invasive introduced species such as sowthistle, cat's ear, brome, and ryegrass are placing remaining populations at risk (DoE 2013k).

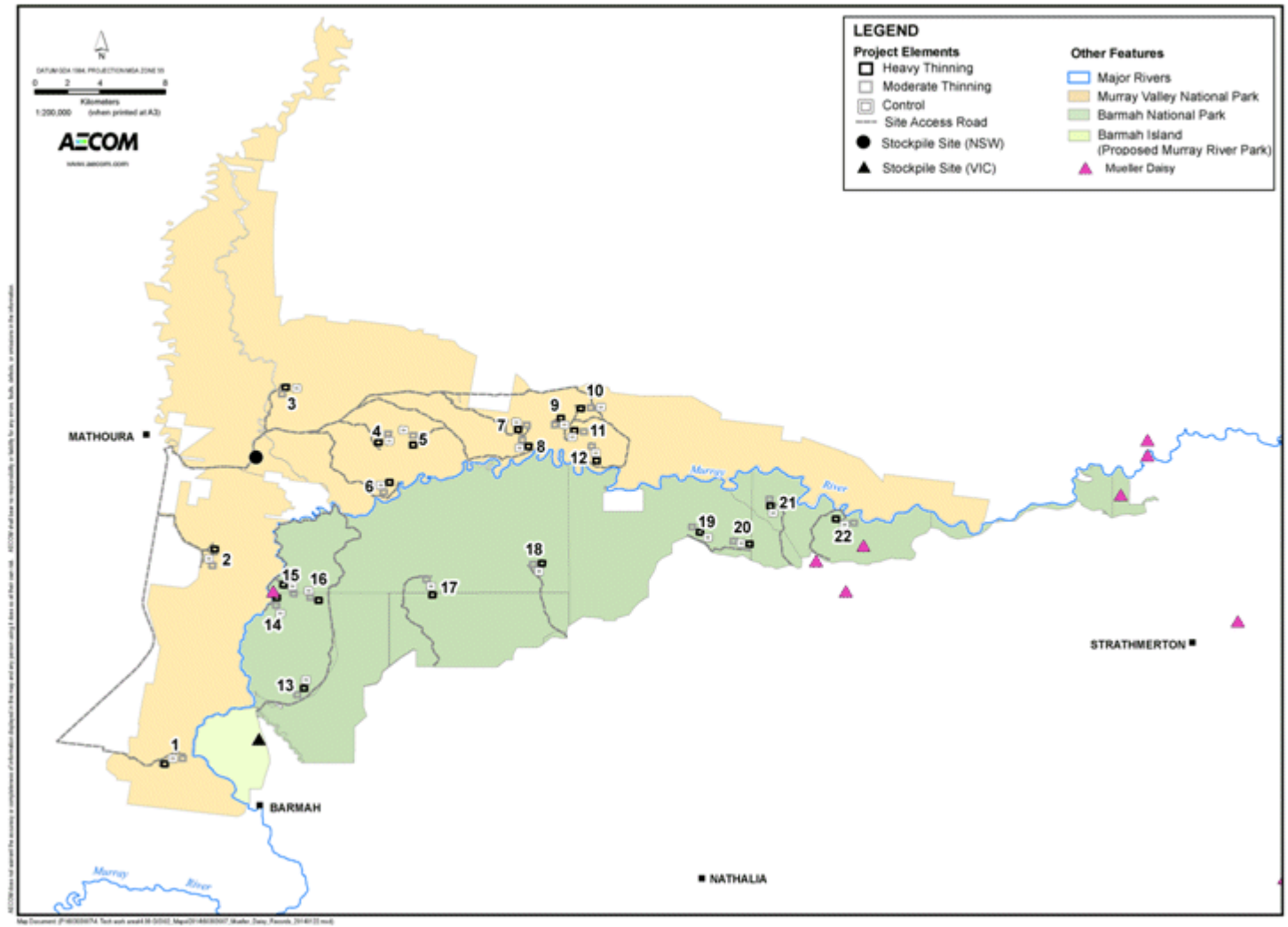

Figure 17: Locations where the Mueller daisy, *Brachyscome muelleriodes*, has been recorded within the ecological thinning trial area.

4.3.13. Grey box *Eucalyptus microcarpa* grassy woodlands and derived native grasslands of south-eastern Australia

Within Barmah–Millewa, stands of inland riverine grey box woodland are considered to be part of the EPBC Act-listed grey box *Eucalyptus microcarpa* grassy woodlands and derived native grasslands of south-eastern Australia, for which the recognised status is endangered (Figure 18).

This community predominantly occurs on the drier edge of the temperate grassy eucalypt woodland belt and ranges from central NSW through northern and central Victoria into South Australia. Patches that are disjunct from the main belt of the ecological community occur to the south of the Great Dividing Range in Victoria, around Melton and Sunbury to the west of Melbourne (Oates and Taranto 2001 in TSSC 2010), and also to the west of the Murray River coastal plain in South Australia, around the Flinders and Mount Lofty Ranges near Adelaide (Robertson 1998 in TSSC 2010). However, as found within the floodplain of the Murray River, the ecological community also occupies a complex position in the landscape, occurring within semi-arid floodplain communities (White et al. 2003 in TSSC 2010).

While this activity, and the treatment of proposed thinning plots, will be restricted to river red gum vegetation communities, access to a number of these sites is made via existing track networks which pass through this vegetation community.

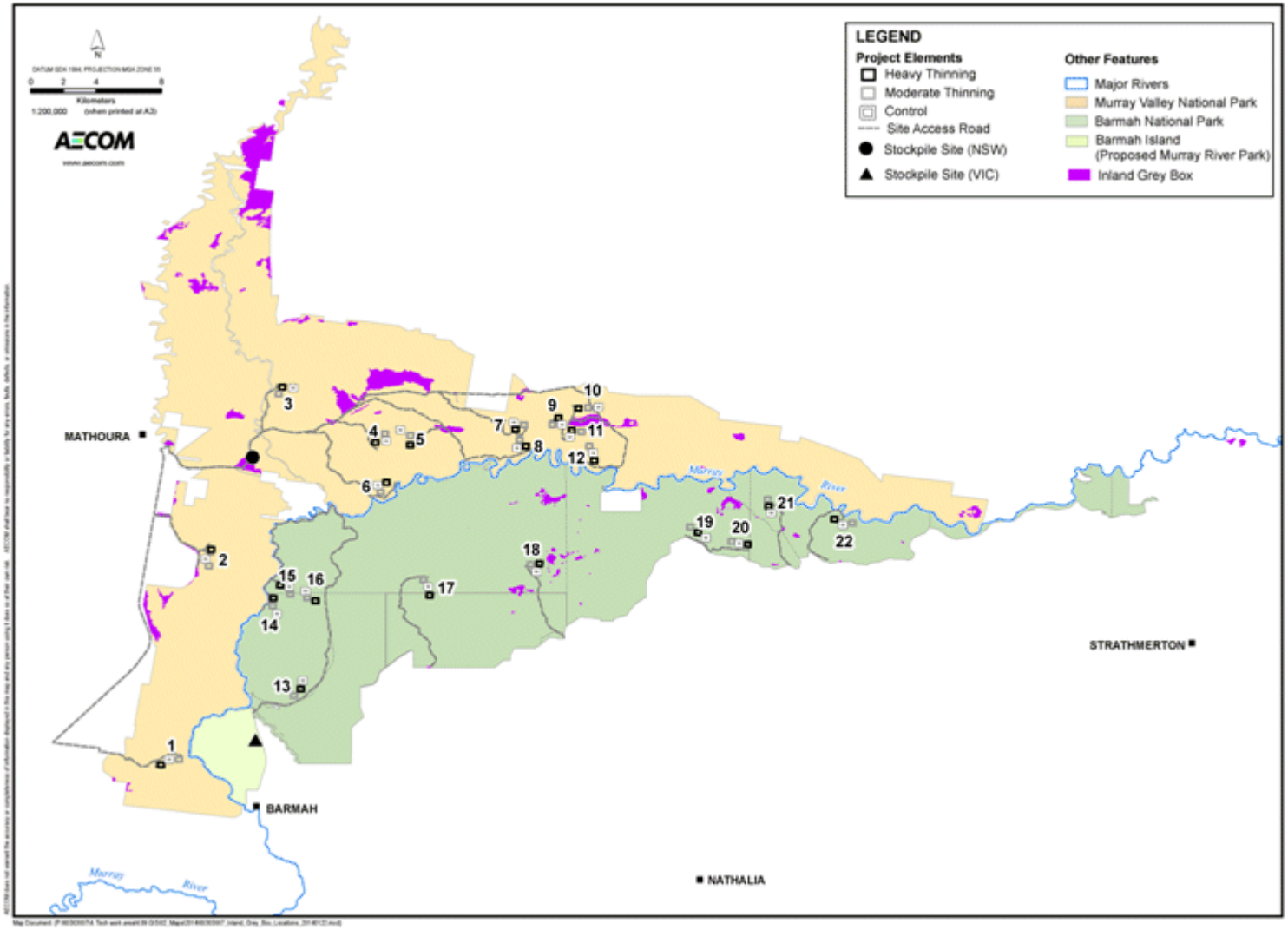

Figure 18: Occurrence of inland Riverina grey box woodland within the ecological thinning trial area

4.3.14. Ramsar Wetlands

Barmah Forest

The Barmah Forest Ramsar site is located on the Murray River floodplain in north Victoria (Figure 19). It is predominantly river red gum open forest and woodland and, along with the adjoining Millewa forest in NSW, forms the largest stand of river red gums in the world. It is also an icon site in The Living Murray program. It features alluvial fan-shaped deposits along the Murray River with ox-bows and meander scrolls as well as source-bordering dunes.

The majority of the forest functions as a single floodplain wetland system which is dependent on regular sustained seasonal flooding. The natural vegetation of the floodplain consists largely of river red gum communities along the major streams, anabranches and billabongs.

Defined wetlands and waterways within Barmah Forest vary from permanent lakes, billabongs and ponding effluents; through shallow basins with prolonged seasonal flooding. These support rushland or grassland communities in the wetter regions, through to gradational river red gum forest and woodland communities with a variety of vegetation understories.

Barmah Forest is an important site for river red gums, which in turn provides services such as sheltering and nesting habitat for a range of species including bats, parrots, possums, snakes, and waterbirds. The Ramsar site supports the most extensive area of moira grass plains in Victoria which are significant breeding and feeding habitat for herons, spoonbills and Whiskered Terns, large breeding colonies of Australian white ibis and straw-necked Ibis, as well as smaller colonies of egret species and spoonbill species.

This Ramsar wetland also contains many sites of cultural significance to Indigenous people, including occupation sites, burial grounds, mounds, middens, scarred trees and stone artefacts at many hundreds of sites. Barmah Forest is recognised for its cultural significance to the traditional owners of country.

NSW Central Murray Forests

The NSW Central Murray Forests Ramsar site covers approximately 84,000 hectares on the floodplain of the Murray River in south-central NSW (Figure 19). It is dominated by river red gum forest and woodland, wet grasslands and marshes, and also supports large areas of black box woodland, and sandhill communities.

Wetland habitats in the site support nationally and internationally significant populations of wetland birds and fish. The wetlands also support at least three species of mammal, seven species of frog, three species of freshwater turtle and numerous reptile taxa.

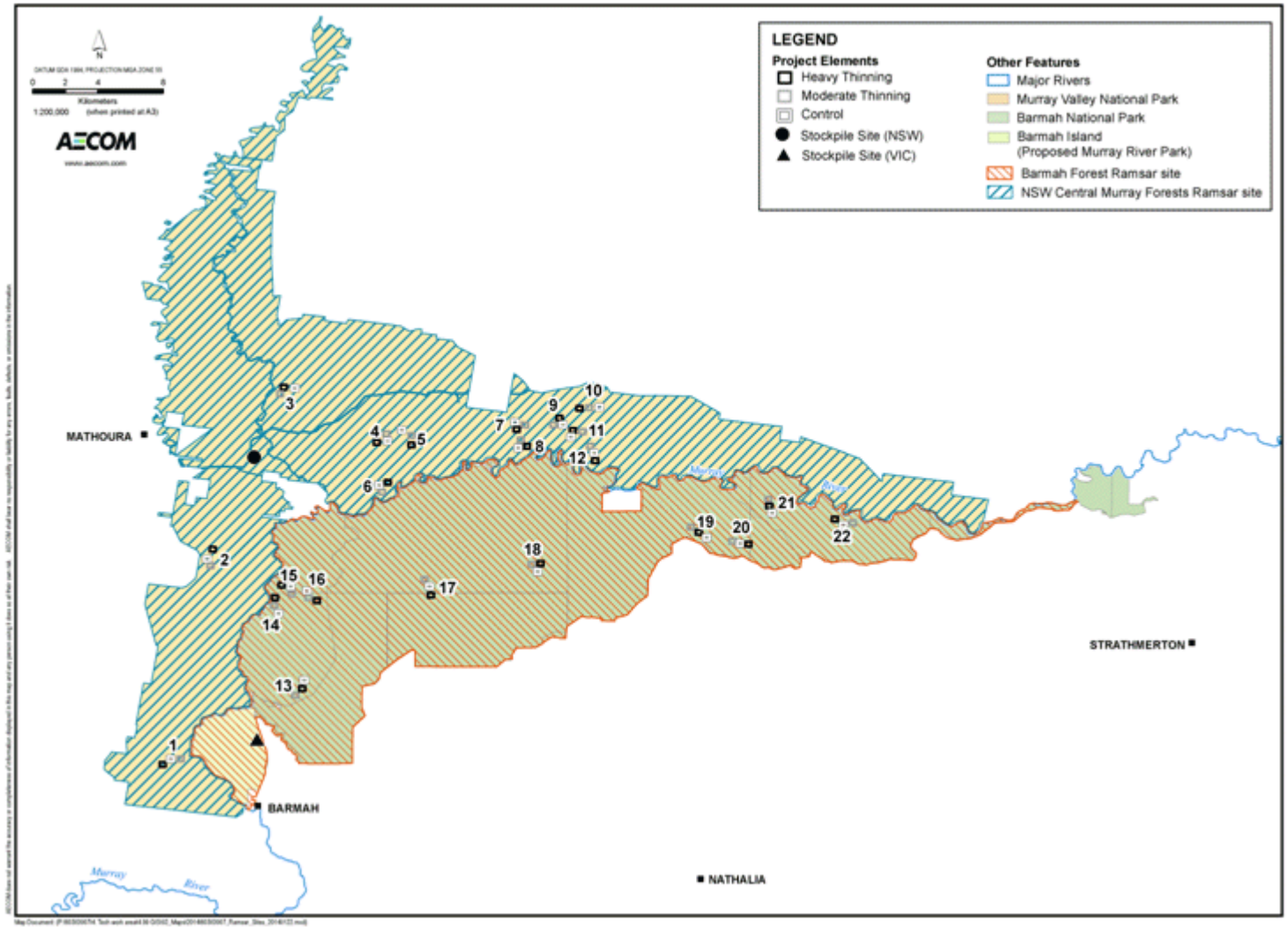

Figure 19: Extent of the Barmah Forest and NSW Central Murray State Forest Ramsar sites within the ecological thinning trial area.

Consistency with plans of management

Plans of management (POMs) are statutory documents that are required to be prepared in accordance with the *National Parks and Wildlife Act 1974* for parks in the NSW reserve system (e.g. Murray Valley National Park) and with *the National Parks Act 1975* for parks in the Victorian reserve system. Within NSW this responsibility falls to the National Parks and Wildlife Group of OEH, while in Victoria the Department of Environment and Primary Industries delegates the responsibility to Parks Victoria under agreement.

In NSW a POM must be prepared as soon as practicable after the reservation of the reserve. In the absence of a POM, management may be undertaken under a Statement of Interim Management Intent (SIMI) approved by a branch director or the deputy chief executive. In the case of the Murray Valley National Park (Millewa group), reserved in July 2010, management directions are currently guided through an approved SIMI.

The proposed ecological thinning trial is consistent with the SIMI (OEH 2012). In particular, to:

- establish an adaptive management approach for managing the reserves which can
  - take into account of past management practices and move to a different management regime
  - recognise important ecological values that are at risk
  - integrate vegetation and water management
  - develop appropriate management objectives for what is a largely modified ecosystem.
- trial ecological thinning as a biodiversity conservation tool for improving forest health and condition.

Similarly, a current POM has not been prepared for Barmah National Park since its reservation. In recognition of the connection which traditional owners (Yorta Yorta Aboriginal Corporation is the Registered Aboriginal Party) have with Barmah, there is an agreement to jointly manage some of the new river red gum parks in Victoria. In the absence of a POM, management actions within Barmah National Park are guided by the POM for Barmah State Park and Barmah State Forest (DCE 1992) and the Barmah Forest Ramsar Site, Strategic Management Plan (DSE 2003f).

Consistency with ecological character descriptions for Ramsar sites

The proposed ecological thinning trial must be consistent with the ecological character description (ECD) for the Ramsar sites. The Perricoota, Koondrook and Campbell's Island State Forests sections of the NSW Central Murray Forests Ramsar site continue to be managed with the harvesting of river red gum timber as its primary focus. In comparison, the Millewa forests are today managed under the primary management objective of conservation and protection.

The draft ECD for the Central Murray Forests Ramsar site (Harrington and Hale 2011) recognises the need for active management of the site to maintain ecological character during periods of low water or moisture availability, including silvicultural thinning of river red gum stands that are under moisture stress to allow remaining stems to survive and become healthier (Harrington and Hale 2011). This proposed ecological thinning trial is consistent

with the ECD and provides an opportunity to critically test this approach in an adaptive management framework.

The ECD for the Barmah Forest Ramsar site notes that the 'condition of the red gum forest is important', and that 'a change in ecological character for this service would be signalled by a decrease in area or decline in condition of the vegetation' (DSE 2008, p11). While the ECD does not specifically make reference to active management of the river red gum forests, the objectives of the proposed ecological thinning trial (as stated in Section 1.3 of this PER) to 'promote a diversity of habitats in the landscape for indigenous species' and 'prevent further decline in canopy condition', are consistent with the ECD's emphasis on river red gum forest condition.

4.4. World heritage and national heritage places

The EPBC Act protected matters search undertaken on 18 February 2012 identified no world heritage or national heritage places within Barmah–Millewa.

Aboriginal cultural heritage and European heritage matters will be addressed in accordance with relevant state requirements.

5. Risks and impacts on matters of national environmental significance

This section describes the expected impacts of the ecological thinning trial on *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)-listed matters of national environmental significance. It does this through a two-stage process:

- risk-based approach to identify and evaluate potential impact pathways, both prior to and post implementation of controls (management and mitigation measures), for those matters with a 'moderate' or 'high' likelihood of occurrence within the river red gum forests (refer to Section 4.3)
- where potential impact pathways present a 'medium', 'high' or 'very high' residual risk to an EPBC Act-listed matter of national environmental significance, the potential impact of the ecological thinning trial is then considered against the Commonwealth matters of national environmental significance included in the *Environment Protection and Biodiversity Conservation Act 1999*, Significant impact guidelines, 1.1 Significant impact guidelines – matters of national environmental significance (DEWHA 2009a).

The potential social and economic impacts of the ecological thinning trial are addressed in Section **Error! Reference source not found.**.

5.1. Risk-based evaluation

The *AS/NZ ISO 31000:2009 (ISO 31000) Risk Management – Principles and Guidelines* (Standards Australia / New Zealand, 2009) is the current standard which provides principles and generic guidelines for risk management. The key steps in the process are illustrated in Figure 20.

A risk assessment consistent with the principles of ISO 31000 has been conducted to inform the assessment of impacts on matters of national environmental significance impact assessment and development of mitigation measures for the proposed ecological thinning trial. This process is described in the following sections.

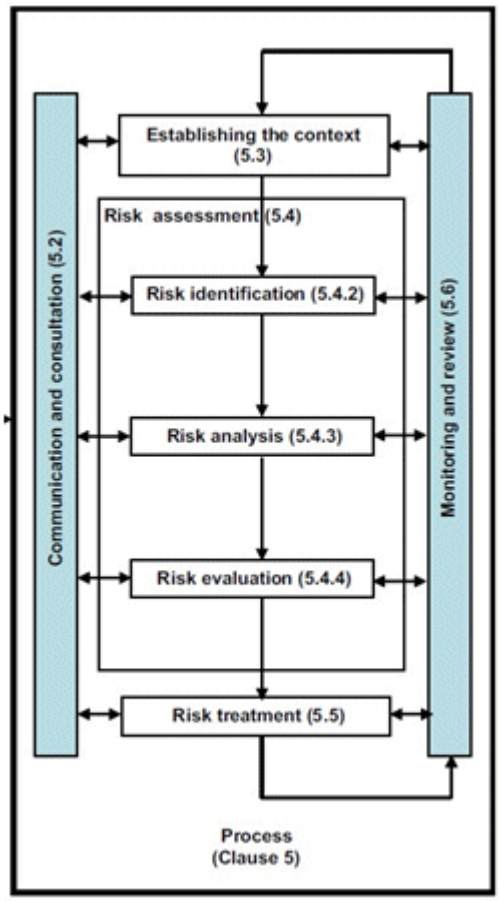

Figure 20: Risk management processes (Source AS/NZ ISO 31000:2009 Risk Management Principles and Guidelines).

5.1.1. Identification of potential impact pathways

The activities of the ecological thinning trial (described in Section 2) were considered in determining the potential impact pathways for EPBC Act-listed matters of national environmental significance.
A list of potential impact pathways was generated for each trial activity; examples are shown in Table 5.1 and the full listing was used in the risk assessment provided in Appendix 7.

This approach demonstrates that the potential impacts associated with trial activities are known and predictable.

Table 5.1: Examples of potential impact pathways.

Project phase	Project activity	Example potential impact pathway
Establishment	Maintenance of formal access roads	Potential spread of weeds and pathogens due to vehicle, equipment and/or pedestrian movement
Establishment	Establishment of natural surface tracks	Potential direct impact on species from removal of native vegetation
Establishment	Maintenance of stockpile sites	Potential impact on soil and/or

Project phase	Project activity	Example potential impact pathway
		waterways such as from vehicle or machinery spills
Treatment	Identification of trees for retention	Potential direct impact on species due to failure to identify habitat feature(s)
Treatment	Felling	Potential direct impact on species due to tree felling
Treatment	Transportation and storage of excess felled material	Potential direct impact on species from increased vehicle traffic
Site monitoring	Conduct flora and fauna survey	Potential direct impact on species and/or habitat, such as through trampling

5.1.2. Initial risk evaluation

As stated in ISO 31000, risk is a combination of:

- the likelihood of an event occurring
- the potential consequences of the event.

Risk evaluation for the proposed ecological thinning trial was conducted for EPBC Act-listed matters of national environmental significance identified in Section 4 as having a 'moderate' or greater likelihood of occurrence in the river red gum forests of Barmah–Millewa.

For each matter of national environmental significance, relevant potential impact pathways were assigned a likelihood of occurrence and a level of consequence in accordance with the guiding descriptors provided in Table 5.2 and Table 5.3. A risk common risk matrix (Table 5.4) was then applied to determine a risk rating for each potential impact. At this stage, the risk evaluation did not take into account any mitigation or control measures that may be applied as part of the proposed ecological thinning trial.

Through this approach, it was possible to identify the key matters of national environmental significance that may be impacted by the proposed ecological thinning trial, as well as the aspects of the trial that will need to be managed to reduce these impacts.

Table 5.2: Definitions of likelihood.

Qualitative description	Likelihood definition
Almost certain	Is expected to occur in most circumstances
Likely	Will probably occur in most circumstances
Possible	Could occur
Unlikely	Could occur but not expected
Rare	Occurs only in exceptional circumstances

Table 5.3: Consequence descriptors.

Negligible	Minor	Moderate	Major	Catastrophic
Change not detectable.	Detectable change without impact on viability.	Detectable change in and impact on viability that is significant at a local level.	Detectable change in and impact on viability that is significant at a regional level.	Detectable change in and impact on population viability that is significant at a state or commonwealth level.

Table 5.4: Risk matrix.

Likelihood	Consequence				
	Negligible	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost certain	Low	Medium	High	Very High	Very High
Likely	Low	Medium	High	High	Very High
Possible	Negligible	Low	Medium	High	High
Unlikely	Negligible	Low	Medium	Medium	High
Rare	Negligible	Negligible	Low	Medium	Medium

5.1.3. Consideration of mitigation/control measures

Following initial risk evaluation, mitigation and control measures were identified and documented for each potential impact pathway. Various types of mitigation measure were considered, including:

- avoidance through the site selection process
- minimisation through timing of the activities
- physical/engineering controls
- operational controls
- induction, training and awareness
- monitoring and measurement
- adaptive management and contingency protocols.

Measures identified through this process have been incorporated into the environmental management plan described in Section **Error! Reference source not found.**.

5.1.4. Residual risk evaluation

In order to confirm that risks to each matter of national environmental significance would be appropriately controlled, all risk ratings were re-evaluated taking into account the identified

controls (management and mitigation measures). The remaining risk following application of controls is termed ‘residual risk’.

5.1.5. Key risk assessment findings

The risk assessment is provided as Appendix 7. It addresses the 15 EPBC Act-listed matters of national environmental significance that have been determined to have a ‘moderate’ or ‘high’ likelihood of occurrence in the river red gum forests (refer to Section 4.3).

The risk assessment considers 716 potential impact pathways. The initial risk evaluation did not identify any ‘very high’ potential impact pathways; however, it did identify 20 ‘high’ and 189 ‘medium’ potential impact pathways.

Following the identified controls, management and mitigation measures, the residual risk evaluation did not identify any remaining ‘high’ potential impact pathways; however, it did identify 39 ‘medium’ potential impact pathways. A summary of the ‘medium’ residual risk impact pathways by EPBC Act-listed matters of national environmental significance is presented in Table 5.5.

The ‘medium’ residual risks (presented in Table 5.5) inform the impact assessment that follows in Section 5.2.

