

DECEMBER
2009

RECOMMENDATIONS REPORT

RIVERINA BIOREGION REGIONAL FOREST ASSESSMENT RIVER RED GUMS AND WOODLAND FORESTS

natural
resources
commission



Enquiries

Enquiries about this recommendations report should be directed to:

Bryce Wilde	Ph: 02 8227 4318 Email: bryce.wilde@nrc.nsw.gov.au
Daniel Hoenig (media enquiries)	Ph: 02 8227 4303 Email: daniel.hoenig@nrc.nsw.gov.au
Postal address	GPO Box 4206, Sydney NSW 2001

This work is copyright. The *Copyright Act 1968* permits fair dealing for study, research, news reporting, criticism and review. Selected passages, table or diagrams may be reproduced for such purposes provided acknowledgement of the source is included.

Printed on ENVI Coated paper, which is made from elemental chlorine-free pulp derived from sustainably-managed forests and non-controversial sources. It is Australian made and certified carbon neutral from an ISO 14001 accredited mill which utilises renewable energy sources.

Document No. D09/4599
ISBN: 978 1 921050 55 8

Print management by e2e (www.e2em.com.au)
GIS services by Ecological Australia

Contents

1	Introduction and overview	4
1.1	Key findings from the NRC's assessment of the red gum forests	4
1.2	Summary and recommendations	4
1.3	Map of proposed forest tenures	10
1.4	Structure of this report	10
2	How has the NRC determined its recommendations?	12
2.1	What makes river red gum forest ecosystems unique?	12
2.2	Policy context and stakeholder values	12
2.3	Resilience: linked social, economic and ecological systems	16
2.4	Methodology for recommending forest management priorities	17
3	Water reforms to save the red gum forest ecosystems	20
3.1	Findings from the final assessment report	20
3.2	Reduced flooding due to river regulation and climate	20
3.3	Basin water reform	22
3.4	Environmental watering to support red gum forest health	22
3.5	Environmental engineering projects and water infrastructure	25
4	Forestry ecosystem management in a water scarce future	26
4.1	Interventionist management of red gum forest ecosystems	26
4.2	Australian Group Selection harvesting technique	26
4.3	A diversity of forest tenures to encourage innovation	26
4.4	Independent audit and public reporting of results	27
5	Conservation planning and priorities	28
5.1	Findings from the final assessment report	28
5.2	Creation of trans-border, iconic national parks	29
5.3	Active management of red gum forest reserves	29
5.4	A regional conservation and adaptive management strategy	29
6	A sustainable future for the forestry industry	30
6.1	Findings from the final assessment report	30
6.2	Sustainable yields and timber resources	30
6.3	What form of forestry industry will be sustainable?	30
7	Sustainable futures for local communities	32
7.1	Engaging communities in managing forests	32
7.2	Socio-economic values in the region	32
7.3	Regional development opportunities	33
	Appendix 1 Terms of Reference	34
	Appendix 2 Recommended management priorities and tenures for forests	35

1 Introduction and overview

The NSW Government asked the Natural Resources Commission (NRC) to assess and make recommendations on the management of the river red gum and woodland forests in the Riverina bioregion. With the benefit of the assessment and recommendations, the Government intends to make a forest agreement “to determine conservation outcomes and a sustainable future for the forests, the forestry industry and local communities”.

This recommendations report explains the NRC’s recommendations on the:

- conservation, protection, economic and ecologically sustainable use of public land in the region (term of reference 2)
- water management and flooding requirements to sustain the forests and identified values and uses under the range of projected impacts of climate change (term of reference 3).

The NRC has also released a final assessment report which draws together the available science and information on these forests (as required under term of reference 1).

The terms of reference (see **Appendix 1**) require the NRC to also assess and make recommendations on the cypress forests in south-western NSW. The NRC will report on the cypress forests in April 2010.

1.1 Key findings from the NRC’s assessment of the red gum forests

The river red gum forests and the industries and social systems they support are in decline due to river regulation, over-allocation of water and drought. This decline is predicted to worsen under climate change. Even with ambitious water reforms there will not be enough water to restore all the red gum forests to health.

The future health of the river red gum forests will depend on whether the particular forest stands can be artificially flooded and how they are managed, including appropriate thinning.

Those forests that are more readily flooded may retain their current