The risk assessment identified ‘felling’ (13 ‘medium’ residual risks) and ‘establishment of natural surface tracks’ (10 ‘medium’ residual risks) to be the highest risk activities with respect to potential impacts on EPBC Act-listed matters of national environmental significance. A summary of the number of ‘medium’ rated risks associated with each project phase and activity is presented in Figure 21.

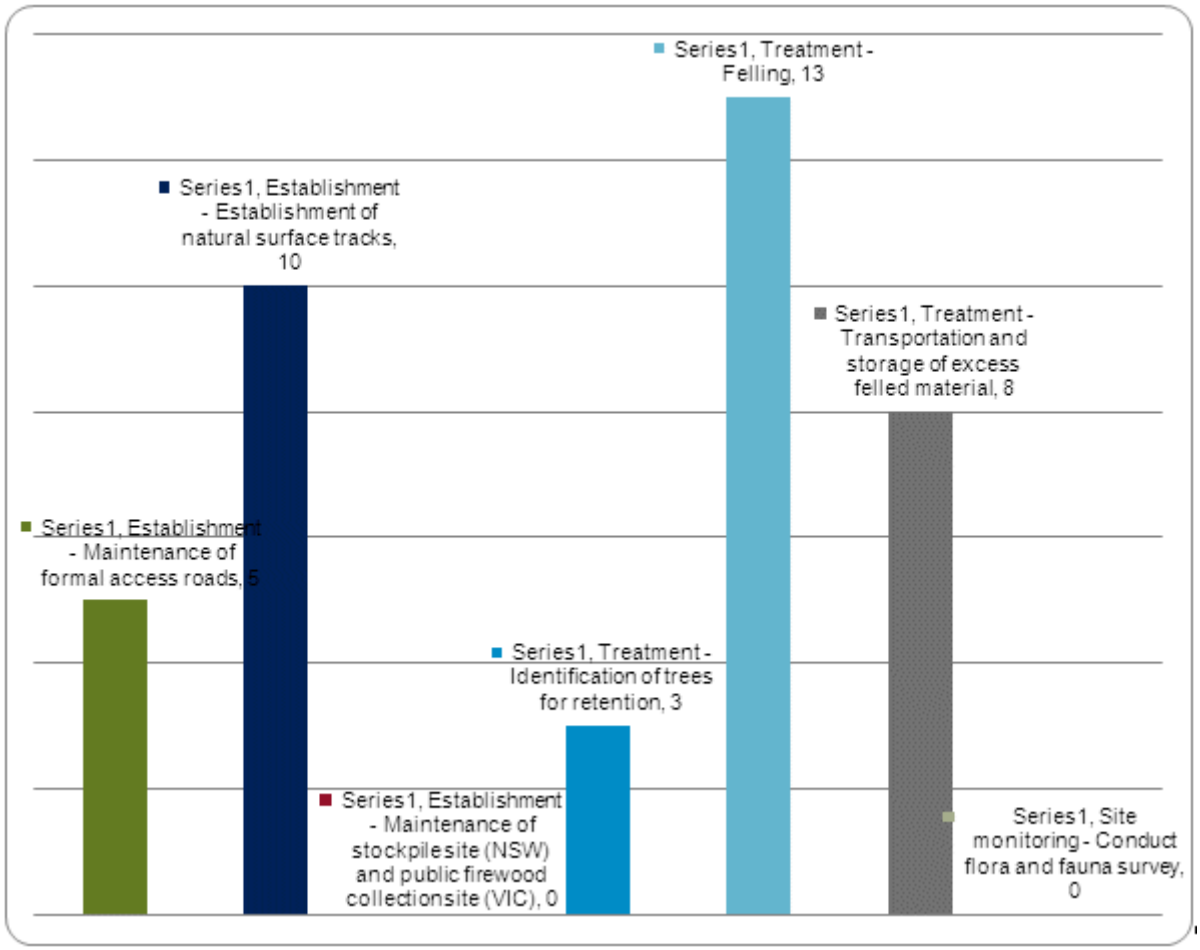

Figure 21: Number of residual risks rated 'medium' by project phase and activity.

Table 5.5: 'Medium' residual risk impact pathways by EPBC Act-listed matters of national environmental significance

Rainbow bee-eater *Merops ornatus*

Project phase	Project activity	Potential impact pathway
Treatment	Felling	Potential removal of, or damage to, known or previously unrecorded habitat feature(s)
Treatment	Transportation and storage of excess felled material	Potential removal of, or damage to, known or previously unrecorded habitat feature(s)

Superb parrot *Polytelis swainsonii*

Project phase	Project activity	Potential impact pathway
Establishment	Establishment of natural surface tracks	Potential removal of, or damage to, known or previously unrecorded habitat feature(s)
Treatment	Identification of trees for retention	Potential direct impact on species due to failure to identify habitat feature(s)
Treatment	Felling	Potential removal of, or damage to, known or previously unrecorded habitat feature(s)

South-eastern long-eared bat *Nyctophilus corbeni*

Project phase	Project activity	Potential impact pathway
Treatment	Identification of trees for retention	Potential direct impact on species due to failure to identify habitat feature(s)
Treatment	Felling	Potential removal of, or damage to, known or previously unrecorded habitat feature(s)

Koala *Phascolarctos cinereus*

Project phase	Project activity	Potential impact pathway
Establishment	Establishment of natural surface tracks	Potential removal of, or damage to, known or previously unrecorded habitat feature(s)
Treatment	Identification of trees for retention	Potential direct impact on species due to failure to identify habitat feature(s)
Treatment	Felling	Potential removal of, or damage to, known or previously unrecorded habitat feature(s)
Treatment	Felling	Potential direct impact on species due to tree felling
Treatment	Transportation and storage of excess felled material	Potential direct impact on species during coarse woody debris removal

River swamp wallaby-grass *Amphibromus fluitans*

Project phase	Project activity	Potential impact pathway
Establishment	Maintenance of formal access roads	Potential adverse water quality impact due to increased runoff/sedimentation
Establishment	Maintenance of formal access roads	Potential spread of weeds and pathogens due to vehicle, equipment and/or pedestrian movement
Establishment	Establishment of natural surface tracks	Potential adverse water quality impact due to increased runoff/sedimentation
Establishment	Establishment of natural surface tracks	Potential spread of weeds and pathogens due to vehicle, equipment and/or pedestrian movement
Treatment	Felling	Potential adverse water quality impact due to increased runoff/sedimentation
Treatment	Felling	Potential spread of weeds and pathogens due to vehicle, equipment and/or pedestrian movement
Treatment	Transportation and storage of excess felled material	Potential adverse water quality impact due to runoff/sedimentation on park access roads
Treatment	Transportation and storage of excess felled material	Potential spread of weeds and pathogens due to vehicle, equipment and/or pedestrian movement

Mueller daisy *Brachyscome muelleroides*

Project phase	Project activity	Potential impact pathway
Establishment	Maintenance of formal access roads	Potential spread of weeds and pathogens due to vehicle, equipment and/or pedestrian movement
Establishment	Establishment of natural	Potential removal of, or damage to, known or previously unrecorded

Project phase	Project activity	Potential impact pathway
	surface tracks	habitat feature(s)
Establishment	Establishment of natural surface tracks	Potential spread of weeds and pathogens due to vehicle, equipment and/or pedestrian movement
Treatment	Felling	Potential removal of, or damage to, known or previously unrecorded habitat feature(s)
Treatment	Felling	Potential spread of weeds and pathogens due to vehicle, equipment and/or pedestrian movement
Treatment	Transportation and storage of excess felled material	Potential removal of, or damage to, known or previously unrecorded habitat feature(s)
Treatment	Transportation and storage of excess felled material	Potential spread of weeds and pathogens due to vehicle, equipment and/or pedestrian movement

Grey box (*Eucalyptus microcarpa*) grassy woodlands and derived native grasslands of south-eastern Australia

Project phase	Project activity	Potential impact pathway
Establishment	Maintenance of formal access roads	Potential direct impact on the community from removal or damage
Establishment	Maintenance of formal access roads	Potential spread of weeds and pathogens due to vehicle, equipment and/or pedestrian movement
Treatment	Transportation and storage of excess felled material	Potential spread of weeds and pathogens due to vehicle, equipment and/or pedestrian movement

Barmah Forest Ramsar site

Project phase	Project activity	Potential impact pathway
Establishment	Establishment of natural surface tracks	Potential increase in edge effects and/or fragmentation due to removal of native vegetation
Establishment	Establishment of natural surface tracks	Potential spread of weeds and pathogens due to vehicle, equipment and/or pedestrian movement
Treatment	Felling	Potential impact on canopy connectivity due to removal of native vegetation
Treatment	Transportation and storage of excess felled material	Potential spread of weeds and pathogens due to vehicle, equipment and/or pedestrian movement

NSW Central Murray State Forest (Millewa Precinct) Ramsar site

Project phase	Project activity	Potential impact pathway
Establishment	Establishment of natural surface tracks	Potential increase in edge effects and/or fragmentation due to removal of native vegetation
Establishment	Establishment of natural surface tracks	Potential spread of weeds and pathogens due to vehicle, equipment and/or pedestrian movement
Treatment	Felling	Potential impact from damage to, or removal of, native vegetation
Treatment	Felling	Potential impact on canopy connectivity due to removal of native vegetation

Project phase	Project activity	Potential impact pathway
Treatment	Felling	Potential spread of weeds and pathogens due to vehicle, equipment and/or pedestrian movement

5.2. Impact assessment by matter of national environmental significance

This section considers the potential impact to EPBC Act-listed matters of national environmental significance where a 'medium' residual risk (refer to Table 5.5) was identified. It assesses impacts against the Commonwealth matters of national environmental significance included in the *Environment Protection and Biodiversity Conservation Act 1999*, Significant impact guidelines, 1.1 Significant impact guidelines – matters of national environmental significance (DEWHA 2009a).

Significant impact guidelines for each category are specifically:

- listed threatened species
- listed threatened ecological communities
- migratory species protected under international agreements
- wetlands of international important (listed under the Ramsar Convention).

According to the significant impact guidelines, an action will require approval by the Minister if the action has, will have, or is likely to have a significant impact on a EPBC Act-listed species in any of the following categories:

- extinct in the wild
- critically endangered
- endangered
- vulnerable.

The requirements of applicable national recovery plans have also been considered as part of the impact assessment.

5.2.1. Significant impact criteria for EPBC Act-listed species and communities

The EPBC Act significant impact guidelines provide specific criteria to be used in impact assessments for each category of listing.

Critically endangered or endangered EPBC Act-listed species

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of a population
- reduce the area of occupancy of the species
- fragment an existing population into two or more populations
- adversely affect habitat critical to the survival of a species
- disrupt the breeding cycle of a population
- modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

- result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat
- introduce disease that may cause the species to decline, or
- interfere with the recovery of the species.

An action is likely to have a significant impact on a critically endangered or endangered community if there is a real chance or possibility that it will:

- reduce the extent of an ecological community
- fragment or increase fragmentation of an ecological community
- adversely affect habitat critical to the survival of a species
- disrupt the breeding cycle of a population
- modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns
- cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting
- cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:
    - assisting invasive species, that are harmful to the listed ecological community, to become established, or
    - causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community
- interfere with the recovery of the ecological community.

What is a population of a species?

A 'population of a species' is defined under the EPBC Act as: an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable threatened species, occurrences include but are not limited to:

- a geographically distinct regional population, or collection of local populations, or
- a population, or collection of local populations, that occurs within a particular bioregion.

What is habitat critical to the survival of a species or ecological community?

'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
- to maintain genetic diversity and long term evolutionary development, or
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act.

Vulnerable EPBC Act-listed species

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of an important population of a species
- reduce the area of occupancy of an important population
- fragment an existing important population into two or more populations
- adversely affect habitat critical to the survival of a species
- disrupt the breeding cycle of an important population
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
- result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
- introduce disease that may cause the species to decline, or
- interfere substantially with the recovery of the species.

What is an important population of a species?

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- key source populations either for breeding or dispersal
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species range.

5.2.2. Assessment of potential significant impacts on EPBC Act-listed species

Following from the likelihood of presence and risk assessments in Section 4.2.3, the only EPBC Act-listed vulnerable species that the ecological thinning trial has the potential to impact are:

- superb parrot *Polytelis swainsonii*
- south-eastern long-eared bat *Nyctophilus corbeni*
- koala (combined populations of Qld, NSW and the ACT) *Phascolarctos cinereus*
- river swamp wallaby-grass *Amphibromus fluitans*
- Mueller daisy *Brachyscome muelleroides*.

Table 5.6 presents the assessment of significant impact to vulnerable EPBC Act-listed species.

Conclusion

Following from the assessment in Table 5.6, no significant impacts are predicted to occur to any EPBC Act-listed vulnerable species.

Table 5.6: Assessment of potential significant impact to vulnerable EPBC Act-listed species.

Criteria	Superb parrot	South-eastern long-eared bat	Koala	River swamp wallaby-grass	Mueller daisy
Possibility that the action would lead to a long-term decrease in the size of an important population of a species	Unlikely. Superb parrot is a breeding resident of the river red gum forests of Barmah–Millewa. The proposed ecological thinning trial will impact potential habitat trees during felling, but is aimed at improving the health of retained trees. The trial method has been specifically designed to avoid all existing hollow-bearing trees, which are important for superb parrot breeding. The trial will reduce some of the available food resources in the short term from trees within plots, but there will be limited impact on ground flora. The trial is not expected to lead to a reduction in the size of the superb parrot population in the short or long term.	Unlikely. Limited records exist in Victoria or NSW as it is cryptic and little research has been undertaken to fully understand the population biology or the species. It is understood that past tree clearing is likely to be a major factor in the decline of the species in association with habitat loss and fragmentation associated with agriculture, mining activities and forestry (DEH 2006j). While treatment phase activities may impact on individuals, given the small scale of the trial in the context of Barmah–Millewa (total treatment area is only 0.6% of the 66,000 ha), it is not expected to impact the population.	Unlikely. Where koalas occur along the Murray River, river red gum is considered a primary food tree species (DECC 2008c). The species of eucalypt and the extent of tree cover are the most important habitat characteristics for the koala. Ultimately the trial aims to test whether thinning improves the heath and condition of river red gum forests. Additionally, there is an abundant population of koalas on Ulupna Island, which is adjacent to Barmah National Park and upstream of the trial. The temporary disturbance of the trial and any unexpected mortalities of koalas are not expected to lead to the long-term decrease in the size of the koala population within Barmah–Millewa.	Surveys of the plot sites yielded no individuals of river swamp wallaby-grass. Furthermore, plots are not located in habitat of river swamp wallaby-grass, and no prior records exist within treatment plots. The activity may result in a short-term impact on the species; however, it is unlikely that any long-term disadvantage or threat to the occurrence or survival of any local populations will occur.	Surveys of the plot sites yielded no individuals of Mueller daisy. Sites are located away from the few known collection records in Barmah–Millewa. The total treatment area is only 0.6% of the 66,000 hectare Barmah–Millewa river red gum forests. So, considering the extent of the activity within the context of the wider unaffected forest area, the activity will not disproportionally affect native flora species, and impacts to ground layer species will be localised and likely to be short-term.
Possibility that the action would reduce the area of occupancy of an important population	The breeding population of the superb parrot along the Murray River mainly occurs between Cobram and Echuca in the south, north along the Edward River to Deniliquin, and is centred on the Barmah–Millewa (DSE 2003c). Disturbance in the trial plots will have minimal impact on superb parrot foraging areas/breeding habitat and will not impact the distribution or area of occupancy of the species.	The species is limited in its distribution in Australia to the Murray–Darling basin, where it is scattered and rarely recorded. It is distributed throughout inland NSW; however, there are limited records from Victoria. Records do indicate populations in the river red gum forests along the Murray River. The total treatment area is only 0.6% of the 66,000 hectare Barmah–Millewa river red gum forests, meaning the vast majority of the river red gum forests will remain unaltered, and as such the trial is not predicted	The koala population within Barmah–Millewa is not recognised as a: • key source population for breeding or dispersal • population that is necessary for maintaining genetic diversity, and/or • population that is near the limit of the species range. Given the scale of activities and the mobility of koalas, it is not expected that there will be any reduction in the area of occupancy.	Unlikely. No native flora species listed on the EPBC Act were detected during comprehensive pre-thinning floristic and threatened species surveys undertaken by OEH Scientific Services Division, National Parks and Wildlife Service and qualified ecologists. The total treatment area is only 0.6% of the 66,000 hectare Barmah–Millewa river red gum forests. So, considering the extent of the activity within the context of the wider unaffected	Unlikely. No native flora species listed on the EPBC Act were detected during comprehensive pre-thinning floristic and threatened species surveys undertaken by OEH Scientific Services Division, National Parks and Wildlife Service and qualified ecologists. The total treatment area is only 0.6% of the 66,000 hectare Barmah–Millewa river red gum forests. So, considering the extent of the

Criteria	Superb parrot	South-eastern long-eared bat	Koala	River swamp wallaby-grass	Mueller daisy
		to impact on the area of occupancy of south-eastern long-eared bat.		forest area, the activity will not disproportionally affect native flora species, and impacts to ground layer species will be localised and likely to be short-term. The activity will not reduce the area of occupancy of river swamp wallaby-grass.	activity within the context of the wider unaffected forest area, the activity will not disproportionally affect native flora species, and impacts to ground layer species will be localised and likely to be short-term. The activity will not reduce the area of occupancy of Mueller daisy.
Possibility that the action would fragment an existing important population into two or more populations	While it is acknowledged that the trial will impact on some nesting and foraging habitat, the activity will occur over 396 hectares (or 0.6%) with plots spread relatively evenly across the 66,000 hectare Barmah–Millewa river red gum forests. Treatment plots will be thinned to desired spacings between trees, causing some fragmentation on a very localised scale (i.e. 50– 100m). However, the plots will not be completely cleared of river red gum trees, and furthermore it is expected that the trial will generate improvements to river red gum crown health in the longer term, which would at least partially offset any localise fragmentation. Overall, the activity will maintain more than 99% of the Barmah–Millewa as undisturbed and as such is not considered to fragment the population of the species. Fauna species which may be negatively affected by the activity will be able	While it is acknowledged that the trial will impact on some nesting and foraging habitat, the activity will occur over 396 hectares (or 0.6%) with plots spread relatively evenly across the 66,000 hectare Barmah–Millewa river red gum forests. Treatment plots will be thinned to desired spacings between trees, causing some fragmentation on a very localised scale (i.e. 50– 100m). However, the plots will not be completely cleared of river red gum trees, and furthermore it is expected that the trial will generate improvements to river red gum crown health in the longer term, which would at least partially offset any localise fragmentation. Overall, the activity will maintain more than 99% of the Barmah–Millewa as undisturbed and as such is not considered to fragment the population of the species. Fauna species which may be negatively affected by the activity will be able to	While it is acknowledged that the trial will impact on some nesting and foraging habitat, the activity will occur over 396 hectares (or 0.6%) with plots spread relatively evenly across the 66,000 hectare Barmah–Millewa river red gum forests. Treatment plots will be thinned to desired spacings between trees, causing some fragmentation on a very localised scale (i.e. 50– 100m). However, the plots will not be completely cleared of river red gum trees, and furthermore it is expected that the trial will generate improvements to river red gum crown health in the longer term, which would at least partially offset any localise fragmentation. Overall, the activity will maintain more than 99% of the Barmah–Millewa as undisturbed and as such is not considered to fragment the population of the species. Fauna species which may be negatively affected by the activity will be able to find refuges from	As the trial sites are located outside the habitat requirements of river swamp wallaby-grass (although there are scattered records in the vicinity of some sites), the treatment plots are not considered likely to further fragment the population of river swamp wallaby-grass. There is the potential for site access roads and surface tracks to come in proximity with the habitat of river swamp wallaby-grass. However, riparian corridors will not be impacted on by this activity and buffers will be established to mitigate any potential impacts caused by this activity. Thus, again activities associated with roads and tracks are not considered likely to further fragment the population of river swamp wallaby-grass.	Unlikely. Given the temporary nature of the trial it is considered that an adequate soil seed bank will be retained across the sites to permit species to survive, reproduce and recolonise areas, in the unlikely event that a population is disturbed. Areas of retained vegetation (particularly understorey species) are adequate enough so that any flora species displaced by the activity will be able to regenerate either from seed reserves maintained within the soils of the disturbed sites, or from individuals nearby, growing in unaffected areas. Within the broader context of these forests, ecological thinning will not cause any long-term impacts on forest fragmentation or connectivity

Criteria	Superb parrot	South-eastern long-eared bat	Koala	River swamp wallaby-grass	Mueller daisy
	to find refuges from impacts within close proximity and over an extensive area.	find refuges from impacts within close proximity and over an extensive area.	impacts within close proximity and over an extensive area.		as the thinned plots will become part of the mosaic of vegetation structures and habitat types provided within the Barmah–Millewa.
Possibility that the action would adversely affect habitat critical to the survival of a species	Unlikely as both the species is present across a wider area based on the amount of available habitat in Barmah–Millewa. While it is acknowledged that the 'removal of river red gum forests is reducing the availability of suitable nesting hollows for the species' (DEH 2006g), the trial is only occurring in a small area and is designed to avoid important nesting habitat of the superb parrot. Similarly, by protecting all visible hollow-bearing trees, potential nest sites for the south-eastern long-eared bat will be protected. Typically disturbances of forest environments created through timber harvesting result in the reduced abundance of important resources that take a long time to develop (Vest et al. 2008). These include large, mature hollow-bearing trees and trees with large, spreading crowns. Other impacts on the hollow resource may include changes in spatial arrangement of hollow-bearing trees from a random to a clumped distribution, and the reduced recruitment of hollow-bearing trees through high rates of attrition of retained stems under some silvicultural systems (Gibbons	Unlikely as both the species is present across a wider area based on the amount of available habitat in Barmah–Millewa. While it is acknowledged that the 'removal of river red gum forests is reducing the availability of suitable nesting hollows for the species' (DEH 2006g), the trial is only occurring in a small area and is designed to avoid important nesting habitat of the superb parrot. Similarly, by protecting all visible hollow-bearing trees, potential nest sites for the south-eastern long-eared bat will be protected. Typically disturbances of forest environments created through timber harvesting result in the reduced abundance of important resources that take a long time to develop (Vest et al. 2008). These include large, mature hollow-bearing trees and trees with large, spreading crowns. Other impacts on the hollow resource may include changes in spatial arrangement of hollow-bearing trees from a random to a clumped distribution, and the reduced recruitment of hollow-bearing trees through high rates of attrition of retained stems under some silvicultural systems (Gibbons and Lindenmeyer 1997). Historical timber	No critical habitat has been declared under the EPBC Act or the NSW *Threatened Species Conservation Act 1995*. The trial will not adversely affect habitat critical to the survival of a species, because the trial design retains habitat trees.	Unlikely. River Swamp Wallaby-grass is found in southern NSW across the Murray catchment from lagoons beside the Murray River near Cooks Lagoon, Mungabareena Reserve, in eastern Albury, at Ettamogah and at Charles Sturt University's campus at Thurgoona. The species is also known from Victoria, and Tasmania (OEH 2012g). In northern Victoria numerous populations exist near the Murray River and its tributaries including the Ovens and Broken Rivers (TSSC 2008). There are 146 known locations from which this species has been recorded within Barmah–Millewa. The trial will not impact on habitat critical to the survival of the species.	Unlikely. In NSW the Mueller daisy formerly occurred along the Murrumbidgee River from Wagga Wagga and Narrandera and along the Murray where it is known from Tocumwal. Today it occurs in only a single known location near Morundah (Lucas 2010). In Victoria the species occurs only along the Murray River from near Tocumwal to the Ovens River. There are three known locations from which this species has been recorded within the Barmah forest only. No records are currently known for this species from within the Millewa forest. Targeted threatened species searches and floristic surveys associated with the proposed ecological thinning trial did not detect the species at any of the proposed plots. The trial will not impact on habitat critical to the survival of the species.

Criteria	Superb parrot	South-eastern long-eared bat	Koala	River swamp wallaby-grass	Mueller daisy
	and Lindenmeyer 1997). Historical timber harvesting within the river red gum forests has led to an overall reduction in the number of hollow-bearing trees in many parts of the Barmah–Millewa. Thomson et al (2011) found there was a relationship between hollow size and tree diameter for river red gum forests at Barmah and that stand structure could be managed by thinning to enhance this. Similarly Water Technology (2012) found that the majority of hollow-bearing trees in river red gum forest plots had a DBH >50 cm and that the thinning methods examined would potentially stimulate further hollow development. Thus, it is hypothesised that the trial will result in an increase in hollow-bearing trees.	harvesting within the river red gum forests has led to an overall reduction in the number of hollow-bearing trees in many parts of the Barmah–Millewa. Thomson et al (2011) found there was a relationship between hollow size and tree diameter for river red gum forests at Barmah and that stand structure could be managed by thinning to enhance this. Similarly Water Technology (2012) found that the majority of hollow-bearing trees in river red gum forest plots had a DBH >50 cm and that the thinning methods examined would potentially stimulate further hollow development. Thus, it is hypothesised that the trial will result in an increase in hollow-bearing trees.			
Possibility that the action would disrupt the breeding cycle of an important population	The proposed timing of the ecological thinning trial means the activity would be undertaken during autumn and winter, after the critical spring-summer breeding season has passed. Staging of the treatment phase will occur such that sites which are closest to, or have higher risk of disturbing individuals, will be prioritised. Where site conditions require a delay to treatment activities, components of the treatment phase may be deferred until after the superb parrot	Very little information is known of the species' reproductive biology and as such there is the potential that the trial may disrupt the breeding cycles of any individuals occurring within plots. Given that the species has not been recently recorded in Barmah–Millewa, as well as the small area within which the treatment is occurring in the context of the river red gum forests, any residual impact on breeding is not considered significant.	Births occur between October and May each year, with female koalas producing a single offspring. The newly born koala remains in the pouch for 6-8 months before gaining independence from 12 months of age. The trial is planned to occur in autumn and winter, and thus may impact the koala at the end of the breeding cycle. Prior to felling all trees will be inspected for the presence of the koala. Once begun, noise and movement associated with felling activities are likely to ward-off any lone koalas from entering the plots. It is recognised that some disturbance	Not relevant as the trial will avoid the habitat of river swamp wallaby-grass. There is the potential spread of weeds and pathogens due to vehicle, equipment and/or pedestrian movement and water quality impact due to increased runoff/sedimentation. However, working under appropriate conditions, providing appropriate buffers and the implementation of weed and pathogen hygiene protocols is expected to mitigate any impacts to sexual reproduction of both river swamp	Not relevant as the trial will avoid the three known sites of Mueller daisy within the Barmah Forest. There is the potential spread of weeds and pathogens due to vehicle, equipment and/or pedestrian movement, as well as reduced water quality due to increased runoff/sedimentation. However, working under appropriate conditions, providing appropriate buffers and the implementation of weed and pathogen hygiene

Criteria	Superb parrot	South-eastern long-eared bat	Koala	River swamp wallaby-grass	Mueller daisy
	breeding season. Any displaced native fauna are likely to find alternative habitat immediately adjacent to treatment plots, providing undisturbed potential breeding habitat for those species for which a late breeding event may occur.		may occur but that this will occur within a small area of the forest and with sufficient safeguards such that breeding of koala within the forest will not be significantly impacted.	wallaby-grass and Mueller daisy.	protocols is expected to mitigate any impacts to sexual reproduction of both river swamp wallaby-grass and Mueller daisy.
Possibility that the action would modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Unlikely. It is acknowledged that the activity will modify and destroy some habitat for both species. It is acknowledged that the 'removal of river red gum forests is reducing the availability of suitable nesting hollows for the species' (DEH 2006g); however, the aim of the trial is to investigate whether improved ecological outcomes (river red gum canopy quality and persistence) can result through thinning. Both species are present across a wide area and have significant available habitat in Barmah–Millewa. The trial will have a relatively small footprint in the context of the entire Barmah–Millewa, and the treatment design includes retention of important nesting habitat areas. As such nether species are considered likely to decline as a result of the trial.	Unlikely. It is acknowledged that the activity will modify and destroy some habitat for both species. It is acknowledged that the 'removal of river red gum forests is reducing the availability of suitable nesting hollows for the species' (DEH 2006g); however, the aim of the trial is to investigate whether improved ecological outcomes (river red gum canopy quality and persistence) can result through thinning. Both species are present across a wide area and have significant available habitat in Barmah–Millewa. The trial will have a relatively small footprint in the context of the entire Barmah–Millewa, and the treatment design includes retention of important nesting habitat areas. As such nether species are considered likely to decline as a result of the trial.	Treatment phase activities will remove some smaller river red gum trees within treatment plots. Koalas have been recorded across their range to feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species (OEH 2012f). They are mobile animals and will walk or swim to find appropriate food trees. The trial is not expected to isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	Unlikely. The trial will avoid the habitat of river swamp wallaby-grass. There is the potential spread of weeds and pathogens due to vehicle, equipment and/or pedestrian movement and water quality impact due to increased runoff/sedimentation. However, working under appropriate conditions, providing appropriate buffers and the implementation of weed and pathogen hygiene protocols is expected to mitigate any impacts to sexual reproduction of both river swamp wallaby-grass and Mueller daisy.	Unlikely. The trial will avoid the three known sites of Mueller daisy within the Barmah Forest. There is the potential spread of weeds and pathogens due to vehicle, equipment and/or pedestrian movement and water quality impact due to increased runoff/sedimentation. However, working under appropriate conditions, providing appropriate buffers and the implementation of weed and pathogen hygiene protocols is expected to mitigate any impacts to sexual reproduction of both river swamp wallaby-grass and Mueller daisy.
Possibility that the action would result in invasive species that are harmful to a vulnerable species	Unlikely. While there is some potential for vehicle, equipment and/or pedestrian movement to increase the spread of weeds, the trial will implement weed and pathogen management protocols. Other existing park management	Highly unlikely that the trial will result in the spread of an invasive species relevant to the south-eastern long-eared bat.	Highly unlikely that the trial will result in the spread of an invasive species relevant to the koala. Dogs are known to predate on koalas; however, the trial is not expected to have any material impact on dog numbers within Barmah–Millewa.	Unlikely. While there is some potential for vehicle, equipment and/or pedestrian movement to increase the spread of weeds, the trial will implement weed and pathogen management protocols. Other existing park management	Unlikely. While there is some potential for vehicle, equipment and/or pedestrian movement to increase the spread of weeds, the trial will implement weed and pathogen management

Criteria	Superb parrot	South-eastern long-eared bat	Koala	River swamp wallaby-grass	Mueller daisy
becoming established in the vulnerable species' habitat	practices are also in place to manage invasive species.			practices are also in place to manage invasive species. Appropriate buffers will result in the avoidance of activities that could transport weeds into the habitat of River Swamp Wallaby-grass.	protocols. Other existing park management practices are also in place to manage invasive species.
Possibility that the action would introduce disease that may cause the species to decline	Unlikely. While there is some potential for vehicle, equipment and/or pedestrian movement to increase the spread of diseases and pathogens, the trial will implement weed and pathogen management protocols. Other existing park management practices are also in place to manage spread of diseases.	Highly unlikely that the trial will result in the spread of a disease relevant to the south-eastern long-eared bat. In addition, the trial will implement a weed and pathogen management protocol.	Highly unlikely that the trial will result in the spread of a disease relevant to the koala. In addition, the trial will implement a weed and pathogen management protocol.	Unlikely. While there is some potential for vehicle, equipment and/or pedestrian movement to increase the spread of diseases and pathogens, the trial will implement weed and pathogen management protocols. Other existing park management practices are also in place to manage spread of diseases.	Unlikely. While there is some potential for vehicle, equipment and/or pedestrian movement to increase the spread of diseases and pathogens, the trial will implement weed and pathogen management protocols. Other existing park management practices are also in place to manage spread of diseases.
Possibility that the action would interfere substantially with the recovery of the species	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely

5.2.3. Assessment of potential significant impacts on EPBC Act-listed ecological communities

Following from the likelihood of presence and risk assessments, the only EPBC Act-listed ecological community that the ecological thinning trial has the potential to impact is the endangered grey box (*Eucalyptus microcarpa*) grassy woodlands and derived native grasslands of south-eastern Australia. Table 5.7 presents an assessment of significant impact for this community.

Table 5.7: Assessment of potential significant impact to EPBC Act-listed ecological communities.

Criteria – 'Possibility that the action would...'	**Grey box (*Eucalyptus microcarpa*) grassy woodlands and derived native grasslands of south-eastern Australia**
Reduce the extent of an ecological community	Plot locations have only been selected within river red gum forests and thus avoid this community. Some transport routes pass through this community but no removal of any grey box trees will occur and transport routes are not expected to reduce the area or geographic distribution of the community.
Fragment or increase fragmentation of an ecological community	The distribution of the community is naturally fragmented within the Barmah–Millewa floodplain (refer to Figure 18). Transport routes already exist within the forest but may require some additional maintenance, such as pruning of overhanging branches. Maintenance activities will not occur within recognised grey box woodlands and any limited amount of tree pruning or removal of groundcover is not expected to further fragment the community.
Adversely affect habitat critical to the survival of a species	No measurable impacts on the condition of grey box (*E. microcarpa*) grassy woodlands and derived native grasslands of south-eastern Australia are expected as a result of the trial.
Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns	Neither the trial plots nor the transport routes are expected to have any measurable impact on abiotic factors present within the community.

Criteria – 'Possibility that the action would...'	Grey box (*Eucalyptus microcarpa*) grassy woodlands and derived native grasslands of south-eastern Australia
Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting	No 'harvesting' or planned removal of species will occur within this community. As discussed there may be some maintenance of transport routes that has the potential to temporarily remove groundcover or small regrowth. No change in species composition is expected within this community.
Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: • assisting invasive species, that are harmful to the listed ecological community, to become established, or • causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community	No impact on quality is expected. The greatest risk to the Community is associated with the transport and distribution of weeds. Associated haulage of excess timber (once the target 45 tonnes per hectare coarse woody debris is reached) will travel along existing road infrastructure within both Barmah and Millewa and will pass through small areas of the ecological community. Weeds may be transported through this process. Thus, weed and pathogen hygiene protocols will be put in place to control the spread of weeds.
Interfere with the recovery of the ecological community.	The trial is not expected to interfere with the recovery of the community or any species within it.

Conclusion

No significant impacts to grey box (*E. microcarpa*) grassy woodlands and derived native grasslands of south-eastern Australia are predicted from the ecological thinning trial based on the current project description and site survey results.

5.2.4. Assessment of potential significant impacts on migratory fauna

Following from the likelihood of presence and risk assessments, the only EPBC Act-listed migratory species that the ecological thinning trial has the potential to impact is the rainbow bee-eater (*Merops ornatus*).

The *Significant Impact Guidelines for 36 Migratory Shorebird Species (EPBC Act Policy Statement 3.21 – DEWHA 2009b)* has been developed recently in light of the specific Australian conditions for shorebirds and the potential for the international criteria to provide insufficient protection for migratory shorebirds in Australia. Under these draft guidelines a site must support:

- at least 0.1 per cent of the fly-way population of a single species, or

- at least 2000 migratory shorebirds, or
- at least 15 shorebird species.

However, the rainbow bee-eater is not covered by the above-mentioned document.

The rainbow bee-eater does breed in Australia. The breeding season extends from August to January. The nest is located within an enlarged chamber at the end of a long burrow or tunnel that is excavated into flat or sloping ground in the banks of rivers, creeks and dams and in roadside cuttings etc. Eggs are laid onto bare ground in clutches of between two and eight and are incubated by both sexes.

Southern populations of rainbow bee-eater move north during winter and migrate back south during the spring summer months. The species is widespread throughout Australia and the Barmah–Millewa region. The species is known to thrive in a wide variety of habitats which is reflected in the national and international distribution. Given that <1 per cent of habitat will be impacted by the ecological thinning trial, significant impacts to the rainbow bee-eater are not predicted to occur.

Conclusion

No significant impacts are predicted to occur to any EPBC Act-listed migratory species.

5.2.5. Assessment of potential significant impacts on Ramsar wetlands

Following from the likelihood of presence and risk assessments, the only wetlands listed under the Ramsar convention for internationally significant wetlands that the ecological thinning trial has the potential to impact are:

- Barmah Forest Ramsar Site
- NSW Central Murray Forests Ramsar Site.

Assessments of significant impact for these sites are presented in Table 5.8 and Table 5.9.

Conclusion

Based on the assessments in Table 5.8 and Table 5.9, no significant impacts are predicted to occur to any Ramsar sites as a result of the proposed ecological thinning trial.

Table 5.8: Assessment of potential significant impact on Barmah Forest Ramsar Wetland (Ecological Character Description from Hale and Butcher 2011).

Barmah Forest Ramsar site ecological character description (critical components, processes and services)	Significant impact criteria	Assessment of significant impact
Hydrology Inundation of the site is driven largely by flows within the Murray River. The hydrology of the site is highly regulated and seasonality of low and moderate flow is determined largely by irrigation needs. Large scale floods that inundate the forest are generally the result of catchment scale rainfall events. Groundwater may be important for maintaining tree health but remains a knowledge gap.	A substantial and measurable change in the hydrological regime of the wetland, for example, a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the defined wetland.	No measurable impacts to the hydrology of the Barmah Forest Ramsar Site are expected. Activities undertaken as part of the trial will not affect the volume, timing, duration or frequency of ground and surface water flows to and within the defined wetland.
Hydrology Inundation of the site is driven largely by flows within the Murray River. The hydrology of the site is highly regulated and seasonality of low and moderate flow is determined largely by irrigation needs. Large scale floods that inundate the forest are generally the result of catchment scale rainfall events. Groundwater may be important for maintaining tree health but remains a knowledge gap.	A substantial and measurable change in the water quality of the wetland – for example, a substantial change in the level of salinity, pollutants, or nutrients in the wetland, or water temperature which may adversely impact on biodiversity, ecological integrity, social amenity or human health,	No substantial and measurable changes expected as a result of trial activities. A number of management measures are in place: • Establishment or treatment activities will not be undertaken during or immediately after rainfall events, or where floodwater has encroached into a site. • A minimum 50-metre protection buffer from mapped waterways will be maintained. Additionally, a 20-metre protection buffer will be established around unmapped drainage lines where possible. • All plant and equipment will be maintained to limit risk of accidental spills. All refuelling will occur in designated bunded areas. Spill kits will be available in all vehicles and machinery involved in the Project, including mobile refuelling vehicles. Any spills, will be reported to the Implementation Coordinator. In the event of any spills, contaminated soils will be removed and disposed of in a manner consistent with relevant legislation. • All personnel must complete a project induction prior to commencing work on site, which will include information on waterway protective buffers.

Barmah Forest Ramsar site ecological character description (critical components, processes and services)	Significant impact criteria	Assessment of significant impact
Vegetation The two critical wetland vegetation categories are: river red gum forests and floodplain marshes. Approximately 85 per cent of the site is covered in inundation dependent river red gum woodland and black box woodland. River red gum forest is the dominant vegetation community, comprising 75 per cent of the site. Floodplain marshes include moira grass (*Pseudoraphis spinescens*) plains, giant rush (*Juncus ingens*) beds, common reed (*Phragmites australis*) beds, moist grasslands, herblands and semi-permanent marshes. The wetland supports two nationally threatened wetland flora species: Mueller daisy and river swamp wallaby-grass	Areas of the wetland being destroyed or substantially modified.	The trial is not expected to significantly reduce the area of river red gum within the Barmah Forest Ramsar Site. The treatment area for this trial constitutes 0.6 per cent of the total area of these forests. Given the limited extent of trial activity, it is unlikely to have a disproportionate effect on native flora. Sites will be located greater than 100 metres from the nearest road to minimise disturbance effects and near fire trails to minimise the need for the establishment of natural surface tracks. Vehicles will keep to formal access roads in accordance with existing park management practices and be of an appropriate size so that widening of the roads will not be required. Given the temporary nature of the trial, an adequate soil seed bank will be retained across the selected sites to permit species to survive, reproduce and recolonise areas. The trial is unlikely to cause any long term impacts on forest fragmentation or connectivity.
Vegetation The two critical wetland vegetation categories are: river red gum forests and floodplain marshes. Approximately 85 per cent of the site is covered in inundation dependent river red gum woodland and black box woodland. River red gum forest is the dominant vegetation community, comprising 75 per cent of the site. Floodplain marshes include moira grass (*Pseudoraphis spinescens*) plains, giant rush (*Juncus ingens*) beds, common reed (*Phragmites australis*) beds, moist grasslands, herblands and semi-permanent marshes. The wetland supports two nationally threatened wetland flora species: Mueller daisy and river swamp wallaby-grass	An invasive species that is harmful to the ecological character of the wetland being established (or an existing invasive species being spread) in the wetland.	It is unlikely that the trial will lead to the establishment or spread of invasive species in a way that could harm the ecological character of the wetlands. A weed and pathogen hygiene protocol will apply to all vehicles, equipment and personnel. All vehicles will be cleaned using high-pressure water or compressed air prior to entering the national parks, significantly reducing the likelihood that invasive species and/or disease will be introduced to the Ramsar site. Further, site selection avoided known occurrences of listed species, including Mueller daisy and river swamp wallaby-grass. Surveys of the plot sites yielded no individuals of these species. Treatment and control plots are located away from these species' habitat and are not located in or within 50 metres of, established wetlands.

Barmah Forest Ramsar site ecological character description (critical components, processes and services)	Significant impact criteria	Assessment of significant impact
Fish 17 native species of fish have been recorded from within the site. Results from surveys indicate that abundance varies considerably and that invasive species generally comprise 10 to 30 per cent of the total abundance and up to 70 per cent of biomass. Supports three native threatened fish species: silver perch (*Bidyanus bidyanus*), Murray cod (*Maccullochella peelii*) and trout cod (*Maccullochella macquariensis*).	The habitat or lifecycle of native species, including invertebrate faun and fish species, dependent upon the wetland being seriously affected.	No measurable impacts on fish species, including threatened species, are expected as a result of the trial. A number of control measures will be in place to ensure water quality is not affected. A minimum 50 metre protection buffer from waterways will be maintained. Additionally, a 20 metre protection buffer will be established around unmapped drainage lines where possible. No establishment or treatment activities will be undertaken during or immediately after rainfall events, or where floodwater has encroached into a site. All plant and equipment will be maintained to limit risk of accidental spills. All refuelling will occur in designated bunded areas. Spill kits will be available in all vehicles and machinery involved in the Project, including mobile refuelling vehicles. Any spills, will be reported to the implementation coordinator. In the event of any spills, contaminated soils will be removed and disposed of in a manner consistent with relevant legislation. All personnel must complete a project induction prior to commencing work on site, which will include information on waterway protective buffers.
Wetland birds Sixty species of wetland birds have been recorded from the site. This includes seven species listed under international migratory agreements and two threatened species: superb parrot and Australasian bittern. Over 100,000 birds have been recorded in the site during times of flood. The site is significant for supporting the breeding of colonial nesting waterbirds and contains a significant breeding population of superb parrots.	The habitat or lifecycle of native species dependent upon the defined wetland being seriously affected.	The trial is unlikely to affect the lifecycle of native wetland birds dependent on the Barmah Forests Ramsar site. Site selection avoided known occurrences of listed species, including superb parrots. Treatment and control plots are not located in, or within, 50 metres of defined wetlands. Further, if a species were identified in a plot, it was assigned as a control plot. The trial is not expected to significantly reduce the area or distribution of river red gums and the avoidance of larger, hollow containing trees will minimise potential impact on species such as the superb parrot. The timing of trial activities will avoid the breeding season for most listed bird species, including the superb parrot. A suitably qualified ecologist will identify trees for retention, including marking red river gums used by superb parrots, these are: trees with a DBH >40 cm;

Barmah Forest Ramsar site ecological character description (critical components, processes and services)	Significant impact criteria	Assessment of significant impact
		containing a visible hollow; or are dead trees with a DBH >20 cm, for retention. The treatment area for this trial constitutes 0.6 per cent of the total area of these forests, leaving more than 99 per cent of the species' habitat undisturbed. Given the limited extent of trial activity, it is unlikely to have a disproportionate effect on wetland birds.
Diversity of wetland types The site supports part of the largest remaining river red gum forest in Australia and provides a mosaic of vegetated habitats	This critical service is linked to changes in the frequency and duration of wetland wetting and drying as well as changes in the extent and condition of wetland vegetation. It is unlikely that this trial will affect the hydrology or vegetation of this site. *See hydrology and vegetation*	This critical service is linked to changes in the frequency and duration of wetland wetting and drying as well as changes in the extent and condition of wetland vegetation. It is unlikely that this trial will affect the hydrology or vegetation of this site. *See hydrology and vegetation*
Biodiversity The site supports the regionally significant moira grass vegetation community and a significant number of plant and animal species	The critical service relates not only to species richness but also to the presence and extent of moira grasslands within the site. It is unlikely that the trial will have a significant impact on wetland bids, fish and vegetation occurring on this site. *See wetland birds, fish and vegetation*	The critical service relates not only to species richness but also to the presence and extent of moira grasslands within the site. It is unlikely that the trial will have a significant impact on wetland bids, fish and vegetation occurring on this site. *See wetland birds, fish and vegetation*
Physical habitat Barmah Forest provides habitat for feeding and breeding of wetland birds.	This critical service is linked to changes in the frequency and duration of wetland wetting	This critical service is linked to changes in the frequency and duration of wetland wetting and drying as well as changes in extent and condition of wetland vegetation. Wetland bird abundance can also be used as a surrogate

Barmah Forest Ramsar site ecological character description (critical components, processes and services)	Significant impact criteria	Assessment of significant impact
	and drying as well as changes in extent and condition of wetland vegetation. Wetland bird abundance can also be used as a surrogate measure. Impact can be observed through changes in the duration of specific flow events, extent and condition of river red gum forests and woodlands, extent of floodplain marshes and abundance of wetland birds, which are unlikely to be significantly affected by this trial. *See hydrology, vegetation and wetland birds*	measure. Impact can be observed through changes in the duration of specific flow events, extent and condition of river red gum forests and woodlands, extent of floodplain marshes and abundance of wetland birds, which are unlikely to be significantly affected by this trial. *See hydrology, vegetation and wetland birds*
Threatened species Barmah Forest supports seven species listed under the EPBC Act and/or the IUCN Red List of Threatened Species	This critical service is indicated by the presence of threatened species at this site. It is unlikely that this trial will have a significant impact on threatened species at this site. *See wetland birds fish and vegetation*	This critical service is indicated by the presence of threatened species at this site. It is unlikely that this trial will have a significant impact on threatened species at this site. *See wetland birds fish and vegetation*
Ecological connectivity Barmah Forest provides important migratory routes between riverine, wetland and floodplain habitats o fish spawning and recruitment	The site maintains connectivity between the river and floodplain wetlands and channels for fish spawning	The site maintains connectivity between the river and floodplain wetlands and channels for fish spawning and recruitment. This service is maintained by hydrology and can also be indicated by the species richness and abundance of native fish. It is unlikely that this trial will have a significant impact on either of

Barmah Forest Ramsar site ecological character description (critical components, processes and services)	Significant impact criteria	Assessment of significant impact
	and recruitment. This service is maintained by hydrology and can also be indicated by the species richness and abundance of native fish. It is unlikely that this trial will have a significant impact on either of these characteristics. *See for hydrology and native fish*	these characteristics. *See for hydrology and native fish*
Organic carbon cycling As part of a major floodplain system, the site is important for cycling of nutrients, particularly carbon both on the floodplain and as a source of organic carbon to receiving waterways	This service is provided by the uptake of carbon by vegetation, the deposition of organic matter (coarse woody debris and litter) on the floodplain and the mobilisation of particular and dissolved organic carbon to the receiving river systems with flood return waters. It is unlikely that the trial will have a significant impact on any of these characteristics. *See for hydrology and vegetation*	This service is provided by the uptake of carbon by vegetation, the deposition of organic matter (coarse woody debris and litter) on the floodplain and the mobilisation of particular and dissolved organic carbon to the receiving river systems with flood return waters. It is unlikely that the trial will have a significant impact on any of these characteristics. *See for hydrology and vegetation*

Table 5.9: Assessment of potential significant impact on NSW Murray Forests Ramsar Wetland (ecological character description from Harrington and Hale 2011).

NSW Central Murray Forests Ramsar Wetland ecological character description (critical components, processes and services)	Significant impact criteria	Assessment of significant impact
Hydrology Inundation of the site is driven largely by flows within the Murray River. The hydrology of the site is highly regulated and seasonality of low and moderate flow is determined largely by irrigation needs. Large scale floods that inundate the forest are generally the result of catchment scale rainfall events. Groundwater may be important for maintaining tree health but remains a knowledge gap.	A substantial and measurable change in the hydrological regime of the wetland, for example, a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland.	No measurable impacts to the hydrology of the NSW Murray Forests Ramsar Wetland are expected. Activities undertaken as part of the trial will not affect the volume, timing, duration or frequency of ground and surface water flows to and within the wetland.
Hydrology Inundation of the site is driven largely by flows within the Murray River. The hydrology of the site is highly regulated and seasonality of low and moderate flow is determined largely by irrigation needs. Large scale floods that inundate the forest are generally the result of catchment scale rainfall events. Groundwater may be important for maintaining tree health but remains a knowledge gap.	A substantial and measurable change in the water quality of the wetland; for example, a substantial change in the level of salinity, pollutants, or nutrients in the wetland, or water temperature which may adversely impact on biodiversity, ecological integrity, social amenity or human health,	No substantial and measurable changes expected as a result of trial activities. A number of management measures are in place: • Establishment or treatment activities will not be undertaken during or immediately after rainfall events, or where floodwater has encroached into a site. • A minimum 50-metre protection buffer from waterways will be maintained. Additionally, a 20-metre protection buffer will be established around unmapped drainage lines where possible. • All plant and equipment will be maintained to limit risk of accidental spills. All refuelling will occur in designated bunded areas. Spill kits will be available in all vehicles and machinery involved in the project, including mobile refuelling vehicles. Any spills, will be reported to the Implementation Coordinator. In the event of any spills, contaminated soils will be removed and disposed of in a manner consistent with relevant legislation. • All personnel must complete a project induction prior to commencing work on site, which will include information on waterway protective buffers.

NSW Central Murray Forests Ramsar Wetland ecological character description (critical components, processes and services)	Significant impact criteria	Assessment of significant impact
Vegetation The two critical wetland vegetation categories are: river red gum forests and floodplain marshes. Over 90 per cent of the site is covered in inundation dependent river red gum woodland and Black Box woodland. These have a combined extent of over 76,000 hectares. River red gum forest is the dominant vegetation community, comprising 65 per cent of the site. Condition at the time of listing was poor to moderate, with less than 20 per cent of the river red gum forest in good condition in both Millewa and Koondrook–Perricoota Forest Group. Floodplain marshes include moira grass (*Pseudoraphis spinescens*) plains, giant rush (*Juncus ingens*) beds, common reed (*Phragmites australis*) beds, moist grasslands, herblands and semi-permanent marshes. The wetland supports two nationally threatened wetland flora species: daisy and river swamp wallaby-grass.	Areas of the wetland being destroyed or substantially modified.	The trial is not expected to significantly reduce the area of river red gum within the Barmah Forest Ramsar Site. The treatment area for this trial constitutes 0.6 per cent of the total area of these forests. Given the limited extent of trial activity, it is unlikely to have a disproportionate effect on native flora. Sites will be located greater than 100 metres from the nearest road to minimise disturbance effects and near fire trails to minimise the need for the establishment of natural surface tracks. Vehicles will keep to formal access roads in accordance with existing park management practices and be of an appropriate size so that widening of the roads will not be required. Given the temporary nature of the trial, an adequate soil seed bank will be retained across the selected sites to permit species to survive, reproduce and recolonise areas. The trial is unlikely to cause any long term impacts on forest fragmentation or connectivity.
Vegetation The two critical wetland vegetation categories are: river red gum forests and floodplain marshes. Over 90 per cent of the site is covered in inundation dependent river red gum woodland and Black Box woodland. These have a combined extent of over 76,000 hectares. River red gum forest is the dominant vegetation community, comprising 65 per cent of the site. Condition at the time of listing was poor to moderate, with less than 20 per cent of the river red gum forest in good condition in both Millewa and Koondrook–Perricoota Forest Group. Floodplain marshes include moira grass (*Pseudoraphis*	An invasive species that is harmful to the ecological character of the wetland being established (or an existing invasive species being spread) in the wetland.	It is unlikely that the trial will lead to the establishment or spread of invasive species in a way that could harm the ecological character of the wetlands. A weed and pathogen hygiene protocol will apply to all vehicles, equipment and personnel. All vehicles will be cleaned using high-pressure water or compressed air prior to entering the national parks, significantly reducing the likelihood that invasive species and/or disease will be introduced to the Ramsar site. Further, site selection avoided known occurrences of listed species, including Mueller daisy and river swamp wallaby-grass. Surveys of the plot sites yielded no individuals of these species. Treatment and control plots are located away from these species' habitat and are not located in, or within 50 metres of, defined wetlands.

NSW Central Murray Forests Ramsar Wetland ecological character description (critical components, processes and services)	Significant impact criteria	Assessment of significant impact
spinescens) plains, giant rush (*Juncus ingens*) beds, common reed (*Phragmites australis*) beds, moist grasslands, herblands and semi-permanent marshes. The wetland supports two nationally threatened wetland flora species: daisy and river swamp wallaby-grass.		
Fish Seventeen native species of fish have been recorded from within the site. Results from surveys indicate that abundance varies considerably and that invasive species generally comprise 10 to 30 per cent of the total abundance and up to 70 per cent of biomass. Supports three native threatened fish species: silver perch (*Bidyanus bidyanus*), Murray cod (*Maccullochella peelii*) and trout cod (*Maccullochella macquariensis*).	The habitat or lifecycle of native species, including invertebrate faun and fish species, dependent upon the wetland being seriously affected.	No measurable impacts on fish species, including threatened species, are expected as a result of the trial. A number of control measures will be in place to ensure water quality is not affected. A minimum 50-metre protection buffer from waterways will be maintained. Additionally, a 20-metre protection buffer will be established around unmapped drainage lines where possible. No establishment or treatment activities will be undertaken during or immediately after rainfall events, or where floodwater has encroached into a site. All plant and equipment will be maintained to limit risk of accidental spills. All refuelling will occur in designated bunded areas. Spill kits will be available in all vehicles and machinery involved in the project, including mobile refuelling vehicles. Any spills, will be reported to the implementation coordinator. In the event of any spills, contaminated soils will be removed and disposed of in a manner consistent with relevant legislation. All personnel must complete a project induction prior to commencing work on site, which will include information on waterway protective buffers.

NSW Central Murray Forests Ramsar Wetland ecological character description (critical components, processes and services)	Significant impact criteria	Assessment of significant impact
Wetland birds Sixty-seven species of wetland birds have been recorded from the site. This includes 11 species listed under international migratory agreements and three threatened species: Australian painted snipe (*Rostratula benghalensis australis*); superb parrot (*Polytelis swainsonii*) and Australasian bittern (*Botaurus poiciloptilus*). Over 100,000 birds have been recorded in the site during times of flood. The site is significant for supporting the breeding of colonial nesting waterbirds and contains a significant breeding population of superb parrots.	The habitat or lifecycle of native species dependent upon the wetland being seriously affected.	The trial is unlikely to affect the lifecycle of native wetland birds dependent on the Barmah Forests Ramsar site. Site selection avoided known occurrences of listed species, including superb parrots. Treatment and control plots are not located in, or within 50 metres of, defined wetlands. Further, if a species were identified in a plot, it was assigned as a control plot. The trial is not expected to significantly reduce the area or distribution of river red gums and the avoidance of larger, hollow containing trees will minimise potential impact on species such as the superb parrot. The timing of trial activities will avoid the breeding season for most listed bird species, including the superb parrot. A suitably qualified ecologist will identify trees for retention, including marking red river gums used by superb parrots, these are: trees with a DBH >40 cm; containing a visible hollow; or are dead trees with a DBH >20 cm, for retention. The treatment area for this trial constitutes 0.6 per cent of the total area of these forests, leaving more than 99 per cent of the species' habitat undisturbed. Given the limited extent of trial activity, it is unlikely to have a disproportionate effect on wetland birds.
Significant wetland types The site supports part of the largest remaining river red gum forest in Australia and provides a mosaic of vegetated habitats.	This critical service is linked to changes in the frequency and duration of wetland wetting and drying and changes in the extent and condition of wetland vegetation. It is unlikely that this service will be affected by the trial. *See hydrology and vegetation*	This critical service is linked to changes in the frequency and duration of wetland wetting and drying and changes in the extent and condition of wetland vegetation. It is unlikely that this service will be affected by the trial. *See hydrology and vegetation*
Physical habitat NSW Central Murray Forests provide habitat for feeding	This critical service is linked to changes in the frequency and	This critical service is linked to changes in the frequency and duration of wetland wetting and drying as well as change in the extent and condition

NSW Central Murray Forests Ramsar Wetland ecological character description (critical components, processes and services)	Significant impact criteria	Assessment of significant impact
and breeding of wetland bids.	duration of wetland wetting and drying as well as change in the extent and condition of wetland vegetation. Wetland bird abundance can also be used as a surrogate measure. Impact can be observed through changes in the duration of specific flow events, extent and condition of river red gum forests and woodlands, extent of floodplain marshes and abundance of wetland birds, which are unlikely to be significantly affected by this trial. *See hydrology, vegetation and wetland birds*	of wetland vegetation. Wetland bird abundance can also be used as a surrogate measure. Impact can be observed through changes in the duration of specific flow events, extent and condition of river red gum forests and woodlands, extent of floodplain marshes and abundance of wetland birds, which are unlikely to be significantly affected by this trial. *See hydrology, vegetation and wetland birds*
Threatened species NSW Central Murray Forests support one plant species, three species of bird and six species of fish listed under the EPBC Act and/or IUCN Red List of Threatened Species	This critical service is indicated by the presence of threatened species at this site. It is unlikely that this trial will have a significant effect on threatened species at this site. *See wetland birds, fish and vegetation*	This critical service is indicated by the presence of threatened species at this site. It is unlikely that this trial will have a significant effect on threatened species at this site. *See wetland birds, fish and vegetation*
Ecological connectivity NSW Central Murray Forests provide important migratory routes between riverine, wetland and floodplain habitats o fish spawning and recruitment	The site maintains connectivity between the river and floodplain wetlands and channels for fish spawning and recruitment. This service is maintained by hydrology and can also be indicated by the species richness and abundance of native fish. It is unlikely that this trial will have a significant impact on either	The site maintains connectivity between the river and floodplain wetlands and channels for fish spawning and recruitment. This service is maintained by hydrology and can also be indicated by the species richness and abundance of native fish. It is unlikely that this trial will have a significant impact on either of these characteristics. *See hydrology and native fish*

NSW Central Murray Forests Ramsar Wetland ecological character description (critical components, processes and services)	Significant impact criteria	Assessment of significant impact
	of these characteristics. *See hydrology and native fish*	

5.2.6. Cumulative impacts

The risk and impact assessments demonstrate that trial activities will not have a significant impact on any individual EPBC Act-listed matter of national environmental significance.

However, the trial will be undertaken within river red gum forests with declining health (Cunningham et al. 2009a, 2009b, 2011; Jurskis et al. 2005; MDBC 2006; Pennay 2009). Continued river regulation and the likelihood of more frequent and intense droughts under climate change predictions suggest these conditions are likely to persist.

While recognising these broader conditions, given the limited spatial and temporal extent of the trial — treatment plots constitute only 0.6 per cent of the river red gum forests and treatment activities are planned to occur over three months — it is unlikely that this will significantly impact the existing ecosystem resilience of the river red gum forest within the Barmah–Millewa.

Furthermore, the ultimate goal of the trial is to provide a scientific assessment to determine how ecological thinning affects biodiversity, canopy condition and resilience, and minimise tree mortality within identified plots of river red gum forest, thereby addressing key gaps in knowledge about how to manage this important forest type.

6. Environmental management plan

This environmental management plan (EMP) sets out a framework for continuing management, mitigation and monitoring programs to address potential impacts on *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)-listed matters of national environmental significance during the ecological thinning trial. It is has been developed to be consistent with the principles of AS/NZS ISO 14001:2004 *Environmental management systems—Requirements with guidance for use*, and is presented as follows:

- planning
  - legal and other requirements
  - risk management
  - organisational structure and responsibility
- implementation and operation
  - project delivery standards for each phase of the ecological thinning trial
  - communication
  - details of operational plans to be used during project delivery
  - document and record control
- checking
  - monitoring and measurement
  - non-conformance, corrective and preventative action
  - contingency measures
  - auditing
- management review and continuous improvement
- a statement regarding residual impacts on matters of national environmental significance, including any additional offsetting requirements.

6.1. Planning

6.1.1. Legal and other requirements

Relevant project approvals, legal requirements, and other relevant requirements have been identified in Table 6.1 below. This information will be reviewed during the ecological thinning trial and updated to reflect any changes.

Where legislation requires a specific management action or response, these requirements have been identified within this EMP as environmental controls, environmental monitoring programs, or within contingency plans. Compliance with legal and other relevant requirements will be evaluated annually during the ecological thinning trial.

Table 6.1: Legislation and other requirements relating to the proposed ecological thinning trial.

Act, plan or policy	Description and relevance
Commonwealth - *Environment Protection and Biodiversity Conservation Act 1999*	The EPBC Act requires that all actions that are likely to have a significant impact on matters of national environmental significance must be referred to the Commonwealth Minister who determines whether further assessment is required or not. This Act is administered by the Commonwealth Department of the Environment (DoE).

Act, plan or policy	Description and relevance
(EPBC Act)	This Public Environment Report is being developed to assess potential impacts on matters of national environmental significance listed under the Act.
Victoria - *Aboriginal Heritage Act 2006*	This Act provides for the protection and management of Victoria's Aboriginal heritage with processes linked to the Victorian planning system. In order to manage activities that may harm Aboriginal cultural heritage, the Cultural Heritage Management Plan (CHMP), established under the Act, is required if all or part of the activity area is an area of cultural heritage sensitivity and all or part of the activity is a high impact activity. At a local level, the Act provides for registered Aboriginal parties (RAPs), which are responsible for evaluating and approving CHMPs. A CHMP may be required for treatment phase activities. If deemed to be required, this would be obtained prior to commencement of the trial in Barmah.
Victoria - *Environment Protection Act 1970*	This Act provides a legislative framework for the protection of the environment in Victoria. The ecological thinning trial must be compliance with: • Environment Protection (Industrial Waste Resource) Regulations 2009 – set out the requirements for transporting prescribed industrial waste in Victoria • State Environmental Protection Policy (Waters of Victoria) – applies to all surface waters in the State. It defines environmental quality objectives and indicators that must be met to protect beneficial uses (including aquatic ecosystems) • State Environment Protection Policy (Groundwaters of Victoria) – sets the framework for the protection of groundwater from activities potentially detrimental to groundwater quality, and it includes a classification of groundwater quality on the basis of background concentrations of salinity, measured as total dissolved solids
Victoria - *Flora and Fauna Guarantee Act 1988* (FFG Act)	This Act establishes a framework for biodiversity conservation and sustainable use of native flora and fauna in Victoria. Under Section 48 of the FFG Act, the secretary may issue a licence to take, trade in, keep, move or process protected flora on public land. While the ecological thinning trial is design to avoid impacts to protected flora, there may be instances where it is necessary to move a listed species. In such circumstances a permit will be obtained prior to any removal.
Victoria - *National Parks Act 1975*	Establishes the statutory basis for the protection, use and management of national and other parks across Victoria. Under Section 27 of this Act, works by a public authority within a park reserved and managed under the provisions of the Act are subject to the consent by the Minister. A condition of this consent if that the proposed works comply with the management objectives and strategies for the park, in this case, Barmah National Park. This Act also establishes the statutory basis to allow the Secretary to authorise material felled in accordance with a Licence granted under the *Forests Act 1958* that expired before June 30 2009, to be used for domestic firewood in accordance with conditions determined by the secretary until 30 June 2015.
Victoria - *Planning and Environment Act 1987*	This Act establishes a framework for planning the use, development and protection of land in Victoria. Local planning schemes are enabled under this Act. In Victoria the ecological thinning trial is located in a Public Conservation Resource Zone (PCRZ) under the Moira Planning Scheme.
Victoria - *Wildlife Act 1975*	This Act provides for the protection and conservation of wildlife. Under Section 28A of this Act, a management authorisation may be required to 'hunt, take or destroy wildlife'. While the ecological thinning trial is design to avoid impacts to wildlife, there may be instances where wildlife are impacted and so a management authorisation will be obtained prior to commencement.
Victoria - *Catchment and Land Protection Act 1994*	The purpose of the Act is to set up a framework for the integrated management and protection of catchments, to encourage community participation in the management of land and water resources, and set up a system of controls on noxious weeds and pest animals. As land manager Parks Victoria (PV) has an obligation to manage the spread and impact of

Act, plan or policy	Description and relevance
	pest plants and animals. For the ecological thinning trial these issues are addressed by the weed and pathogen protocol in this EMP, along with the Pest Plants and Animals Strategy for Barmah National Park.
New South Wales - *Environment Planning and Assessment Act 1979* (EP&A Act)	This Act establishes a framework for the management, development and conservation of land and resources, promotes sharing of responsibility for environmental planning, and provides opportunity for public involvement in environmental planning and assessment. A Review of Environmental Factors (REF) for the ecological thinning trial is required under Part 5 the Act. A REF examines the significance of likely environmental impacts of the activities and the measure required to mitigate any adverse impacts to the environment. As OEH is a public authority, and all treatment sites are located on lands gazetted as national park, OEH is able to determine the REF. The activity is also therefore not subject to development approval from local government. An REF for the NSW component of this activity has been completed, placed on public exhibition, determined and approved through the OEH's Conservation and Regulation Division (now known as the Regional Operations Group).
New South Wales - *Fisheries Management Act 1994*	This Act seeks to conserve, develop and share the fishery resources of the State for the benefit of present and future generations. Degradation of native riparian vegetation along NSW watercourses is identified as a Key Threatening Process under the NSW *Fisheries Management Act 1994*. Additionally, the 'Aquatic Ecological Community in the natural drainage system of the Lower-Murray River Catchment' is listed as an Endangered Ecological Community (EEC) under the Act. This activity has been assessed as being consistent with the priority threat abatement strategies, in particular the rehabilitation of degraded areas. Communication with DPI – Fisheries has been undertaken with regard to this activity during which it was indicated (by DPI) that this activity does not pose a significant risk to the EEC or threatened fish species and does not require approval under the Act.
New South Wales - *Heritage Act 1977*	This Act provides the framework for managing heritage including identifying and managing items of State heritage significance. A search of OEH's Historic Heritage Information Management System has been conducted for areas subject to and surrounding the proposed ecological thinning trial. The trial will have no impacts on items of Historic Heritage value or items of potential heritage value, and hence no approvals are required under this Act.
New South Wales - *National Parks and Wildlife Act 1974*	This Act provides for the protection of native flora and fauna, including threatened species and their habitat. While this Act does not specifically outline ecological thinning as an activity, the proposed activity is supported through this Act, as the activity seeks to trial, through undertaking of appropriate research and monitoring, ecological thinning as a conservation management tool to maintain ecosystem and the conservation of the biodiversity found within the ecosystem. In addition, this Act requires that the REF must state whether or not the proposed activity is likely to have an impact on Aboriginal cultural heritage. Information as to how this assessment was made must also be included. All on-park activities must undertake an appropriate level of assessment as required and outlined in OEH's Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW.
New South Wales - *Threatened Species Conservation Act 1995*	This Act provides for the protection and management of biodiversity and threatened species in NSW. This Act integrates the conservation of threatened species into development control processes established by the EP&A Act. The mechanism to assess the potential impacts on threatened species, populations and ecological communities is through the Assessment of Significance set out in this Act. This assessment is undertaken as part of the REF to determine whether there is likely to be a significant effect on threatened species, populations, ecological communities or their habitats. This assessment

Act, plan or policy	Description and relevance
	requires that relevant (known or potential) threatened species, populations and communities and critical habitats listed under both the Act and the *Fisheries Management Act 1994* be included in the assessment.
New South Wales - *Rural Fires Act 1997*	This Act provides the framework for preventing, mitigating and suppression and managing bush and other fires. OEH has the duty to prevent the occurrence of bushfires and to minimise the danger of spread of bushfires on or from land under its control. ecological thinning trial activities in NSW must be conducted in a manner consistent with the Fire Management Strategy for the Millewa group of forests.
New South Wales - *National Park Estate (Riverina Red Gum Reservation) Act 2010*	This Act provides for the reservation of the river red gum forests as national parks. In regards to the use of thinning residue for the supply to the domestic firewood Part 4, Section 16 (2) of this Act states that 'wood obtained from ecological thinning undertaken by the Director-General in any lands reserved under the *National Parks and Wildlife Act 1974* in the Riverina area may be deposited in firewood collection zones for collection by the holders of licence under this section'.
New South Wales - Protection of the Environment Operations (Waste) Regulation 2005 (NSW)	These regulations set requirements for tracking of prescribed waste in NSW. The Regulations would be applicable to the proposed ecological thinning trial in the event of any chemical (e.g. fuel or hydraulic fluid) spills requiring clean-up and disposal at an appropriate landfill.

6.1.2. Risk management

Potential risks to matters of national environmental significance have been identified through a risk assessment process consistent with *AS/NZ ISO 31000:2009 (ISO 31000) Risk Management – Principles and Guidelines*. Key risks identified were discussed in Section 5 of this PER, with a full register provided in Appendix 7.

The risk register included in Appendix 7 will be maintained as a planning tool throughout the ecological thinning trial. Where necessary, the register will be updated to reflect changing circumstances (e.g. implementation of a contingency measure), with the associated mitigation measures reviewed and updated accordingly to ensure the environmental risk is managed effectively.

6.1.3. Organisational structure and responsibility

The proponents, the Department of Environment and Primary Industries (DEPI) and NSW OEH, have overall responsibility for implementation of the ecological thinning trial in accordance with this EMP.

Figure 22 shows the organisational structure for implementation of the ecological thinning trial, and the specific environmental responsibilities are provided in **Error! Reference ource not found.**.

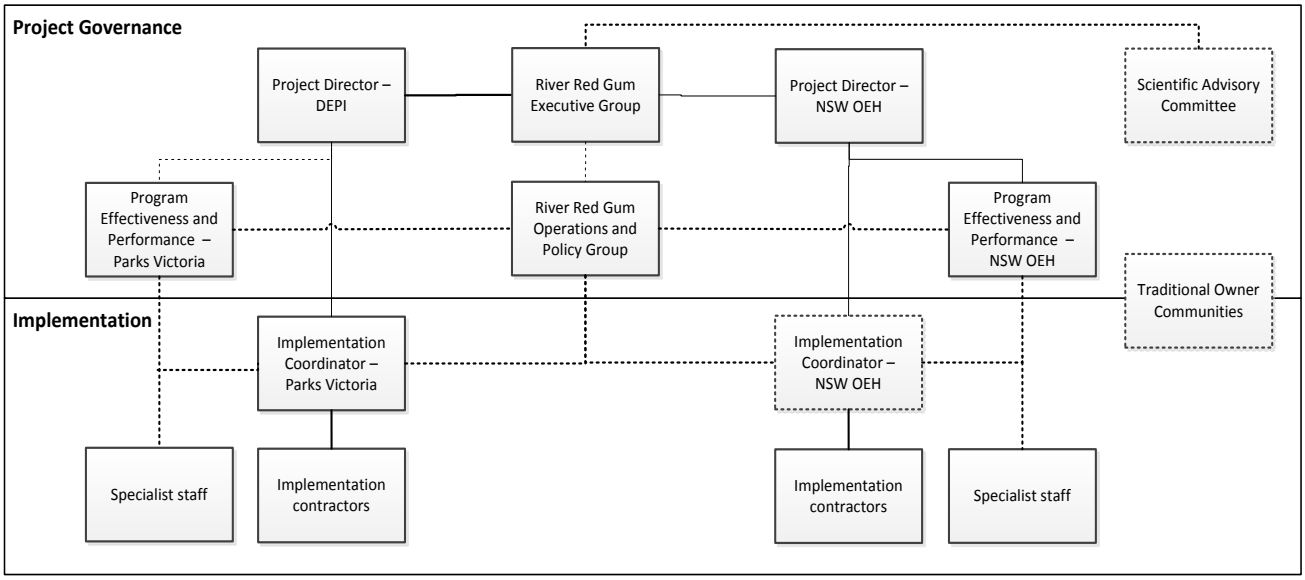

Figure 22: Organisational structure for implementation of the ecological thinning trial.

Table 6.2: Specific environmental management responsibilities by role.

Role	Responsibilities
Project director	• Approve this EMP and any major revisions or amendments prior to, or during, the ecological thinning trial • Report to statutory agencies on environmental performance as required • Lead the management review of this EMP.
Program effectiveness and performance	• Oversee implementation of ecological monitoring program and adaptive management framework • Ensure all monitoring personnel undertake a project induction prior to commencing work on the ecological thinning trial • Monitor and report to the project director as required • Be aware of, and fully comply with, the applicable requirements of this EMP.
Implementation coordinator	• Lead implementation of this EMP and management initiatives to meet statutory, regulatory and approval requirements • Ensure environmental risks are managed in accordance with this EMP • Ensure all activities are carried out in an environmentally sustainable way • Ensure that environmental requirements are included in contracts • Provide contractor personnel with adequate plans and procedures to manage environmental risks in accordance with regulatory requirements and this EMP • Keep accurate environmental records as required by this EMP • Provide adequate resourcing of appropriately skilled and

Role	Responsibilities
	experienced personnel • Ensure that adequate systems are in place and that community issues, complaints and comments are handled in a timely manner • Monitor and report to the project director on environmental performance as required • Establish and implement an audit schedule • Be aware of, and fully comply with, the applicable requirements of this EMP and any applicable operational plans.
Implementation contractors	• Ensure that all team members are aware of, and fully comply with, the requirements of this EMP and any applicable operational plans • Undertake regular monitoring of coarse woody debris levels as required by the scope of works for the ecological thinning trial • Keep accurate environmental records (e.g. equipment wash-down logs) as required by this EMP • Ensure all team members undertake a project induction prior to commencing work on the ecological thinning trial • Report all environmental incidents, near-misses and non-conformances to the implementation coordinator.
Specialist staff	• Where applicable to role, support implementation coordinator in monitoring contractor compliance with EMP requirements • Be aware of, and fully comply with, the requirements of this EMP and any applicable operational plans • Keep accurate environmental records (e.g. equipment wash-down logs) as required by this EMP • Undertake a project induction prior to commencing work on the ecological thinning trial • Report all environmental incidents, near-misses and non-conformances to the implementation coordinator.
River Red Gum Executive Group/Operations and Policy Group	• Responsible for reviewing and approving changes to trial activities as per the change management procedure in Section 6.3.5 • Refer to Section 7.1.1 for further detail.
River Red Gum Scientific Advisory Committee	• Responsible for reviewing and approving changes to trial activities as per the change management procedure in Section 6.3.5. • Refer to Section 7.1.3 for further detail.

6.2. Implementation and operation

6.2.1. Project delivery standards

Project delivery standards have been developed to address key environmental risks, impacts and legal requirements. The project delivery standards are a collation of the management and mitigation measures, environmental monitoring, and contingency plans for the proposed ecological thinning trial.

Each project delivery standard includes:

- an objective – the performance goal
- performance criteria – performance level(s) at which the objective is demonstrated as being achieved
- application – the physical areas to which the project delivery standard applies
- environmental controls – management and mitigation measures (including timing, implementation responsibility and indicative cost) developed to manage potential impacts on EPBC Act-listed matters of national environmental significance identified in Section 5 of this PER
- reference to environmental monitoring programs where applicable
- reference to relevant contingency plans.

Project delivery standards have been developed for each project phase:

- establishment phase (Table 6.3)
- treatment phase (Table 6.4 and

- Table 6.5)

site monitoring phase (

- Table 6.6).

These project delivery standards will form part of the contractual agreements between the relevant contractor and Parks Victoria (PV) or National Parks and Wildlife Service (NPWS).

Establishment phase

Objective

To appropriately manage establishment works

Performance criteria

Compliance with legislation listed in Section 6.1.1

Conformance with all environmental limits and controls specified in the project delivery standard

Application

All establishment phase activities, specifically maintenance of access roads, establishment of natural surface tracks, and maintenance of stockpile sites

Table 6.3: Establishment phase – project delivery standard.

Environmental controls	Timing/ frequency	Responsibility
1. Flora and fauna		
• All proposed natural surface track routes will be walked and surveyed for threatened species by a suitably qualified ecologist.	Prior to track establishment	Implementation coordinator/ specialist staff
• If any removal of native vegetation is required, a suitably qualified ecologist will assess this vegetation prior to removal.	Prior to removal	Implementation coordinator/ specialist staff
• Any removal of native vegetation will be to the minimum extent necessary and in accordance with existing park management practices.	At all times	Implementation coordinator/ contractors
• Contractors will not travel at speeds greater than 50 kilometres/hour within a national park.	At all times	Contractors
• If EPBC Act-listed species are identified by the contractor during maintenance activities, the 'Unexpected future detection of matters of national environmental significance' contingency will apply.	As required	Contractors/ specialist staff
• Injury or death of native flora and fauna species will be reported to the implementation coordinator. The implementation coordinator will maintain a record of all reports and actions.	Immediately	All personnel
• All machinery will be fitted with appropriate mufflers to minimise noise and will be regularly serviced.	At all times	Contractors

Environmental controls	Timing/ frequency	Responsibility
2. Soil and waterway management		
• Natural surface tracks will not be bladed off (i.e. stripped of ground layer vegetation to expose bare earth).	At all times	Implementation coordinator/ contractors
• Widths for natural surface tracks will be kept within a maximum of 4 metres. Routes for natural surface tracks will avoid drainage feature crossings where possible.	At all times	Implementation coordinator/ contractors
• A minimum 50-metre protection buffer from waterways will be maintained. Additionally, a 20-metre protection buffer will be established around unmapped drainage lines where possible.	At all times	Implementation coordinator/ contractors
• Use of B-double vehicles, which would require road widening, will not be permitted.	At all times	Contractors
3. Fuels, oils, chemicals and hazardous goods		
• Pre-start checks will be conducted to identify any machinery faults.	Daily	Contractors
• All vehicles, plant and equipment will be maintained to limit risk of accidental spills.	As per manufacturer instructions	Contractors
• Spill kits will be carried in all contractor vehicles.	At all times	Contractors
• All refuelling will occur in designated bunded areas.	At all times	Contractors
• Any spills will be reported to the implementation coordinator.	Immediately	All personnel
• Soils or other material contaminated by a spill will be removed and disposed of in a manner consistent with the Environment Protection (Industrial Waste Resource) Regulations 2009 (Vic) or Protection of the Environment Operations (Waste) Regulation 2005 (NSW).	As soon as practicable	Contractors
4. Weed and pathogen protocol		
• All machinery will be cleaned using high-pressure water or compressed air prior to entering a national park.	Prior to entering parks	All personnel
• Prior to moving between sites, or exiting a national park, machinery and equipment will be manually cleaned to remove dirt.	Prior to moving between sites	All personnel
• Contractors will be required to keep a formal record of equipment clean downs undertaken.	After each clean down	Contractors
5. Fire and emergency management		
• Machinery that may be a source of ignition will not be used during periods of extreme fire danger or days of	Where	All personnel

Environmental controls	Timing/ frequency	Responsibility
total fire ban.	applicable	
• Chainsaws and machinery will be fitted with functioning spark arresters.	At all times	Contractors
• Fire extinguishers will be located within machinery in order to combat fuel fires.	At all times	Contractors
• A fire emergency and evacuation plan will be prepared and implemented for each site as part of the operational plan.	Prior to commencement at a site	Implementation coordinator/ contractor
• Vehicles will keep to formal access roads in accordance with existing park management practices, which will reduce the risk of ignition.	At all times	All personnel
• Fire extinguishers (water only) will be made readily available in periods of high fire danger.	At all times during period of high fire danger	Contractors
• No fires will be lit on the site and littering of cigarette butts will not be permitted.	At all times	All personnel
6. Training and awareness		
• All personnel must complete a project induction and be suitably qualified to undertake their work.	Prior to commencing work	All personnel

Monitoring program

Refer Section 6.3.1:

- equipment clean down records
- local rainfall event monitoring
- post-flood water quality monitoring

Contingencies

Refer Section 6.3.3:

- unexpected future detection of matters of national environmental significance
- flooding
- discovery of suspected Aboriginal cultural heritage item/site
- unauthorised firewood collection

Estimated indicative cost to implement controls in this project delivery standard

$50,000

Treatment phase (identification of trees for retention)
Objective

To appropriately manage identification of trees for retention

Performance criteria

Compliance with legislation listed in Section 6.1.1

Conformance with all environmental limits and controls specified in the project delivery standard

Application

Identification of trees for retention within all treatment plots

Other activities in the treatment phase are covered by a separate project delivery standard (

Table 6.5)

Table 6.4: Treatment phase (identification of trees for retention) – project delivery standard.

Environmental controls	Timing/ frequency	Responsibility
1. Flora and fauna		
• A tree marking manual will be developed and distributed to all contractor personnel. The manual will clearly specify requirements for: • consistent marking and symbols to be used • spacing requirements • locating and setting up plots • trees that must be retained • selecting trees	Prior to commencement of the treatment phase	Implementation coordinator
• A suitably qualified ecologist will identify trees for retention in accordance with the Tree Marking Manual, including all trees that: • have a DBHOB >40 cm • contain a visible hollow • are dead with DBHOB>20 cm	No greater than four weeks prior to commencement of felling operations at a site	Implementation coordinator/ specialist staff
• All trees for retention will be marked with brightly coloured spray paint.	At all times	Implementation coordinator/ specialist staff
• In order to confirm EPBC Act-listed species are not present during felling, an additional walk-through will be conducted by a suitably qualified ecologist immediately prior to commencement of the first day of felling operations. If habitat suspected of use by an EPBC Act-listed species (e.g. nest site) is found to be present, the 'Unexpected future detection of matters of national environmental significance' contingency will apply.	Immediately prior to commencement of the first day of felling operations at a site	Implementation coordinator/ specialist staff
• Injury or death of native flora and fauna species will be reported to the implementation coordinator. The implementation coordinator will maintain a record of all reports and actions.	Immediately	All personnel
2. Weed and pathogen protocol		
• All machinery will be cleaned using high-pressure water or compressed air prior to entering a national park.	Prior to entering parks	All personnel
• Prior to moving between sites, or exiting a national park, machinery and equipment will be manually cleaned to remove dirt.	Prior to moving between sites	All personnel

Environmental controls	Timing/ frequency	Responsibility
3. Fire and emergency management		
• A fire emergency and evacuation plan will be prepared and implemented for each site as part of the operational plan.	Prior to commencement at a site	Implementation coordinator/ contractors
• Vehicles will keep to formal access roads in accordance with existing park management practices, which will reduce the risk of ignition.	At all times	All personnel
• Fire extinguishers (water only) will be made readily available in periods of high fire danger.	At all times during period of high fire danger	Implementation coordinator/ contractors
• No fires will be lit on the site and littering of cigarette butts will not be permitted.	At all times	All personnel
4. Training and awareness		
• All personnel must complete a project induction and be suitably qualified to undertake their work.	Prior to commencing work	All personnel

Monitoring program

- Ad-hoc observations made during tree mark up

Contingencies

Refer Section 6.3.3:

- unexpected future detection of matters of national environmental significance
- flooding
- discovery of suspected Aboriginal cultural heritage item/site.

Estimated indicative cost to implement controls in this project delivery standard

$25,000

Treatment phase (felling and transportation and storage)
Objective

To appropriately manage felling activities, and transportation and storage of excess felled material

Performance criteria

Compliance with legislation listed in Section 6.1.1

Conformance with all environmental limits and controls specified in the project delivery standard

Application

Felling activities within treatment plots.

Transportation of excess felled material along park access roads to stockpile sites.

Other activities in the treatment phase are covered by a separate project delivery standard (Table 6.4).

Table 6.5: Treatment phase (felling and transportation and storage) – project delivery standard.

Environmental controls	Timing/ frequency	Responsibility
1. Flora and fauna		
• If any removal of native vegetation is required, a suitably qualified ecologist will assess this vegetation prior to removal.	Prior to removal	Implementation coordinator/ specialist staff
• Any removal of native vegetation will be to a minimum extent and in accordance with existing park management practices.	At all times	Implementation coordinator/ contractors
• Contractors will not travel at speeds greater than 50 kilometres/hour within a national park.	At all times	Contractors
• In order to confirm EPBC Act-listed species are not present during felling, an additional walk-through will be conducted by a suitably qualified ecologist immediately prior to commencement of the first day of felling operations. If an EPBC Act-listed species, habitat suspected of use by the species (e.g. nest site) is found to be present, the 'unexpected future detection of matters of national environmental significance' contingency will apply.	Immediately prior to commencement of the first day of felling operations at a site	Implementation coordinator/ specialist staff
• Injury or death of native flora and fauna species will be reported to the implementation coordinator. The implementation coordinator will maintain a record of all reports and actions.	Immediately	All personnel
• All coarse woody debris that exists within a treatment plot prior to the commencement of felling activities will not be disturbed and will not be removed from the plot.	At all times	Contractors
• Depending on the site location and conditions, trees may be removed to temporary 'log landings' prior to loading onto trucks. Native vegetation will not be cleared to establish a log landing.	If log landings are required	Contractors
• Treatment operations will be undertaken during daylight hours.	At all times	Contractors
• All machinery will be fitted with appropriate mufflers to minimise noise and will be regularly serviced.	At all times	Contractors

Environmental controls	Timing/ frequency	Responsibility
2. Soil and waterway management		
• Natural surface tracks will not be bladed off (i.e. stripped of ground layer vegetation to expose bare earth).	At all times	Implementation coordinator/ contractors
• Widths for natural surface tracks will be kept within a maximum of 4 metres. Routes for natural surface tracks will avoid drainage feature crossings where possible.	At all times	Implementation coordinator/ contractors
• A minimum 50-metre protection buffer from waterways will be maintained. Additionally, a 20-metre protection buffer will be established around unmapped drainage lines where possible.	At all times	Implementation coordinator/ contractors
• Use of B-double vehicles, which would require road widening, will not be permitted.	At all times	Contractors
• Felled material will be removed to trucks using forwarders, which do not drag trees along the ground.	At all times	Contractors
• Treatment activities will cease during or immediately following rainfall events, or where floodwater has encroached onto a site.	During rainfall or as directed by implementation coordinator	Contractors/implementation coordinator
3. Fuels, oils, chemicals and hazardous goods		
• Pre-start checks will be conducted to identify any machinery faults.	Daily	Contractors
• All vehicles, plant and equipment will be maintained to limit risk of accidental spills.	As per manufacturer instructions	Contractors
• Spill kits will be carried in all contractor vehicles.	At all times	Contractors
• Heribicide will be carried in secure containers.	At all times	Contractors
• Heribicide will be mixed and equipment rinsed well away from any waterway.	At all times	Contractors
• All refuelling will occur in designated bunded areas.	At all times	Contractors
• Any spills will be reported to the Implementation Coordinator.	Immediately	All personnel
• Any soils or other material contaminated by the spill will be removed and disposed	As soon as practicable	Contractors

Environmental controls	Timing/ frequency	Responsibility
of at a landfill site in a manner consistent with the Environment Protection (Industrial Waste Resource) Regulations 2009 (Vic) or Protection of the Environment Operations (Waste) Regulation 2005 (NSW).		
4. Weed and pathogen protocol		
• All machinery will be cleaned using high-pressure water or compressed air prior to entering a national park.	Prior to entering parks	All personnel
• Prior to moving between sites, or exiting a national parks, machinery and equipment will be manually cleaned to remove dirt.	Prior to moving between sites	All personnel
• Contractors will be required to keep a formal record of equipment clean downs undertaken.	After each clean down	Contractors
5. Fire and emergency management		
• A fire emergency and evacuation plan will be prepared and implemented for each site as part of the operational plan.	Prior to commencement at a site	Implementation coordinator/ contractor
• Machinery that may be a source of ignition will not be used during periods of extreme fire danger or days of Total Fire Ban.	Where applicable	All personnel
• Chainsaws and machinery will be fitted with functioning spark arresters.	At all times	Contractors
• Fire extinguishers will be located within machinery in order to combat fuel fires.	At all times	Contractors
• Vehicles will keep to formal access roads in accordance with existing park management practices, which will reduce the risk of ignition.	At all times	All personnel
• Fire extinguishers (water only) will be made readily available in periods of high fire danger.	At all times during period of high fire danger	Contractors
• No fires will be lit on the site and littering of cigarette butts will not be permitted.	At all times	All personnel
• Contractors will ensure that coarse woody debris levels do not exceed a limit of 45–50 tonnes/hectare (unless pre-felling levels exceed this amount, in which case the pre-felling level will be maintained).	At all times	Contractors
6. Training and awareness		
• All personnel must complete a project	Prior to commencing	All personnel

Environmental controls	Timing/ frequency	Responsibility
induction and be suitably qualified to undertake their work.	work.	

Monitoring program

Refer Section 6.3.1:

- contractor site inspections
- equipment clean down records
- local rainfall event monitoring
- post-flood water quality monitoring.

Contingencies

Refer Section 6.3.3:

- unexpected future detection of matters of national environmental significance
- flooding
- discovery of suspected Aboriginal cultural heritage item/site
- unauthorised firewood collection.

Estimated indicative cost to implement controls in this project delivery standard

$50,000

Site monitoring phase

Objective

To appropriately manage site monitoring activities

Performance criteria

Compliance with legislation listed in Section 6.1.1

Conformance with all environmental limits and controls specified in the project delivery standard

Application

Site monitoring activities within all treatment and control plots

Table 6.6: Site monitoring phase – project delivery standard.

Environmental controls	Timing / frequency	Responsibility
1. Flora and fauna		
• Surveys of flora and fauna are to be conducted by a suitably qualified ecologist.	As required by experimental design	Implementation coordinator/ specialist staff
• Monitoring in NSW will occur under a scientific licence (SL 100124) and animal care and ethics licence (AEC 090316/01).	At all times	Implementation coordinator/ specialist staff
• Monitoring in Victoria will be conducted under a research permit from DEPI to be obtained prior to commencement of scientific monitoring activities on public land.	At all times	Implementation coordinator/ specialist staff
• Access for site monitoring will occur on foot from existing site access roads.	At all times	Implementation coordinator/ specialist staff
• Injury or death of native flora and fauna species will be reported to the implementation coordinator. The implementation coordinator will maintain a record of all reports and actions.	Immediately	All personnel
2. Weed and pathogen protocol		
• All machinery will be cleaned using high-pressure water or compressed air prior to entering a national park.	Prior to entering parks	All personnel
• Prior to moving between sites, or exiting a national park, machinery and equipment will be manually cleaned to remove dirt.	Prior to moving between sites	All personnel
3. Fire and emergency management		
• A fire emergency and evacuation plan will be prepared and implemented for each site as part of the operational plan.	Prior to commencement at a site	Implementation coordinator/ specialist staff
• Vehicles will keep to formal access roads in accordance with existing park management practices, which will reduce the risk of ignition.	At all times	All personnel
• Fire extinguishers (water only) will be made readily available in periods of high fire danger.	At all times during period of high fire danger	Implementation coordinator/ specialist staff
• No fires will be lit on the site and littering of cigarette butts will not be permitted.	At all times	All personnel

Environmental controls	Timing / frequency	Responsibility
4. Training and awareness • All personnel must complete a project induction and be suitably qualified to undertake their work.	Prior to commencing work	All personnel

Monitoring program

Refer Section 6.3.1:

- monitoring of trial outcomes
- post-flood water quality monitoring.

Contingencies

Refer Section 6.3.3:

- flooding.

Estimated indicative cost to implement controls in this project delivery standard

$25,000

6.2.2. Aboriginal cultural heritage matters

In NSW, written approval from traditional owner groups is required before the ecological thinning trial can commence. Representatives of Yorta Yorta Nation Aboriginal Corporation and Cummeragunja Local Aboriginal Land Council undertook cultural heritage site assessments of proposed thinning treatment plots in NSW. Letters of clearance have been received for all treatment plots within NSW. Recommendations made by these groups for each of the trial sites have been included within the operational plan for each site and inductions with work crews will identify any cultural heritage conditions prior to commencing work on the plot. Requirements for each site vary according to what was located during the assessment. Some sites require no action, while other sites require the buffering of a cultural site.

In Victoria, Yorta Yorta Nation Aboriginal Corporation representatives undertook cultural heritage site assessments of proposed plots in Victoria. Yorta Yorta cultural heritage staff will inspect additional areas of concern such as proposed 'natural surface tracks' prior to work commencing. Ongoing consultation will occur between PV and Yorta Yorta under the joint management arrangements for the Barmah National Park.

6.2.3. Induction, training and awareness requirements

All personnel conducting work related to the ecological thinning trial (e.g. NPWS and PV staff, contractors and their employees and/or subcontractors) must first undertake a project induction. Induction topics will include, but not be limited to:

- an overview of the activity
- legal and other requirements
- key environmental issues, including information on EPBC Act-listed matters of national environmental significance
- environmental mitigation and control measures
- work health and safety requirements
- emergency response requirements (including bushfire)
- incident and non-conformance reporting
- waste management
- communication requirements

- consequence of departure from the requirements of this EMP.

All personnel shall be suitably qualified and experienced to undertake their work in an environmentally responsible manner.

Prior to the commencement of the treatment activities at each site, a site-specific induction will be held. These inductions will include the identification of exclusion zones (i.e. areas where thinning or vehicle usage is prohibited), buffers, sites of cultural significance and other matters outlined in the operational plan for each site. Contractors engaged to undertake the thinning operations will be expected to provide a site safety induction to all employees and/or sub-contractors prior to the operations commencing. A copy of the induction must be provided to the NPWS or PV implementation coordinator.

Once thinning operations commence the contractor must conduct weekly on-site 'toolbox talks', with all employees and/or subcontractors in attendance. A 'toolbox talk' form must be completed after the talk and signed by all attendees. Any visitors to the site during the operation will also be required to sign a visitor log and be accompanied by an inducted person at all times.

Records of training and inductions will be maintained by the implementation coordinators.

6.2.4. Communication

Internal communication

Internal communication methods include meetings, toolbox meetings, emails, newsletters and notices.

The successful implementation and long-term monitoring of the ecological thinning trial relies on the ongoing consultation between the cross-border parties, namely OEH, PV, DEPI. Coordination meetings attended by implementation coordinators will be held at least fortnightly during the establishment and treatment phases, and as required during the site monitoring phase.

Specialist advice will also be sought as required during the trial. This may include traditional owner groups, ecologists and additional specialists from within OEH, PV and DEPI.

External communication

A variety of methods will be used to enable information to be distributed to, and received from, interested members of the community and key stakeholders. These may include the following:

- departmental/agency websites
- email
- media releases
- newspaper advertisements
- direct verbal or written advice (e.g. telephone, letter, email).

Key stakeholders include Commonwealth, state and local government bodies, park users, participants in domestic firewood programs, industry representatives, and Aboriginal and heritage groups.

All complainants will receive a response as soon as practicable using existing internal agency guidelines for park management issues.

6.2.5. Operational plans

An operational plan will be developed for each trial site. Operational plans will be developed in collaboration by OEH, PV and DEPI, and will detail specifics for implementation including:

- specific operational requirements for marking, felling and coarse woody debris levels
- legal conditions and responsibilities
- safety requirements, including emergency response and traffic control
- general environmental and cultural heritage requirements
- site-specific environmental and cultural heritage conditions and controls (including exclusion zones)
- soil and drainage feature conditions (including buffer zones).

Operational plans will be concise documents approximately 10 pages in length, and will include a map of the site and associated environmental controls. See Appendix 5 for example operational plans to be used by NPWS and PV.

Within NSW, each operational plan will be forwarded to the Office of Environment and Heritage (OEH) – Regional Operations Group for their information. This is a condition of the approved REF for the activity under NSW legislation.

6.2.6. Document and record control

Environmental documents and records will be managed in accordance with existing PV and NPWS document control systems. All records will be maintained for the life of the ecological thinning trial, and may form evidence for an audit or management review.

Contractors will be required to maintain copies of all documentation, including coupe diaries, site sign-in registers and toolbox talk records.

6.3. Checking

6.3.1. Monitoring and measurement

Environmental performance will be monitored by:

- process monitoring and inspections– monitoring of operational activities and compliance with environmental controls/conditions (e.g. inspections of plots during treatment, tracking of equipment clean down)
- environmental monitoring – monitoring of specific parameters (e.g. water quality) to assess physical effects of ecological thinning trial activities.

As part of the monitoring surface water quality, the implementation coordinators will use existing data collected by the NPWS and Goulburn Broken Catchment Management Authority (GBCMA) under the *National Water Quality Management Strategy* and the Living Murray Initiative, as well as groundwater gauges operated by NPWS. Further detail on existing monitoring activities is provided in Appendix 8.

Table 6.7 outlines the monitoring activities that will be implemented during the ecological thinning trial.

Table 6.7: Monitoring activities to be conducted during the ecological thinning trial.

Monitoring activity	Trial phase	Frequency	Responsible parties
Process monitoring and inspections	—	—	—
Contractor site inspections At least one site per week will be inspected at random during felling operations to assess compliance with this EMP, the operational plan and any subordinate documents. A contractor site-inspection checklist will be developed prior to commencement of the trial. The checklist will be completed for each site inspection and copies retained for the length of the trial.	Treatment (felling and transportation)	Weekly	Implementation coordinator
Equipment Clean Down Records A formal equipment clean-down record template will be developed prior to commencement of the trial. Contractors will be required to document clean downs conducted on all machinery under the weed and hygiene protocols listed in the project delivery standards. Records are to be provided to implementation coordinators.	Establishment and Treatment (felling and transportation)	After all equipment clean downs	Contractors
Environmental monitoring	—	—	—
Local rainfall event monitoring The implementation coordinator or a delegate will monitor weather forecasts on a daily basis to identify potential for major rainfall events. Contractors will not be permitted to commence operations during a period where a major rainfall event is forecast.	All	Daily during establishment and treatment phase	Implementation coordinator
Post-flood water quality monitoring In the case of a flooding event in the Barmah–Millewa, implementation coordinators will liaise with NPWS and GBCMA personnel responsible for water quality monitoring in response to flooding events that may generate a blackwater event. Additional samples may be taken at	All	After flooding events	Implementation coordinator

Monitoring activity	Trial phase	Frequency	Responsible parties
the discretion of the implementation coordinator. Data will be interrogated to identify any potential effects from ecological thinning trial activities. Monitoring is conducted for temperature, dissolved oxygen, conductivity, pH, redox potential, depth and turbidity. The location of monitoring sites vary occurring to the extent of the flooding event, the location of potential effluent sites (where flows from the forests return to the river system) and at locations which allow the assessment of cumulative changes in water quality (Childs et al. 2012). The need for additional water quality monitoring during the ecological thinning trial has been considered. Due to the flat topography of the Barmah–Millewa, runoff from localised rainfall events is expected be retained within the forest and is unlikely to enter rivers or other flowing waterways.			
Monitoring of trial outcomes Monitoring of the scientific outcomes of the ecological thinning trial will be conducted as per the Experimental Design and Monitoring Plan (see Appendix 1).	Site monitoring	As per Experimental Design and Monitoring Plan	Implementation coordinator

6.3.2. Non-conformance, corrective and preventative action

Environmental incidents, near-misses and non-conformances are to be reported by all personnel where applicable. Registers of all reports are to be maintained by the NPWS and PV implementation coordinators, with this register also used to track the implementation of corrective and preventative actions.

The requirement to report incidents, near-misses and non-conformances will be included in inductions and reinforced during the project. A ‘no-blame’ reporting culture will be promoted, with contractor personnel be encouraged to report any previously unknown matter (e.g. unmarked hollow-bearing tree, site of potential cultural heritage significance etc.) which they observe during ecological thinning trial activities.

6.3.3. Contingency measures

Table 6.8 details management responses that would be implemented should one of the following scenarios occur:

- unexpected future detection of matters of national environmental significance
- discovery of suspected aboriginal cultural heritage item/site
- bushfire
- flooding
- unauthorised firewood collection from trial plots.

Table 6.8: Contingency measures.

Scenario	Contingency measure
Unexpected future detection of matters of national environmental significance	All treatment and control plots were surveyed for listed species by a suitably qualified ecologist. Site selection avoided known occurrences of listed species. In the event that EPBC Act-listed species are identified during establishment, treatment or monitoring activities, these activities will immediate cease in the vicinity of the listed species. The individual who identifies the species is to notify immediately notify the implementation coordinator. The implementation coordinator will consult with a suitably qualified ecologist to determine the most appropriate course of action. This may include establishment of buffer zones in which no felling activities will occur. The following species-specific buffer areas are mandatory: The implementation coordinator will maintain a record of all reports and actions.
Discovery of suspected Aboriginal cultural heritage item/site	In the unlikely event that an Aboriginal cultural heritage feature, or a feature suspected of being of Aboriginal cultural heritage significance, is disturbed during construction, a 'stop work' contingency protocol will be applied: • works will cease immediately within the applicable plot • the identified feature will be protected (e.g. temporary fencing) • liaison with Aboriginal Affairs Victoria or NSW Office of Communities (Aboriginal Affairs) and Registered Aboriginal Parties (Cummeragunja Local Aboriginal Land Council or the Yorta Yorta Nation Aboriginal Corporation) to determine further requirements • implement requirements • police will be contacted should human remains be discovered. All construction crew will be made aware of stop work contingency measures if Aboriginal cultural heritage is uncovered during construction.

Scenario	Contingency measure
Flooding	Proposed timing of the ecological thinning trial has been chosen to minimise the likelihood of flooding in Barmah–Millewa during the establishment and treatment phases. To minimise the risk flooding during treatment activities, the proposed treatments will be scheduled in a staged order, focusing on sites which are most likely to be affected by flooding first and those sites less likely to be flooded last. However, there remains some potential for flooding to occur during this period. Should flooding occur prior to the commencement of any works, the treatment of those sites unaffected by the flooding will occur first, and then those sites affected by the flooding will be undertaken once the site has been deemed sufficiently dry and accessible by parks management personnel. Should flooding occur during treatment activities at a given site, the activities will cease immediately and will not recommence until the site has been deemed sufficiently dry and accessible by parks management personnel.
Unauthorised firewood collection	The collection of firewood from within Barmah–Millewa is managed through strategic domestic firewood programs involving the identification of designated firewood collection areas for residents living within a specified restricted area (i.e. only NSW Riverina residents may collect firewood from identified areas within Millewa forest, while only Victorian residents living in Campaspe Shire, Moira Shire and City of Greater Shepparton may collect from within the Barmah forest). NPWS and PV compliance activities monitor and where necessary enforce relevant legislated park management regulations where illegal firewood collection is found to occur.

6.3.4. Auditing

PV and NPWS will develop an environmental audit program to assess the conformance of the ecological thinning trial with the requirements of this EMP. The program will take account of:

- the timing of the proposed thinning activities
- the environmental risks of the trial
- project delivery standards.

At a minimum, an audit will be conducted concurrently with site monitoring to be undertaken 1 year after the commencement of thinning operations. A second audit will be conducted during the 5 year monitoring period.

The audit will evaluate performance on the basis of PV and NPWS environmental management records. The audit activities may also include direct observation of activities, as relevant.

The audit report will include:

- summary of findings
- audit objective
- audit scope
- audit activities
- audit reference documents
- audit findings and conclusion.

The audit findings will inform the management review of the EMP (see Section 6.4). The audit report will be provided to the Commonwealth DoE and the River Red Gum Executive Group.

6.3.5. Change management

The need for changes to trial activities as described in Section 2 of this Public Environment Report may be identified through the following processes:

- monitoring and measurement
- audits
- management reviews
- in response to unexpected events requiring implementation of a contingency measure (e.g. extreme rainfall/flooding).

Prior to implementation, proposed changes will require review and approval, including an assessment of the risk associated with the change, and compliance with legal requirements. Changes that would require review and approval include:

- alteration to the timing of treatment phase activities – review and approval provided by the cross-border River Red Gum Operations and Policy Group
- modification of treatment methods – review and approval provided by the River Red Gum Executive Group and SAC
- adjustment of environmental monitoring requirements – review and approval provided by the River Red Gum Executive Group and SAC.

6.4. Management review and continuous improvement

A review of this EMP and environmental performance will be undertaken by the PV and NPWS project directors upon receipt of environmental audit findings.

The review will consider:

- results of the environmental audit, including findings regarding compliance with product delivery standard
- compliance with legal requirements, including statutory approvals and other commitments
- environmental performance monitoring results
- results of inspections and surveys

- project risk profile
- lessons learned.

Management reviews will ensure the continued effectiveness, suitability and adequacy of environmental management arrangements and identify opportunities for continuous improvement. Where an opportunity for continual improvement has been identified as part of the management review process, the following actions may be considered:

- development of new procedures
- modification of existing procedures
- modification to project schedule
- modification to training schedule and/or programs
- review of risk register
- seek input from relevant specialists
- consideration of further investigations.

Any action arising from the management review will be assigned responsibility and tracked until completion.

6.5. Additional offsetting requirements

Based on the impact assessment conducted in Section 5, and taking into account the control measures described in this environmental management plan, it is considered that the proposed ecological thinning trial will not result in a significant impact on any EPBC Act-listed matter of national environmental significance. As such, no offsetting of impacts will be required.

7. Consultation

This section outlines the stakeholder engagement and consultation activities that have already taken place, as well as those that are proposed.

Additional to the consultation outlined below, a rigorous scientific review process has occurred to ensure that the experimental design meets the trial objectives, and that outcomes can be rigorously monitored. This scientific review process is a critical part of the consultation undertaken for this activity, and is discussed in Section 8.

7.1. Cross-border committees and groups

With the establishment of the Barmah–Millewa as national parks in Victoria and NSW, cross-border committees have been established at various levels to develop joint strategies to manage these reserves and promote the persistence of indigenous flora and fauna.

7.1.1. River Red Gum Executive Group

This group provides overarching communication and guidance regarding policy, planning, programs and operations as well as other cross-border initiatives relevant to the river red gum reserves. The group consists of:

- Michael Wright – Office of Environment and Heritage (OEH), Deputy Chief Executive of National Parks and Wildlife Service (NPWS)
- Mark Peacock – OEH, Director, Western Branch, NPWS
- Bill Jackson – Parks Victoria (PV), Chief Executive
- Nina Cullen – Department of Environment and Primary Industries (DEPI), Director, Land Management.

River Red Gum Operations and Policy Group (sub-committee of executive group)

This group monitors the implementation of programs and policies that apply across the river red gum forests in both states, with a particular focus on the implementation of the ecological thinning trial.

- Craig Stubbings, PV Northern Region Director
- Stuart Hughes, PV Northern Region Operations Manager
- Ross McDonnell, Regional Manager – Western Rivers Region NPWS
- Daniel Basham, Area Manager – South West Area NPWS.

7.1.2. Joint NSW–Victoria Working Group

Key representatives from OEH and PV have met on an as needs basis since May 2011 to discuss ecological thinning trial design, monitoring programs and resourcing strategies. Core personnel in the working group have been:

- Tim O'Kelly (OEH NPWS)
- Chris McCormack (PV)
- Paul Childs (OEH NPWS)
- Jeff Carboon (PV)

- David Parker (OEH NPWS)
- Patrick Pigott (PV)
- Dr Emma Gorrod (OEH Scientific Services Division)

Members of this group continue to provide technical, operational and logistical advice and support in relation to the proposed ecological thinning trial. Additional personnel from DEPI and NSW Environment Protection Authority (EPA) have also contributed to the Working Group at various stages.

7.1.3. River Red Gum Adaptive Management Scientific Advisory Committee

The River Red Gum Scientific Advisory Committee (SAC) was established to provide quality assured scientific advice to government on the management of the river red gum forests and reserves. This group meets on an as-needs basis up to three times per year. This group endorsed the ecological thinning trial program and associated monitoring methodology on 1 December 2011. The SAC is discussed further in Section 8.

7.2. Other agencies and stakeholders consulted to date

A range of other agencies and stakeholders were consulted regarding the proposed ecological thinning trial. A summary of the outcomes of this consultation is provided in Table 7.1.

Table 7.1: Outcomes of consultation undertaken to date.

Agency/ stakeholder	Consultation activities	Outcomes of consultation
Department of the Environment (DoE), formerly Department of Sustainability, Environment, Water, Population and Communities (SEWPaC)	Representatives from OEH have discussed the adaptive management projects proposed for the NSW river red gum reserves with DoE representatives. On 25 November 2011, OEH provided SEWPaC via email with a summary of the scope and scale of the project, and indicated that when the experimental design and monitoring plan was completed the project would be referred to the Commonwealth under the EPBC Act. Consultation has also been conducted regarding the revision of the NSW Central Murray Forests Ramsar Ecological Character Description (ECD). The consultation and input into the content of the ECD has included discussion regarding the proposed ecological thinning program. On 29 June 2013, representatives from SEWPaC met on-site with representatives from DEPI, OEH and PV to discuss the trial,	The proposed ecological thinning trial is currently progressing through the EPBC Act referral process, as described further in Section 7.3 below.

Agency/ stakeholder	Consultation activities	Outcomes of consultation
	focusing on the rationale and approvals processes.	
Environmental Liaison Office (NSW)	A meeting was held involving representatives from peak NSW environment groups (Wilderness Society, National Parks Association, Nature Conservation Council) and OEH representatives on 9 December 2011. OEH provided an update on the basis and development of the proposed trial.	The proposed ecological thinning trial was noted by these groups.
Forestry Corporation of NSW (FCNSW) (formerly Forests NSW)	This agency was consulted regarding the potential for a cross-tenure trial. Representatives visited the site with OEH staff and a copy of the draft river red gum ecological thinning trial design was provided to Forests NSW for comment on 2 March 2012.	Comments were received from FCNSW which raised concerns about the project's potential costings and potential for the trial to compete against FCNSW for harvesting contractors engaged in thinning activities and the impacts that this may have on harvesting operations within local state forests.
Friends of the Earth	Representatives from OEH met with Friends of the Earth to outline and discuss the proposed ecological thinning trial. This included an on-site visit to Millewa.	While the proposed ecological thinning trial is not supported by Friends of the Earth, representatives said that they understood the intent of the activity. Additionally, Friends of the Earth supports the joint management of the river red gum forests.
Murray Darling Basin Authority (MDBA)	Representatives from OEH have discussed the adaptive management projects proposed for the NSW river red gum reserves with the MDBA.	The proposed ecological thinning trial was noted by these groups.
Murray Shire and the collective Riverina and Murray Region Organisation of	Details of the proposed trial have been presented to these organisations.	The proposed ecological thinning trial was noted by these groups.

Agency/ stakeholder	Consultation activities	Outcomes of consultation
Councils		
NSW Office of Water and Murray CMA	The implementation coordinators of a re-snagging program for fish habitat and riverbank stabilisation along the Murray River were consulted regarding the potential opportunities which the ecological thinning program may have to supply surplus thinning residue for this project, thus providing an additional environmental benefit.	Specifications were provided and this will be part of the re-use of surplus thinning residue generated in NSW.
NSW National Parks Association (NPA), Wilderness Society and Colong Foundation	On 14 March 2011, representatives from OEH delivered a presentation on the adaptive management projects proposed for the NSW river red gum reserves to the NPA and Wilderness Society at the NPA office in Sydney.	The proposed ecological thinning trial was noted by these groups.
NSW Natural Resources Commission (NRC)	This organisation provided the recommendation to implement an ecological thinning trial in its River Red Gum Forests and Woodlands Assessment Final Report (2010). Since then, various meetings have been held between NPWS and NRC representatives, with updates provided on the trial and comment provided by NRC representatives.	Progress in developing the ecological thinning trial was noted by the NRC.
River Red Gum Technical Advisory Group (Parks Victoria (PV))	This external committee was set up by PV in 2010 to support establishment of the Active Forest Health Program. It comprised independent scientists and community representatives from a range of organisations outside PV. A Technical Advisory Group meeting to visit sites and discuss the ecological thinning trial was held in February 2012.	The River Red Gum Technical Advisory Group generally supported the objectives and design of the ecological thinning trial. However, a minority view was expressed by some members regarding potential negative impacts on Barmah National Park as a result of trial activities proposed activities.
River red gum	Some members of the local river red gum timber industry have been critical of the	The proposed ecological thinning trial is not fully

Agency/ stakeholder	Consultation activities	Outcomes of consultation
timber industry representatives	reservation of the former state forests on the NSW side of the Murray River due to the apparent loss of personal income and perceived impact to the regional economy. PV staff held a timber industry briefing regarding the establishment of river red gum parks (including the topic of ecological thinning) in October 2010. On-site briefings regarding the tender process for ecological thinning trial felling contractors were held with commercial operators in October 2012 (Millewa) and January 2013 (Barmah).	supported by this group. Some Victorian representatives reported concern regarding the trial's implications for ongoing access to timber harvesting resources.
Victorian Environmental Assessment Council (VEAC)	The organisation provided the recommendation in their River Red Gum Forests Investigation Final Report (2008) that ecological thinning of river red gum forests be trialled.	Following a community consultation process, the Victorian Government provided a response to VEAC recommendations including broad support to investigate ecological thinning.
Victorian National Parks Association (VNPA) and Wilderness Society (Vic)	Formal briefings were held by PV September 2010 (regarding the Active Forest Health Program, which includes ecological thinning), and again in May 2012 with specific reference to the ecological thinning trial. Informal conversations were also held between staff of these organisations.	Following the 2012 meeting, VNPA expressed its concerns over several aspects of design and implementation of the ecological thinning trial. It also sought comment on the design of the ecological thinning trial from independent scientific experts. Although not supporting the proposed design of the ecological thinning trial, the VNPA understood the need to investigate river red gum forest health issues as reported on by VEAC.
Yorta Yorta Nation Aboriginal	Regular has communication has occurred during planning of the trial, including	Letters of clearance have been received for all

Agency/ stakeholder	Consultation activities	Outcomes of consultation
Corporation and Cummeragunja Local Aboriginal Land Council	assessment of potential impacts and identification of ameliorative requirements. Representatives from Yorta Yorta Nation Aboriginal Corporation and Cummeragunja Local Aboriginal Land Council undertook cultural heritage site assessments of proposed thinning treatment plots in NSW. Representatives from Yorta Yorta Nation Aboriginal Corporation undertook cultural heritage site assessments of proposed thinning treatment plots in Victoria. Meetings were also held with representatives of these organisations to discuss potential opportunities for training, capacity building and work opportunities which may occur during the ecological thinning trial.	treatment plots within NSW. Recommendations made by these stakeholder groups will be considered for inclusion in site-specific operational plans where applicable. Ongoing consultation will occur between PV and Yorta Yorta under the joint management arrangements for the Barmah National Park.

7.3. Consultation as part of statutory approvals processes

7.3.1. Public Environment Report

On 24 December 2012, the proposed ecological thinning trial was referred to the Commonwealth Minister for the Environment under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). A period for public comment was provided as required under the EPBC Act, during which time 12 public submissions were received. In response to the submissions, some minor changes were made to the process model; however, the comments did not result to any change in the proposed Experimental Design and Monitoring Plan.

On 6 February 2013, a delegate of the Minister determined that assessment and approval is required as the action has the potential to have a significant impact on matters of national environmental significance that are protected under Part 3 of the EPBC Act, specifically:

- wetlands of international importance (sections 16 and 17B)
- listed threatened species and communities (sections 18 and 18A)
- listed migratory species.

It was determined that the proposed activity be assessed by a Public Environment Report (PER). On 28 October 2012, the Minister released the *Draft tailored guidelines for the preparation of a draft Public Environment Report'*, with the general public provided an opportunity to provide comment prior to finalisation of the guidelines in April 2013.

7.3.2. Review of Environmental Factors

An opportunity for public comment was provided as part of the Review of Environmental Factors (REF) under the NSW *Environmental Planning and Assessment Act 1979*. Three submissions were received in total, of which two objected to the proposal.

While one submission received did not make a definitive statement that could be considered as supporting the proposal, neither did it make a definitive statement objecting to the proposal. Instead, this proposal offered comments of precaution and highlighted the need for monitoring over many seasons. The submission made comment of potential impacts on the forest ecosystem, including the potential for an increase in more aggressive species and the resulting reduction of biodiversity, a congregation of insect pests and the proliferation of mistletoes.

The two objectors, including one from the river red gum timber industry, claimed that the river red gum forests of Millewa did not exist prior to European settlement, and that the forests would never have seen a build-up of 45–50 tonnes of coarse woody debris across the forest floor.

The results of this public exhibition did not result in any change to the proposed activity.

7.4. Ongoing consultation

7.4.1. Cross-border consultation

Ongoing communication between the managing agencies will occur as described in Section 6.2.4.

The River Red Gum Executive Group, the River Red Gum Operations and Policy Group and the Joint NSW–Victoria Working Group will continue to meet on a regular basis during implementation of the proposed ecological thinning trial.

7.4.2. Community and stakeholder engagement

A period for public comment on this draft PER is now being provided, after which time the PER will be finalised by the proponents taking into account the comments received.

Ongoing communication and engagement with stakeholders during trial activities will occur as described in Section 6.2.4.

8. Scientific Review

This section describes the three key processes that were undertaken to ensure the scientific integrity and robustness of the ecological thinning trial:

- development of the process model underpinning the experimental design (Process Model Consultative Group)
- review and endorsement of the Experimental Design and Monitoring Plan by the River Red Gum Adaptive Management Scientific Advisory Committee (SAC)
- independent review of the Experimental Design and Monitoring Plan by Dr Andrew Robinson.

8.1. Process Model Consultative Group

A workshop was held on 18–19 August 2011 to initiate the development of a process model for river red gum ecosystems. In the context of the ecological thinning trial, a process model is sought to better predict likely responses of river red gum ecological communities to thinning.

The core aim of the workshop was to generate plausible models of ecological cause and effect under alternative management scenarios (Walshe et al. 2011). To achieve this, a group of experts with river red gum and/or floodplain ecology experience were invited to participate (refer Table 8.1).

Table 8.1: Process Model Consultative Group participants.

Name	Organisation
Facilitators	—
Dr Emma Gorrod	NSW Office of Environment and Heritage (OEH)
Dr Terry Walshe	University of Melbourne
Dr Libby Rumpff	University of Melbourne and member of SAC
Participants	—
Dr Skye Wassens	Charles Sturt University and member of SAC
Assoc. Prof. Ian Lunt	Charles Sturt University and member of SAC
Keith Ward	Goulburn Broken CMA
Dr Shaun Cunningham	Monash University
Prof. David Keith	NSW OEH
Michael Pennay	NSW OEH
Rick Webster	NSW OEH
Sharon Bowen	NSW OEH
Patrick Pigott	Parks Victoria

Name	Organisation
Facilitators	—
Phil Peglar	Parks Victoria
Assoc. Prof. Leon Bren	University of Melbourne and member of SAC
Prof. Richard Kingsford	University of NSW and member of SAC
Prof. Barbara Downes	University of Melbourne
Dr Andrew Hayward	Victorian DSE (now Department of Environment and Primary Industries (DEPI))
Tuesday Phelan	Victorian DSE (now DEPI)
Ben Tate	Water Technology
Dr Steve Hamilton	Water Technology

8.1.1. Findings

The outcome of the workshop was development, by consensus, of process models for woodlands and grassland systems on the floodplain, and two competing models on stand structure and surface water for forests. These models were used to prepare a state and transition model for manipulation of these vegetation systems using ecological thinning and environmental flows (Walshe et al. 2011).

As a result, the state and transition model was formalised as a Bayesian belief network, as in described in Rumpff et al (2011). Bayesian networks are favoured as they allow prior beliefs about system response to be updated as new data arises, they have the ability to deal with a mix of data sources, they can be built with stakeholders, and they are presented graphically, thus facilitating communication. Analysis of these models was used in development of the experimental design and methodology for the ecological thinning trial (Office of Environment and Heritage (OEH), Parks Victoria (PV) and DSE (now Department of Environment and Primary Industries (DEPI) 2012).

The report by Walshe et al (2011) on the outcomes of this workshop is provided in Appendix 9.

8.2. Independent scientific review of experimental design

As part of the critical review process, the experimental design and monitoring approach was provided to Dr Andrew Robinson for critical independent scientific peer review (see Appendix 6 for the full review).

Dr Robinson attained his PhD in Forest Resources from the University of Minnesota, USA completing his thesis ‘Forest ecosystem dynamics: a systematic approach to modelling in a model-rich environment’. Since this he has held the positions of Associate Professor of Forest Mensuration and Forest Biometrics at the University of Idaho and authored two books in forest analytics and scientific programming and programming, as well as numerous peer-reviewed articles in many international scientific journals.

Dr Robinson currently holds the position of senior lecturer in applied statistics in the Department of Mathematics and Statistics at the University of Melbourne, and is Deputy Director of the Centre of Excellence for Biosecurity Risk Analysis.

8.2.1. Findings

The review by Dr Robinson found that:

> *'the proposed experimental design gets the big picture right. The design uses replication, blocking across anticipated gradients, hierarchical structure, and randomisation as a basis for applying the experiment to the river red gum forest…The design proposes measurement and monitoring of an extensive suite of variables of interest; the variables occupy a reasonable and appropriate gradient of spatial and temporal scale, and are tightly connected to the motivating hypotheses. The design is very well motivated through extensive and correct use of the available scientific and grey literature. The outcome of the broad hypothesis tests is appropriately uncertain'.*

Dr Robinson recommended that some modifications be made to the trial which may improve the specification, robustness, or utility of the design, as shown in Table 8.2.

Table 8.2: Independent scientific peer review recommendations and subsequent responses by the proponents.

No.	Recommendation	Response
1	The aims should be drafted to reflect the broad sweep of interest.	Trial aims were clarified.
2	The count of sites in the low stem density stratum should be increased.	The number of sites in low stem density strata was doubled.
3	The site count and treatment specification should be as balanced as possible across state boundaries.	Sites were distributed – 12 in NSW and 10 in Victoria.
4	Remote sensing instruments such as SPOT should be canvassed as candidate tools for measuring stand-level crown treatment response.	A project was initiated to consider the usefulness of Landsat derived data for stand level treatment response and validated against ADS40 imagery.
5	Digital photography should be canvassed as a candidate tool for measuring tree-level crown treatment response.	Multiple hemispherical photographs are taken at each site.
6	The quarter-hectare sub-plots for mature trees should be stem-	Each tree will be geo-located and mapped.

No.	Recommendation	Response
	mapped before and after treatment.	
7	The post-treatment health of the remaining stems should be recorded, for example as damage class or health class.	Post-treatment health of the remaining stems will be recorded.
8	Some choice should be made about the size of the statistical tests that will be used for the motivating hypotheses.	Potential statistical tests, and their size, have been considered.
9	When the data are collected, the analysis of the data should proceed at multiple levels.	The analysis of the data will proceed at multiple levels.

8.3. River Red Gum Adaptive Management Scientific Advisory Committee

To provide advice regarding development an adaptive management strategy for river red gum parks and reserves, OEH and DEPI established the River Red Gum Adaptive Management SAC. This committee provides quality-assured scientific advice to government on the management of river red gum forests and reserves, as outlined in the committee's Terms of Reference. Members are listed in Table 8.3 below.

Table 8.3: River Red Gum Adaptive Management Scientific Advisory Committee members.

Name	Organisation
Chairpersons	—
Dr Graham Mitchell	Foursight Associates Pty Ltd (Independent Chair)
Dr Kate Wilson	NSW Office of Environment and Heritage (OEH; Deputy Chair)
State agency representatives	—
Dr Andrew Haywood	Victorian Department of Environment and Primary Industries
Ross McDonnell	NSW OEH
Independent scientists	—
Assoc. Prof. Ian Lunt	Charles Sturt University
Dr Skye Wassens	Charles Sturt University
Assoc. Prof Leon Bren	University of Melbourne

Name	Organisation
Prof. Rod Keenan	University of Melbourne
Dr Libby Rumph	University of Melbourne
Prof. Richard Kingsford	University of NSW

The independent scientists on the committee have expertise in one or more of the following fields:

- flora and fauna of river red gum forests and associated floodplain and woodland ecosystems
- ecological processes of river red gum forests and associated floodplain and woodland ecosystems
- water regimes for floodplain, wetland and woodland ecosystems
- management of river red gum forests and associated floodplain and woodland ecosystems
- design and implementation of ecological experiments at a landscape-scale using the principles of adaptive management.

In a letter dated 11 September 2013, SEWPaC (now DoE) informed OEH and DEPI confirmed that '*the SAC is an appropriate entity to conduct a peer review of the trial's objectives, experimental design, and methodology and to assess the expected robustness of results to achieve the stated objectives of the ecological thinning trial.'* A copy of this letter is provided in Appendix 10.

8.3.1. Findings

The SAC recommended the independent review of the experimental design by Dr Andrew Robinson, as described in Section 8.2. After receiving and reviewing the findings of Dr Robinson, on the 1 December 2011 the SAC provided its support to the ecological thinning trial and approved the experimental design. The following recommendations/findings were provided in meeting minutes (River Red Gum Adaptive Management Scientific Advisory Committee 2011):

1. *'The SAC supports the ecological thinning trial*
2. *The SAC approves the development of the experimental design subject to prioritisation of monitoring variables – prioritisation is look at resources - timeframes (long term management), costing of monitoring options for management considerations, review cwd [coarse woody debris] at less or greater than 40 t/ha*
3. *Recommendations are to be provided to the Executive Management Group to inform Agency Actions*
4. *It is recognized that important work has being completed*
5. *The SAC considers satisfactory background work has been completed and that research opportunities exist*
6. *The full value of the ecological thinning trial will only be realized by long term monitoring.'*

9. Environmental record of person(s) proposing to take the action

This section details the individual environmental record for each proponent of the ecological thinning trial.

9.1. NSW Office of Environment and Heritage (National Parks and Wildlife Service)

9.1.1. Proceedings

No proceedings under a commonwealth or state law for the protection of the environment or the conservation of natural resources have been undertaken.

Environmental policy and planning framework

The management of the reserve system within NSW is the responsibility of the Office of Environment and Heritage (OEH) National Parks and Wildlife Service (NPWS). Management of reserves occurs within the context of a legislative and policy framework, incorporating the *National Parks and Wildlife Act 1974* (NPW Act), the *Threatened Species Conservation Act 1995* and the policies of the NPWS.

Other legislation, strategies and international agreements may also apply to the management of reserves. In particular, the *Environmental Planning and Assessment Act 1979* (EP&A Act) may require the assessment of environmental impacts of a proposed activity within the reserve.

National parks are reserved under the NPW Act to protect and conserve areas containing outstanding or representative ecosystems, natural and cultural features or landscapes or phenomena. Under the NPW Act (section 30E), national parks are managed to:

- conserve biodiversity, maintain ecosystem functions, protect geological and geomorphological features and natural phenomena and maintain natural landscapes
- conserve places, objects, features and landscapes of cultural value
- protect the ecological integrity of one or more ecosystems for present and future generations
- promote public appreciation and understanding of the park's natural and cultural values
- provide for sustainable visitor or tourist use and enjoyment that is compatible with conservation of natural and cultural values
- provide for sustainable use (including adaptive reuse) of and buildings or structures or modified natural areas having regard to conservation of natural and cultural values
- provide for appropriate research and monitoring.

In addition to the general principles for the management of national parks, specific directions applying to the management of individual reserves and are outlined within approved statements of interim management intent (SIMIs) (for newly acquired reserves) and plans of management (POMs). An approved SIMI exists for the Murray Valley National and Regional Park – Millewa group.

In relation to adaptive management activities, strategies identified for the Millewa group are to:

- recognise important ecological values that are at risk
- establish an adaptive management approach for managing the reserves which can
- trial ecological thinning as a biodiversity conservation tool for improving forest health and condition
- integrate vegetation and water management
- develop appropriate management objectives for what is a largely modified ecosystem
- develop a robust monitoring program of significant biodiversity values which will assist in tracking the transition of one management regime to another and allow for ongoing reporting to key stakeholders about the health and condition of the river red gum ecosystem.

9.2. Victorian Department of Environment and Primary Industries

9.2.1. Proceedings

No proceedings under a Commonwealth or state law for the protection of the environment or the conservation of natural resources have been undertaken.

9.2.2. Environmental policy and planning framework

The management of the reserve system within Victoria falls to the responsibility of Parks Victoria (PV) under delegation from the Victorian Department of Environment and Primary Industries (DEPI). Management of reserves occurs within the context of a legislative and policy framework, incorporating the *National Parks Act 1975*, *Parks Victoria Act 1998*, and the policies of PV and DEPI.

POMs are statutory documents that are required to be prepared in accordance with the *National Parks Act 1975* for parks in the Victorian reserve system. DEPI delegates this responsibility to PV under agreement.

A current POM has not been prepared for Barmah National Park since its reservation. In recognition of the connection traditional owners have with Barmah, there is an agreement to jointly manage some of the new river red gum parks in Victoria. In the absence of a POM, management actions within Barmah National Park are guided by the POM for Barmah State Park and Barmah State Forest (DCE 1992).

10. Economic and social matters

This section documents the potential economic and social impacts of the proposed ecological thinning trial.

10.1. Cost of implementing the trial

The indicative projected cost of implementing the trial is approximately $1.5 million.

10.2. Direct employment

The proposed ecological thinning trial would generate temporary employment opportunities for a skilled workforce during the thinning operations. It is estimated that between 12 and 20 people would be contracted on a full-time basis during the treatment phase, which is planned to last for approximately three months.

The monitoring of treatment on control plots is expected to be undertaken by a mixture of National Parks and Wildlife Service /Parks Victoria staff and external ecological consultants. However, as the monitoring activities are undertaken at one and 5 yearly intervals, the overall impact on employment within the region during the site monitoring phase will be marginal.

The river red gum forests, woodlands and wetlands of Barmah–Millewa have historically provided opportunities for scientific research by government agencies, universities, field naturalist and private interest groups. The trial is expected to generate increased opportunities for these activities, although the extent of this increase cannot yet be quantified.

Opportunities for the involvement of local Aboriginal groups were generated during the planning phase for the trial, specifically through the cultural heritage site assessments of proposed treatment plots undertaken by personnel from the Cummeragunja Local Aboriginal Land Council and Yorta Yorta Nation Aboriginal Corporation. While this work has now been completed, the trial will continue to work with these organisations to provide capacity building and work opportunities where possible as part of the trial, such as through the post-thinning ecological monitoring program.

10.3. Indirect employment and expenditure

Development of the proposed ecological thinning trial methodology and the statutory approvals process has increased local expenditure in the towns of Moama, Mathoura and Deniliquin through attendance of Government staff and contractors invited to participate in local workshops and meetings, and those engaged to undertake pre-thinning ecological surveys and monitoring.

Indirect employment and expenditure benefits can be expected to continue during the trial, particularly in service industries such as accommodation providers and restaurants. The extent of this benefit is dependent on the contractors appointed to conduct thinning operations (i.e. if crews from outside the region are appointed then more additional expenditure can be expected than if locally based crews are used).

The extent of indirect employment and expenditure is typically determined in economic impact assessments using 'multipliers', which provide the expected multiple of spending or jobs generated indirectly per direct job. However, as the proposed ecological thinning trial is not being undertaken for commercial gain (i.e. felled material will not be sold for use by a commercial entity), it is not appropriate to use typical multipliers for the forestry industry of between 1.8 and 2.2 indirect jobs for every direct job (Schirmer 2010).

10.4. Recreation and tourism

The potential for the trial to impact on the aesthetic, recreational and tourism values within Barmah–Millewa has been considered. However, as the thinning activities would apply to only 0.6 per cent of the river red gum forests, the trial is unlikely to limit park access and tourism opportunities. The trial is not expected to impede the use of existing road infrastructure, which is capable of supporting tourism in the region, although some traffic management activities may be required to ensure public safety during the treatment phase.

It was noted in the NSW Natural Resources Commission's 'River Red Gum Assessment Socio-economic Impact Assessment' that the reservation of the river red gum forests of Barmah–Millewa way also lead to 'increases in visitation to these areas', which would in turn lead to 'consumer surplus benefits associated with this increased visitation' (Arche Consulting 2009, p.55). Implementation of a scientific trial across a small percentage of Barmah–Millewa is likely to cause negligible impact of park visitation, as the proposed trial sites are not located within or near key visitation nodes. Furthermore, the trial is likely to be less of an impediment to tourist visitation than the commercial forestry practices that occurred in some areas prior to the reservation of these forests.

10.5. Non-market benefits

As noted in Section 1.3, the proposed ecological thinning trial aims to improve knowledge on river red gum forest management in order to:

- promote a diversity of habitats in the landscape for indigenous species, including key habitat features such as hollow-bearing trees, stand structural diversity and coarse woody debris
- prevent further decline in canopy condition (the proportion of canopy that is dead)
- minimise the risk of mass tree death.

Should the trial find that ecological thinning can be used to generate improvements in forest health and habitat availability, this would be expected to provide non-market benefits to the broader community. This is evidenced by the Victorian Environmental Assessment Council's (VEAC's) River Red Gum Forests Investigation, which found that the Victorian community was willing to pay for environmental outcomes such as an increase in the area of healthy river red gum forest and an increase in the number of breeding pairs of threatened parrots (VEAC in Arche Consulting 2009, p.55).

10.6. Traffic and residential amenity

During treatment operations, limited numbers of internal park roads specific to the site being treated at the time will be closed off to the public to ensure public safety.

All transportation of excess felled material will require some use of public roads. Ten sites require haulage onto the Tocumwal Road (Mathoura–Tocumwal), while two sites require haulage vehicles to enter the Cobb Highway.

The Tocumwal Road is an undivided, two-lane unsealed road, and the Cobb Highway is an undivided two-lane sealed road. Both roads carry generally low volumes of traffic. Haulage vehicles will enter onto the Cobb Highway at two different points situated near the mid-points of two straight stretches of road.

These points have previously provided access for former timber harvesting operations, and continue to be used as haulage routes for timber millers hauling logs from private native forest operations throughout the surrounding area. As the levels of traffic generated by the proposed activity are considered low and of a short duration, impacts on key intersections in the surrounding road network are considered negligible.

The closest residential areas to the trial include the towns of Barmah, Picola and Nathalia in Victoria, and Deniliquin, Mathoura and Moama in NSW. The trial will require some increased movement of trucks transporting excess felled material on park roads during the treatment phase, but this is not expected to impact upon any residents or townships. No adverse impacts on residential amenity are expected during the establishment or site monitoring phases.

11. Conclusion

The proposed ecological thinning trial seeks to address key gaps in knowledge about how to manage river red gum forests to:

- promote a diversity of habitats in the landscape for indigenous species, including key habitat features such as hollow-bearing trees, stand structural diversity and coarse woody debris
- prevent further decline in canopy condition (the proportion of canopy that is dead)
- minimise the risk of mass tree death.

The aims of the ecological thinning trial are:

- to determine how ecological thinning affects biodiversity, canopy condition and resilience, and minimises tree mortality (especially of large trees) within stands of river red gum forest
- to determine how ecological thinning affects characteristics of the stands (i.e. hollow availability and structural diversity) and whether these effects depend on water availability and initial stem density
- to determine how ecological thinning affects characteristics of the trees, such as tree diameter growth rate, tree diameter distribution diversity, branch characteristics, and crown shape and health.

The trial will be conducted in accordance with the Experimental Design and Monitoring Plan (see Appendix 1). Thinning treatments will occur over 396 hectares (44 × 9 ha) of the 66,000 hectare river red gum forests of Barmah–Millewa, with control sites covering an additional 198 hectares (22 × 9 ha). The area subject to treatments constitutes 0.6 per cent of the total area of the Barmah–Millewa river red gum forests.

As part of preparing this public environment report, the existing ecological conditions of the river red gum forests were established through desktop investigations, field surveys and vegetation mapping. This focused on *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)-listed matters of national environmental significance.

Based on this, 15 EPBC Act-listed matters of national environmental significance were determined to have a moderate or higher likelihood of occurrence in trial area. A risk assessment was then undertaken to identify potential pathways through which the ecological thinning trial may impact those listed Matters. This included evaluating the initial risk and residual risk (i.e. risk with and without implementation of mitigation and control measures).

Where potential impact pathways presented a ‘medium’ or higher residual risk to an EPBC Act-listed matter of national environmental significance, the potential impact of the ecological thinning trial was then considered against the Commonwealth matters of national environmental significance listed in the EPBC Act (1.1 Significant impact guidelines – matters of national environmental significance; DEWHA 2009a). Following from these assessments, it was determined that the ecological thinning trial would not have a significant impact on any EPBC Act-listed matters of national environmental significance.

The mitigation and control measures identified through the risk assessment process have been formalised in an environmental management plan (EMP). This plan sets out a framework for continuing management and monitoring to address potential impacts on EPBC Act-listed matters of national environmental significance during trial activities. It

includes project delivery standards for each phase of the ecological thinning trial, which cover the relevant performance criteria, control measures, monitoring requirements, and contingency plans.

Based on the risk and impact assessments, and taking into account the mitigation and control measures described in the EMP, offsetting of potential trial impacts will not be required.

In addition to the potential environmental impact, planning for this trial has also considered long-term and short-term economic and social matters. This trial is aims to address key knowledge gaps for managing river red gum forests for future generations, and as such, the proposed ecological thinning trial is consistent with the principles of ecologically sustainable design.

References

Adam–Gates J (1996) The use of hollows by birds and mammal in dead river red gum and black box trees at Disher Creek, Murray River National Park, South Australia. South Australian Ornithologist 32: 65–75.

Aigner PA, Block WM and Morrison ML (1998) Effect of firewood harvesting on birds in a California oak-pine woodland. Journal of Wildlife Management 62: 485–496.

Allen CD, Savage M, Falk DA, Suckling KF, Swetnam TW, Schulke T, Stacey PB, Morgan P, Hoffman M and Klingel JT (2002) Ecological restoration of Southwestern ponderosa pine ecosystems: a broad perspective. Ecological Applications 12: 1418–1433.

Anon (2003) Changing distribution of the regent honeyeater. Where the regents roam 12: 5.

Arche Consulting (2009) River Red Gum Assessment Socio-economic Impact Assessment Report. Prepared for the Natural Resources Commission, December.

Ayres D, Nash S and Baggett K. (1996) Threatened species of Western NSW. National Parks and Wildlife Service, Hurstville, NSW.

Backhouse G, Loyn J and Cant B (2008) National recovery plan for the murray hardyhead *Craterocephalus fluviatilis*. Department of Sustainability and Environment, Melbourne, Vic.

Bauhus J, Aubin I, Messier C and Connell M (2001) Composition, structure, light attenuation and nutrient content on understorey vegetation in a *Eucalyptus sieberi* regrowth stand 6 years after thinning and fertilisation. Forest Ecology and Management 144: 275–286.

Baker–Gabb DJ (1990) The biology and management of the plains wanderer *Pedionomus torquatus* in NSW. NSW NPWS Species Management Report No. 3. NSW National Parks and Wildlife Service, Sydney, NSW.

Baker–Gabb D (2011) National Recovery Plan for the Superb Parrot *Polytelis swainsonii*. Department of Sustainability and Environment, Melbourne, Vic.

Barrer P (1992) A survey of *Aprasia parapulchella* along parts of the lower Molongo River corridor. ACT Parks and Conservation Wildlife Research Unit, Canberra.

Barrett G, Silcocks A, Barry S, Cunningham R and Poutler R (2003) The New Atlas of Australian Birds. Royal Australasian Ornithological Union, Hawthorn East, Vic.

Bates R (2009) Orchids of South Australia. Flora and Fauna of South Australia Handbooks Committee, Adelaide, SA.

Beardsell C (1997) Sites of faunal and habitat significance in north east Melbourne. Nillumbik Shire Council, Eltham, Vic.

Belcher CA, Webster R and O'Brien W (in prep). Winter home range and ecology of the squirrel glider *Petaurus norfolcensis* in river red gum forest.

Bennett LT and Adams MA (2004) Ecological effects of harvesting in Victoria's native forests: quantification of research outputs. Australian Forestry 67: 212–221.

Benshemesh J (2007) National Recovery Plan for Malleefowl. Department for Environment and Heritage, South Australia.

Berg DR (1995) Riparian silvicultural system design and assessment in the Pacific Northwest Cascade Mountains, USA. Ecological Applications 5: 87–96.

Blakers M, Davies SJJF and Reilly PN (1984) The Atlas of Australian Birds. Royal Australasian Ornithologists Union, Melbourne University Press, Melbourne, Vic.

Bowen S, Powell M, Cox SJ, Simpson SL and Childs P (2012) Riverina red gum reserves mapping program – stage 1. Office of Environment and Heritage, Sydney, NSW.

Brown A, Nicol S and Koehn J (1998) Recovery Plan for the Trout Cod (*Maccullochella macquariensis*) 1998–2006. Department of Natural Resources and Environment, Melbourne, Vic.

Brown PB (1989) The swift parrot *Lathamus discolor* – A report on its ecology, distribution and status, including management considerations. Department of Lands Parks and Wildlife, Tasmania.

Cadwallader PL and Eden AK (1979) Observations of the food of the Macquarie perch *Macquaria australascia* (Pisces: Percichthyidae), in Victoria. Australia Journal of Marine and Freshwater Research 30: 23–30.

Carr GW (1991) New taxa in *Caladenia* RBr, *Chiloglottis* RBr and *Gastrodia* RBr (Orchidaceae) from south eastern Australia. Indigenous Flora and Fauna Association Miscellaneous Papers 1. Indigenous Flora and Fauna Association, Melbourne, Vic.

Caughley J and Gall B (1985) Relevance of zoogeographical transition to conservation of fauna: amphibians and reptiles in the south-western slopes of NSW. Australia Zoologist 21: 513–527.

Chantler P (1999) Family Apodidae (Swifts). J del Hoyo, A Elliott, J Sargatal (eds) *Handbook of the Birds of the World*, Vol. 5. Barn owls to Hummingbirds. Barcelona: Lynx Edicions.

Childs P, McAllister D, Webster R, Wilson E and Norris P (2012) Monitoring blackwater in the Barmah–Millewa icon site. Unpublished 'Intervention Monitoring' report prepared by the NSW Office of Environment and Heritage (National Parks & Wildlife Service and Water, Wetlands & Coast Division) for the Murray–Darling Basin Authority. Final Report: April 2012.

Clarke MF and Oldland JM (2007) Penetration of remnant edges by noisy miners (*Manorina melanocephala*) and implications for habitat restoration. Wildlife Research 34: 253–261.

Clemann N and Gillespie GR (2004) Draft Recovery Plan for *Litoria raniformis* 2004–2008. Department of Environment and Heritage, Canberra, ACT.

Covington WW, Fule PZ, Hart SC and Weaver RP (2001) Modelling ecological restoration effects on ponderosa pine forest structure. Restoration Ecology 9: 421–431.

CSIRO (2008) Water availability in the Murray. A report to the Australian Government from the CSIRO Murray–Darling Basin Sustainable Yields Project. CSIRO, Canberra.

Cunningham SC, Mac Nally R, Read J, Baker PJ, White M, Thomson JR and Griffioen P (2009a) A robust techniques for mapping vegetation condition across a major river system. Ecosystems 12: 207–219.

Cunningham SC, Mac Nally R, Griffioen P and White M (2009b) Mapping the condition of river red gum and black box stands in The Living Murray icon sites. A milestone report to the Murray–Darling Basin Authority. Murray Darling Basin Authority, Canberra, ACT.

Cunningham SC, Baker PJ and Horner GJ (2009c) Proposed ecological thinning trials for river red gum forests of the middle Murray River floodplain in Victoria. Unpublished report prepared by the Australian Centre for Biodiversity, School of Biological Sciences, Monash University (Melbourne, Vic) for Parks Victoria.

Cunningham SC, Thomson JR, Read J, Baker PJ and Mac Nally R (2009d) Does stand structure influence susceptibility of eucalypt floodplain forests to dieback? Austral Ecology, 35: 348–356.

Cunningham SC, Thomson JR, Mac Nally R, Read J and Baker PJ (2011) Groundwater change widespread forecasts forest dieback across an extensive floodplain system. Freshwater Biology 56: 1494–1508.

Curr EM (2001) Recollections of squatting in Victoria, the called the Port Phillip District (From1841–1851). Rich River Printers, Echuca, Vic.

Davis LR, Puettmann KJ and Tucker GF (2007) Overstory response to alternative thinning treatments in young Douglas-fir forests of western Oregon. Northwest Science 81: 1–14.

Day N (1993) Tree perching and presumed roosting of white-throated Needletails *Hirundapus caudacutus*. Australian Bird Watcher 15:43–44.

DCE (1992) Barmah State Park and Barmah State Forest Management Plan. Department of Conservation and Environment, Melbourne, Victoria.

DECC (2008) Reviewed interim vegetation condition benchmarks for the BioMetric tool. Department of Environment and Climate Change, Sydney. Available at http://environment.nsw.gov.au/projects/biometrictool.htm

DECC (2008b) Recovery Plan for the Brush-Tailed Rock-Wallaby (*Petrogale penicillata*). Approved. Department of Environment and Climate Change NSW, Sydney.

DECC (2008c) Recovery Plan for the Koala (*Phascolarctos cinereus*). Approved. Department of Environment and Climate Change NSW, Sydney.

DeGraaf RM, Healy WM and Brooks RT (1991) Effects of thinning and deer browsing on breeding birds in New England oak woodland. Forest Ecology and Management 41: 179–191.

Deignan HG (1964) Birds of the Arnhem Land Expedition. *Records of the American–Australian Scientific Expedition to Arnhem Land*. In: Specht RL (ed) ed. *Zoology* Vol: 345–426. Melbourne: Melbourne University Press.

DEWHA (2009) Biodiversity Assessment – Riverina. In: Australian Natural Resources Atlas. Department of the Environment, Water, Heritage and the Arts. Available at: http://www.anra.gov.au/topics/vegetation/assessment/vic/ibra-riverina.html#intro

DEWHA (2009a) Significant impact guidelines 1.1 Significant impact guidelines – matters of national environmental significance. Environment Protection and Biodiversity Conservation Act, Canberra.

DEWHA (2009b) Significant impact guidelines for 36 migratory shorebird species, Canberra, November.

Dexter BD (1978) Silviculture of the river red gum forests of the central Murray floodplain. Proceedings of the Royal Society of Victoria 90: 175–191.

Disher P (2000) Birds of the Barham district. Barham Landcare Group, Barham, NSW.

DNRE (2002) Forest Management Plan for the mid-Murray Forest Management Area. Department of Natural Resources and Environment, East Melbourne, Vic.

DoE (2013a) *Ardea ibis* — cattle egret. In: Species Profile and Threats Database, Department of Sustainability, Environment, Water, Population and Communities, Canberra, ACT. Accessed November 2013. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=59542

DoE (2013b) *Ardea modesta* — eastern great egret. In: Species Profile and Threats Database, Department of Sustainability, Environment, Water, Population and Communities, Canberra, ACT. Accessed November 2013. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=82410

DoE (2013c) *Apus pacificus* – fork-tailed swift. In: Species Profile and Threats Database, Department of Sustainability, Environment, Water, Population and Communities, Canberra, ACT. Accessed November 2013. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=678

DoE (2013d) *Merops ornatus* — rainbow bee-eater. In: Species Profile and Threats Database, Department of Sustainability, Environment, Water, Population and Communities, Canberra, ACT. Accessed November 2013. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=670

DoE (2013e) *Polytelis swainsonii* — superb parrot. In: Species Profile and Threats Database, Department of Sustainability, Environment, Water, Population and Communities, Canberra, ACT. Accessed November 2013. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=738

DoE (2013f) *Haliaeetus leucogaster* — white-bellied sea eagle. In: Species Profile and Threats Database, Department of Sustainability, Environment, Water, Population and Communities, Canberra, ACT. Accessed November 2013. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=943

DoE (2013g) *Hirundapus caudacutus* – white-throated needletail. In: Species Profile and Threats Database, Department of Sustainability, Environment, Water, Population and Communities, Canberra, ACT. Accessed November 2013. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=682

DoE (2013h) *Craterocephalus fluviatilis* — Murray hardyhead. In: Species Profile and Threats Database, Department of Sustainability, Environment, Water, Population and Communities, Canberra, ACT. Accessed November 2013. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=56791

DoE (2013i) *Phascolarctos cinereus* (combined populations of Qld, NSW and the ACT). In: Species Profile and Threats Database, Department of Sustainability, Environment, Water, Population and Communities, Canberra, ACT. Accessed November 2013. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=85104

DoE (2013j) *Amphibromus fluitans* — river swamp wallaby-grass, floating swamp wallaby-grass. In: Species Profile and Threats Database, Department of Sustainability, Environment, Water, Population and Communities, Canberra, ACT. Accessed November 2013. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=19215

DoE (2013k) *Brachyscome muelleroides* — Mueller daisy. In: Species Profile and Threats Database, Department of Sustainability, Environment, Water, Population and Communities, Canberra, ACT. Accessed November 2013. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=15572

Doody TM, Overton IC 2009. Environmental management of riparian tree health in the Murray–Darling Basin, Australia. River Basin Management V. WIT Press, Southampton, UK, Pp 197–206.

Dow DD (1997) Indiscriminate interspecific aggression leading to almost sole occupancy of space by a single species of bird. Emu 77: 115–121.

DPI (2009) Dryland river red gum forest silviculture. Department of Primary Industries Victoria Note number AG0903. Available at: http://www.dpi.vic.gov.au/forestry/private-land-forestry/individual-species/dryland-river-red-gum-forest-silviculture.

DSE (2003a) Flora and Fauna Guarantee Action Statement 41 – regent honeyeater *Xanthomyza phrygia*. Victorian Department of Sustainability and Environment, Melbourne, Vic.

DSE (2003b) Flora and Fauna Guarantee Action Statement 169 – swift parrot *Lathamus discolor*. Victorian Department of Sustainability and Environment, Melbourne, Vic.

DSE (2003c) Flora and Fauna Guarantee Action Statement 33 – superb parrot *Polytelis swainsonii*. Victorian Department of Sustainability and Environment, Melbourne, Vic.

DSE (2003d) Flora and Fauna Guarantee Action Statement 38 – trout cod *Maccullochella macquariensis*. Victorian Department of Sustainability and Environment, Melbourne, Vic.

DSE (2003e) Flora and Fauna Guarantee Action Statement 66 – plains wanderer *Pedionomus torquatus*. Victorian Department of Sustainability and Environment, Melbourne, Vic.

DSE (2003f) Barmah Forest Ramsar Site Strategic Management Plan. Victorian Department of Sustainability and Environment, Melbourne, Vic.

DSE (2004) Flora and Fauna Guarantee Action Statement 103 – Twelve threatened spider orchids *Caladenia species*. Victorian Department of Sustainability and Environment, Melbourne, Vic.

DSE (2005) Flora and Fauna Guarantee Action Statement 126 – Twelve threatened Swainson peas and Darling peas (*Swainsona* species). Victorian Department of Sustainability and Environment, Melbourne, Vic.

DSE (2008) Flora and Fauna Guarantee Action Statement 237 – ridged water milfoil *Myriophyllum porcatum*. Victorian Department of Sustainability and Environment, Melbourne, Vic.

DSE (2009a) Victorian Government Response to the Victorian Environmental Assessment Council's River Red Gum Forests Investigation Final Report. Victorian Department of Sustainability and Environment, Melbourne, Vic.

DSE (2009b) Flora and Fauna Guarantee Action Statement 252 – winged peppercress *Lepidium monoplocoides*. Victorian Department of Sustainability and Environment, Melbourne, Vic.

ECC (1997) Box-Ironbark Forests and Woodland Investigation Resources and Issues Report. Environment Conservation Council, Melbourne, Vic.

FCNSW (1984) Notes on the silviculture of major NSW forest types – 5. River red gum. Forestry Commission of New South Wales, Sydney.

Fitzsimons JA, Peake P, Frood D, Mitchell M, Withers N, White M and Webster R (2011) Flooding requirements for biodiversity values along the Victorian floodplain of the Murray Valley. Victorian Naturalist 128: 48–85.

Gibbons P and Lindenmeyer DB (1997) Conserving hollow-dependent fauna in timber production forests. Environmental Heritage Monograph No. 3. NSW National Parks and Wildlife Service, Sydney.

Gibbons P and Lindenmeyer DB (2002) Tree hollows and wildlife conservation in Australia. CSIRO Publishing, Collingwood.

Grey MJ, Clarke MF and Loyn RH (1997) Initial changes in the avian communities of remnant eucalypt woodlands following a reduction in the abundance of noisy miners, *Manorina melanocephala*. Wildlife Research 24: 631–648.

Grey MJ, Clarke MF and Loyn RH (1998) Influence of the noisy miner *Manorina melanocephala* on avian diversity and abundance in remnant grey box woodland. Pacific Conservation Biology 4: 55–69.

Goulburn Broken Catchment Management Authority (2013) Goulburn Broken Regional Catchment Strategy 2013–2019. Goulburn Broken Catchment Management Authority, Shepparton, Vic.

Hagar JC, McComb WC and Emmingham WH (1996) Bird communities in commercially thinned and unthinned Douglas-fir stands of western Oregon. Wildlife Society Bulletin 24: 353–366.

Hale J and Butcher R (2011) Ecological Character Description for the Barmah Forest Ramsar Site. Report to the Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Hardie SA (2000) Examination of fish and invertebrate fauna in seven lakes in the Swan Hill–Kerang region, Northern Victoria. Melbourne, Victoria: Department of Natural Resources and Environment.

Harrington B and Hale J (2011) Ecological Character Description for the NSW Central Murray State Forests Ramsar Site. Report to the Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Harrington GN, Maher PN and Baker–Gabb DJ (1988) The biology of the plains-wanderer *Pedionomus torquatus* on the riverine plain of New South Wales during and after drought. Corella 12: 7–13.

Havari BA and Carey AB (2000) Forest management strategy, spatial heterogeneity, and winter birds in Washington. Wildlife Society Bulletin 28: 643–652.

Hateley R (2010) The Victorian Bush: its 'original and natural' condition. Polybractea Press, South Melbourne, Vic.

Hero J-M, Littlejohn M and Marantelli G (1991) A Frogwatch Guide to Victorian Frogs. Victorian Department of Conservation and Environment, Melbourne, Vic.

Higgins PJ (ed) (1999) Handbook of Australian, New Zealand and Antarctic Birds: Volume 4. Parrots to Dollarbird. Oxford University Press, South Melbourne, Vic.

Higgins PJ, Peter JM and Steele WK (eds) (2001) Handbook of Australian, New Zealand and Antarctic Birds: Volume 5. Tyrant-flycatchers to Chats. Oxford University Press, South Melbourne, Vic.

Hobbs JN. (1961) The birds of south-west New South Wales. Emu 61:21–55.

Hope J (1995) Aboriginal burial conservation in the Murray–Darling Basin. Historic Environment 11: 57–60.

Horner GJ, Baker PJ, Mac Nally R, Cunningham SC, Thomson JR and Hamilton F (2010) Forest structure, habitat and carbon benefits from thinning floodplain forests: Managing early stand density makes a difference. Forest Ecology and Management 259: 286–293.

Howitt JA, Baldwin DS, Rees GN and Williams JL (2007) Modelling blackwater: Predicting water quality during flooding of lowland river forests. Ecological Modelling 203: 229–242.

Hughes L and Westoby M (1994) Climate change and conservation policies in Australia: coping with change that is far away and not yet certain. Pacific Conservation Biology 1: 308–318.

Ingram BA, Barlow CG, Burchmore JJ, Gooley GJ, Rowland SJ and Sanger AC (1990) Threatened native freshwater fishes in Australia – some case histories. Journal of Fish Biology 37: 175–182.

Jansen A, Askey–Doran M, Pettit N and Price P (2007) Impacts of land management practices on riparian land. In: Lovett S and Price P (eds) 2007. Principles for riparian lands management. Land and Water Australia, Canberra.

Jolly ID (1996) The effects of river management on the hydrology and hydroecology of arid and semi-arid floodplains, pp. 577–609 In: Anderson MG, Walling DE and Bates PD (eds) Floodplain Processes. Wiley, New York.

Jolly ID, Walker GR and Narayan KA (1994) Floodwater recharge processes in the Chowilla Anabranch System, South Australia. Australian Journal of Soil Science 3:417–435.

Jones DL (2006) A Complete Guide to Native Orchids of Australia, Including the Island Territories. Reed New Holland Publishers, Sydney, NSW.

Jurskis V, Selby M, Leslie D and Jurskis D (2005) Health of River Red Gum, *Eucalyptus camaldulensis*, in NSW Central Murray State Forests. Forests NSW.

Kariuki M (2008) Modelling the impacts of various thinning intensities on tree growth and survival in a mixed species eucalypt forests in central Gippsland, Victoria, Australia. Forest Ecology and Management 256: 2007–2017.

Kearney RE and Kildea MA (2001) The status of the murray cod in the Murray–Darling Basin. Environment Australia. Available at: http://www.environment.gov.au/water/publications/mdb/pubs/murray-cod.pdf.

Keartland GA (1903) Notes of the genera *Polytelis* and *Spathopterus*. Victorian Naturalist 16: 151–153.

Keith D (2004) Ocean shores to desert dunes: the native vegetation of New South Wales and the ACT. Department of Environment and Conservation, Hurstville NSW.

King DI and DeGraaf RM (2000) Bird species diversity and nesting success in mature, clearcut and shelterwood forest in northern New Hampshire, USA. Forest Ecology and Management 129: 227–235.

King AJ, Ward KA, O'Conner P, Green D, Tonkin Z and Mahony J (2010) Adaptive management of an environmental watering event to enhance native fish spawning and recruitment. Freshwater Biology 55: 17–31.

Krockenberger A, Gordon G and Dennis AJ (2012) Koala (south east Qld Bioregion), pp. 352–353 In: Queensland's Threatened Animals, Curtis LK and Dennis AJ (eds.) CSIRO Publishing, Collingwood, Vic.

Lada H and Mac Nally R (2008) Decline and potential recovery of yellow-footed antechinus in parts of south-eastern Australia: A perspective with implications for management. Ecological Management and Restoration 9: 120–125.

Lada H, MacNally R and Taylor AC (2008a) Responses of a carnivorous marsupial (*Antechinus flavipes*) to local habitat factors in two forest types. Journal of Mammalogy 89: 398–407.

Lada H, Thompson JR, Mac Nally R, Horrocks G and Taylor AC (2008b) Evaluating simultaneous impacts of three anthropogenic effects on a floodplain-dwelling marsupial *Antechinus flavipes*. Biological Conservation 134: 527–536.

Lake JS (1971) Freshwater fishes and rivers of Australia. Thomas Nelson Publishers, Melbourne, Vic.

Law BS (2004) Challenges for the management of bats in state forests of NSW, pp. 748–760 In: The Conservation of Australia's Forest Fauna, D Lunney (ed.) Royal Zoological Society of NSW Mosman NSW.

Law B and Anderson J (1999) A survey for the southern myotis *Myotis macropus* (Vespertilionidae) and other bat species in river red gum *Eucalyptus camaldulensis* forests of the Murray River, New South Wales. Australian Zoologist 31: 166–174.

Leslie DJ (2001) Effect of river management on colonially-nesting waterbirds in the Barmah–Millewa forest, south-eastern Australia. Regulated Rivers: Research and Management 17: 21–36.

Leslie D (2005) Is the superb parrot *Polytelis swainsonii* population in Cuba State Forest limited by hollow or food availability? Corella 29: 77–87.

Lucas A (2010) National Recovery Plan for the Mueller Daisy *Brachyscome muelleroides*. Department of Sustainability and Environment, Melbourne.

Lumsden LF and Bennett AF (1995) Bats of a semi-arid environment in south-eastern Australia: biogeography, ecology and conservation. Wildlife Research 22: 217–240.

Mac Nally R (2006) Longer-term response to experimental manipulation of fallen timber on forest floors of floodplain forest in south-eastern Australia. Forest Ecology and Management 229: 155–160.

Mac Nally R and Horrocks G (2002) Habitat change and restoration: responses of a floodplain forest-floor mammal species to manipulations of fallen timber in forests in forests. Animal Biodiversity and Conservation 1: 41–52.

Mac Nally R and Horrocks G (2007) Inducing whole-assemblage change by experimental manipulation of habitat structure. Journal of Animal Ecology 76: 643–650.

Mac Nally R, Parkinson A, Horrocks G, Conole L and Tzaros C (2001) Relationships between terrestrial vertebrate diversity, abundance and availability of coarse woody debris on south-eastern Australia floodplains. Biological Conservation 99: 191–205

Mac Nally R, Cunningham SC, Baker PJ, Horner GJ and Thomson JR (2011) Dynamics of Murray–Darling floodplain forests under multiple stressors: The past, present, and future of an Australia icon. Water Resources Research 47: 1–11. American Geophysical Union, Washington, USA.

McHenry MT, Wilson BR, Lemon JM, Donnelly DE and Growns IG (2006) Soil and vegetation response to thinning white cypress pine (*Callitris glaucophylla*) on the North Western Slopes of New South Wales, Australia. Plant and Soil 285: 245–255.

McDowell RM (1996) Freshwater fishes of south-eastern Australia. Reed Books, Chatswood, NSW.

McKinnon LJ (1993) A significant record of the endangered trout cod *Maccullochella macquariensis* (Pisces: Percichthyidae) made during fish surveys of the Barmah Forest, Victoria. Victorian Naturalist 110: 186–190.

Manning AD, Lindenmayer DB, Nix HA and Barry SC (2005) A bioclimatic analysis for the highly mobile superb parrot of south-eastern Australia, Emu 105: 193–201.

Marchant S and Higgins PJ (eds) (1990) Handbook of Australian, New Zealand and Antarctic Birds: Volume 1. Ratites to Ducks. Oxford University Press, South Melbourne, Vic.

Marchant S and Higgins PJ (eds) (1993) Handbook of Australian, New Zealand and Antarctic Birds: Volume 2. Raptors to Lapwings. Oxford University Press, South Melbourne, Vic.

Mavromihalis J (2010) National Recovery Plan for the Winged Peppercress *Lepidium monoplocoides*. Department of Sustainability and Environment, East Melbourne, Vic.

MDBC (2006) The Barmah–Millewa Forest Icon Site Environmental Management Plan 2006–2007. MDBC Publication No. 30/06. Murray–Darling Basin Commission, Canberra, ACT.

MDBC (2008) Sustainable Rivers Audit Murray–Darling Basin Rivers: Ecosystem Health Check, 2004–2007. Murray–Darling Basin Commission, Canberra, ACT.

Menkhorst P (2012) The food and foraging rate of an Australian Bittern. Australian Field Ornithology 29: 133–142.

Menkhorst P and Hynes E (2010) National Recovery Plan for the Brush-tailed Rock-wallaby *Petrogale penicillata*. Department of Sustainability and Environment, East Melbourne, Vic.

Murphy AH (2006) National Recovery Plan for the Ridged Water-milfoil *Myriophyllum porcatum*. Department of Sustainability and Environment, East Melbourne, Vic.

Murray CMA (2013) Catchment Action Plan 2013–2023. Murray Catchment Management Authority, Albury, NSW.

Murray CMA and OEH (2012) New South Wales Murray Biodiversity Management Plan: A guide to terrestrial biodiversity investment priorities in the central and eastern NSW Murray catchment. Murray Catchment Management Authority, Albury, NSW.

Murray JV, Low Choy S, McAlpine CA, Possingham HP and Goldizen AW (2008) The importance of ecological scale for wildlife conservation in naturally fragmented environments: A case study of the brush-tailed rock-wallaby (*Petrogale penicillata*). Biological Conservation 141: 7–22.

National Murray Cod Recovery Team (2010) National Recovery Plan for the Murray Cod *Maccullochella peelii peelii.* Department of Sustainability and Environment, Melbourne, Vic.

Natural Resource Management Ministerial Council (2009) National Koala Conservation and Management Strategy 2009–2014. Department of the Environment, Water, Heritage and the Arts, Canberra.

Norris RH, Prosser I, Young B, Liston P, Bauer N, Davies N, Dyer F, Linke S and Thoms M (2001) The assessment of river conditions (ARC): An audit of the ecological condition of Australian rivers. Report to the National Land and Water Resources Audit Office.

NPWS (2003) The bioregions of New South Wales: their biodiversity, conservation and history. NSW National Parks and Wildlife Service, Hurstville, NSW.

NRC (2009) Riverina Bioregion Regional Forest Assessment: river red gums and other woodland forests. Final Assessment Report. NSW Natural Resources Commission, Sydney, NSW.

NSW DPI (2013) Threatened and Protected Species Record Viewer. Available at: http://www.dpi.nsw.gov.au/fisheries/species-protection/records/viewer.

NSW DPI (2005a) Murray hardyhead – species profile. Available at: http://pas.dpi.nsw.gov.au/Species/Species_Profile.aspx?SpeciesListingID=2.

NSW DPI (2005b) Trout cod – species profile. Available at: http://pas.dpi.nsw.gov.au/Species/Species_Profile.aspx?SpeciesListingID=4.

NSW DPI (2005c) Macquarie perch – species profile. Available at: http://pas.dpi.nsw.gov.au/Species/Species_Profile.aspx?SpeciesListingID=16.

NSW Government (2010) Integrated Forestry Operations Approval for Riverina Red Gum. NSW Government, Sydney.

OEH, PV and DSE (2012) Ecological thinning trial in NSW and Victorian river red gum reserves: experimental design and monitoring plan. Office of Environment and Heritage, Sydney, NSW and Parks Victoria, Melbourne, Vic.

OEH (2011a) Regent honeyeater *Anthochaera phrygia* – critically endangered species listing. Available at: http://www.environment.nsw.gov.au/determinations/regenthoneyeaterFD.htm

OEH (2011b) Australasian bittern *Botaurus poiciloptilus* – endangered species listing. Available at: http://www.environment.nsw.gov.au/determinations/austbitternFD.htm

OEH (2012a) Regent honeyeater – profile. Available at: http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10841

OEH (2012b) Australasian bittern – profile. Available at: http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10105

OEH (2012c) Swift parrot – profile. Available at: http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10455

OEH (2012d) Superb parrot – profile. Available at: http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10645

OEH (2012e) Southern bell frog – profile. Available at: http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10491

OEH (2012f) Koala – profile. Available at: http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10616

OEH (2012g) Floating swamp wallaby-grass – profile. Available at: http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10045

OEH (2012h) Winged peppercress – profile. Available at: http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10463

OEH (2012i) Corben's long-eared bat – profile. Available at: http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10568

OEH (2012j) Eastern osprey – profile. Available at: http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10585

OEH (2013a) Australian painted snipe – profile. Available at: http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10734

OEH (2013b) Claypan daisy – profile. Available at: http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10107

OEH (2013c) Algeboia. Office of Environment and Heritage. Available at: http://www.environment.nsw.gov.au/aboriginalplaces/Algeboia.htm

Oliver DL (2000) Foraging behaviour and resource selection of the Regent Honeyeater *Xanthomyza Phrygia* in New South Wales. Emu 100: 12–30.

Olsen P, Weston M, Tzaros C and Silcocks A (2005) The State of Australia's Birds 2005: Woodlands and birds. Supplement to Wingspan 15: 32.

Overton IC and Doody TM (2013) The River Murray–Darling Basin: Ecosystem Response to Drought and Climate Change. pp 217–234 In Drought in Arid and Semi-Arid Regions. Springer, Netherlands.

Overton IC, McEwan K and Sherrah JR (2006) The River Murray floodplain inundation model – Hume Dam to Lower Lakes. CSIRO Water for a Healthy Country Technical Report 2006. Canberra, ACT.

Palmer GP and Cahir F (2010) Fire in River Red Gum Communities: Literature Review (49 pages) Final Report to parks Victoria. October 2010. Centre for Environmental Management, University of Ballarat.

Palmer GP, Brown GW, Gibson MS, Pigott JP, Tolsma AD, Wainer J, Yen AL (In press) Box–Ironbark Ecological Thinning Trial: Integrated Analysis and Projected Changes (218 pages) Parks Victoria Technical Report No. 58, Parks Victoria, Melbourne.

Pardoe C (1998) Prehistoric Aboriginal cemeteries of the River Murray. Institute of Aboriginal and Torres Strait Islander Studies, Canberra.

PV and DSE (2009) Active Forest Health Program: Program Guidelines. River Red Gum Implementation: Attachment 3. Parks Victoria and Dept. Sustainability & Environment, Melbourne.

Parker DG, Webster R, Belcher CA and Leslie D (2007) A survey of large forest owls in state forests of south-western New South Wales, Australia. Australian Zoologist 34: 78–84.

Parker DG and Webster R (2012) Superb Parrot. Pp. 292–293 In: Queensland's Threatened Animals. (Curtis LK and Dennis AJ eds) CSIRO Publishing, Collingwood, Vic.

Pennay M (2009) Assessment of river red gum and woodland forest health in the New South Wales Riverina Bioregion using Multi-temporal Landsat TM data generated from the Statewide Landcover and Trees Study (SLATS). Department of Environment, Climate Change and Water, Queanbeyan, NSW.

Phillips SS (2000) Tree species preferences of the Koala *Phascolarctos cinereus* as a basis for the delineation of management areas for recovery planning in New South Wales. Unpublished report prepared for the Koala Recovery Plan.

Pigott JP (2010) River Red Gum Ecological Thinning Trial design (working draft). Unpublished report prepared by the Centre for Environmental Management, University of Ballarat (Vic) for Parks Victoria.

Pigott JP, Palmer GP, Yen A, Tolsma AD, Brown GW, Gibson MS and Wright JR (2010) Establishment of the box-ironbark ecological thinning trial in north central Victoria. Proceedings of the Royal Society of Victoria. 122, 112–123.

Piper SD and Catterall CP (2003) A particular case and general pattern: hyperaggressive behaviour of one species may mediate avifaunal decreases in fragmented Australian forests. Oikos 101:602–614.

Portners MF (1993) The natural vegetation of the Hay Plain: Booligal–Hay and Deniliquin–Bendigo 1:250 000 maps. Cunninghamia 3: 1–122

Pringle JD (1985) The Waterbirds of Australia. National Photographic Index of Australian Wildlife and Angus and Robertson Publishers, Sydney, NSW.

Raadik TA and PS Fairbrother (1999). *Cardross Lakes Aquatic Fauna Monitoring — November 1998 (southern purple-spotted gudgeon, freshwater catfish, Murray hardyhead). Consultancy report to Cardross Lakes Task Group*. Victoria: Freshwater Ecology, Parks Flora and Fauna, Department of Natural Resources and Environment.

Recher HF (1996) Conservation and management of eucalypt forest vertebrates. In: DeGraaf RM and Miller RI (eds) Conservation of Faunal Diversity in Forested Landscapes. Chapman & Hall, London. pp 339–388.

River Red Gum Adaptive Management Scientific Advisory Committee (2011) Meeting Minutes. 1 December.

Robertson P and Coventry N (2012) Monitoring frog responses to flooding in Gunbower Forest – December 2011. Report prepared for the North Central Catchment Management Authority, Bendigo, Vic.

Robinson A (2011) Review of ecological thinning study design. Unpublished report prepared for the NSW Office of Environment and Heritage.

Robinson M (1998) A Field Guide to Frogs of Australia. Reed New Holland, Sydney, NSW.,

Rourke M and Tonkin Z (2009) Barmah–Millewa fish condition monitoring: 2007–2009 milestone report. NSW Department of Industry and Investment and Arthur Rylah Institute for Environmental Research. Department of Sustainability and Environment, Heidelberg, Victoria. Unpublished report submitted to the Murray–Darling Basin Authority.

Rumpff L Duncan DH, Vesk PA, Keith DA and Wintle BA (2011) State-and-transition modelling for adaptive management of native woodlands. Biological Conservation 144:1224–1236.

Rutherford ID (1990) Ancient river, young nation. In: The Murray (Mackay N and Eastburn D, eds) Murray Darling Basin Commission, Canberra, ACT. pp 17–36.

Saunders DL and Tzaros CL (2011) National Recovery Plan for the Swift Parrot *Lathamus discolor*. Birds Australia, Melbourne, Vic.

Schirmer J (2010) Socio-economic characteristics of Victoria's forestry industries, Part 1: Profile of forest industry businesses, employment and spending, and impacts of recent changes on businesses. Victorian Department of Primary Industries, Melbourne, July.

Schonau APG and Coetzee J (1981) Initial spacing, stand density and thinning in eucalypt plantations. Forest Ecology and Management 29: 245–266.

SEWPaC (2013a) Tailored guidelines for the content of a draft Public Environment Report. April.

Sharpe C and Wilson E (2012) Fish surveys at 39 sites throughout Millewa Forest, NSW, with focus on the distribution of Southern pygmy perch (*Nannoperca australis*). May/June 2012. Summary of findings report for the NSW Office of Environment and Heritage.

SKM (2005) Barmah Forest groundwater monitoring review to May 2004. SKM report to Goulburn-Murray Water, Tatura, Vic.

SF NSW (2000) Riverina Grazing Strategy. State Forests of New South Wales, Deniliquin, NSW.

Swift Parrot Recovery Team (2000). Swift Parrot Recovery Plan 2001-2005. [Online]. Department of Primary Industries, Water and Environment. Hobart: Dept of Primary Industries, Water & Environment. http://www.environment.gov.au/biodiversity/threatened/publications/recovery/swift-parrot/index.html

Tarburton MK (1993) Radiotracking a white-throated needletail to roost. *Emu*. 93:121–124.

Thomson J, Horrocks G, Cunningham S and Mac Nally R (2011). Modelling Tree Hollow Availability Over Time in the Barmah Landscape Zone, Australian Centre for Biodiversity, Monash University. Report to the Goulburn Broken Catchment Management Authority.

Trout Cod Recovery Team (2008) National Recovery Plan for the Trout Cod *Maccullochella macquariensis.* Department of Sustainability and Environment, Melbourne, Vic.

TSSC (Threatened Species Scientific Committee) (2003) Commonwealth Listing Advice on *Maccullochella peelii peelii* (Murray Cod, Cod, Goodoo). [Online]. Available at: http://www.environment.gov.au/biodiversity/threatened/species/m-peelii-peelii.html.

TSSC (2008) Commonwealth Listing Advice on *Amphibromus fluitans* (River Swamp Wallaby-grass). [Online]. Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/19215-conservation-advice.pdf

TSSC (2010) Commonwealth listing advice on Grey Box (*Eucalyptus microcarpa*) Grassy Woodland and Derived Native Grasslands of South-eastern Australia. [Online]. Available at: http://www.environment.gov.au/biodiversity/threatened/communities/pubs/86-listing-advice.pdf

Todd JA (2000) Recovery Plan for twelve threatened spider orchids *Caladenia* R. Br. Taxa of Vic and SA – 2000–2004. Department of Natural Resources and Environment, Melbourne, Victoria.

Tonkin Z and Rourke M (2008) Barmah–Millewa fish condition monitoring – 2008 annual summary and refuge habitat report. Arthur Rylah Institute for Environmental Research. Department of Sustainability and Environment, and NSW Department of Industry and Investment Unpublished report submitted to the Murray–Darling Basin Authority.

Tyler MJ (1997) The Action Plan for Australia Frogs. Wildlife Australia Endangered Species Program, Canberra.

Tzaros C (1997) Ecological monitoring of groups of the Grey-crowned Babbler (*Pomatostomus temporalis*) in the Benwell and Guttrum State Forests, north-central Victoria. Department of Natural Resources and Environment, Bendigo, Victoria.

Tzaros CL (2001) Importance of riparian vegetation to terrestrial avifauna along the Murray River, south-eastern Australia. Master of Science Thesis, Deakin University, Melbourne, Vic.

Tzaros C, Ingwersen D and Rogers D (2012) Australian Painted Snipe. pp. 274–275 In: Queensland's Threatened Animals. (Curtis LK and Dennis AJ eds.) CSIRO Publishing, Collingwood, Vic.

VEAC (2008) River Red Gum Forests Investigation. Final Report. Victorian Environmental Assessment Council, East Melbourne, Vic.

Vesk PA, Nolan R, Thompson JR, Dorrough JW and Mac Nally R (2008) Time lags in provision of habitat resources through revegetation. Biological Conservation 141: 174–186.

Walshe T, Rumpff L and Gorrod E (2011) Expert judgement of the ecological response of Barmah–Millewa communities to manipulation of stand structure and surface water. Report on outcomes of a workshop held 18-19 August 2011 at Moama.

Ward, P. (2004) Monitoring frog response to flooding in Barmah–Millewa Forest: 2003/04. Final report prepared for the Barmah–Millewa Forum. Murray–Darling Basin Commission, Canberra, ACT.

Wassens S (2008) Review of the past distribution and decline of the southern bell frog *Litoria raniformis* in New South Wales. Australian Zoologist 34: 446–452.

Water Technology (2009a) River Red Gum Forests and ecological thinning: a review. Report prepared for the Department of Sustainability and Environment, Vic.

Water Technology (2009b) Barmah–Millewa hydrodynamic modelling: model recalibration report. Report prepared for the Goulburn Broken Catchment Management Authority, Vic.

Water Technology (2012) Domestic Firewood and Forest Health Trial. Report prepared for Parks Victoria.

Watkins S, Hladyz S, Whitworth K and Baldwin D (2010) Understanding the relationship between low dissolved oxygen blackwater events and managed flows in the Edward–Wakool River System. The Murray–Darling Freshwater Research Centre, Wodonga, Vic.

Webster R (1988) The superb parrot – A survey of the breeding distribution and habitat requirements. Australian National Parks and Wildlife Service, Canberra; Report Series No. 12.

Webster R (1991) The superb parrot – A report on its use of Barmah State Forest/Park and surrounding box woodland during the 1991/91 breeding season. Unpublished report for Benalla Region, Department of Conservation and Environment, Vic.

Webster R (1993) Assessment of superb parrot nest sites on the south-west slopes and management recommendations. Unpublished report for Queanbeyan District, National Parks and Wildlife Service, NSW.

Webster R (1997) Assessment of superb parrot nesting habitat along the Edward River (Millewa and Gulpa Island State Forests). State Forests of NSW and Department of Land and Water Conservation, Deniliquin, NSW.

Webster R (1998) New South Wales Superb Parrot *Polytelis swainsonii* draft Recovery Plan. NSW National Parks and Wildlife Service, Sydney.

Webster R (2005) A baseline study of terrestrial bird populations in the state forests of the southern Riverina: 1999–2004. Report prepared for Forests NSW, Deniliquin, NSW

Webster R (1998) New South Wales Superb Parrot *Polytelis swainsonii* Draft Recovery Plan. NSW National Parks & Wildlife Service, Sydney.

Webster R, Belcher C and Leslie D (2003) A survey for threatened fauna in south western New South Wales. Australian Zoologist 32: 214–228.

Wesbter R and Logie S (2008) Superb Parrot. In: The State of Australia's Birds 2008 (Olsen P ed). Supplement to Wingspan 18: 33.

White AW and Pyke GH (1999) Past distribution of *Litoria aurea and Litoria castanea* in the Bathurst–Orange area of New South Wales. Herptofauna 29: –9.

Wong DTY, Jones SR, Osborne WS, Brown GW, Robertson P, Michael DR and Kay GM (2011) The life history and ecology of the pink-tailed worm-lizard *Aprasia parapulchella* Kluge – a review. Australian Zoologist 35: 927–940.

12. Appendices

There are 11 appendices for this report, listed below. They are downloadable as a separate document from the OEH website.

Appendix 1 – Experimental Design and Monitoring Plan

Appendix 2 – Coordinates for trial components

Appendix 3 – Environment Protection and Biodiversity Conservation Act 1999 Protected Matters Report

Appendix 4 – Summary report for site surveys

Appendix 5 – Example operational plans to be updated

Appendix 6 – Independent Review of Ecological Thinning Study Design (Robinson 2011)

Appendix 7 – Risk assessment for Environment Protection and Biodiversity Conservation Act 1999-listed matters of national environmental significance with a moderate or greater likelihood of occurrence in the trial area

Appendix 8 – Details of existing surface water and groundwater monitoring conducted in Barmah–Millewa

Appendix 9 – Report on outcomes of the Process Model Consultative Group Workshop

Appendix 10 – Letter from SEWPaC to OEH and DEPI re: independent scientific peer review of the proposed ecological thinning trial

Appendix 11 – Consideration of public submissions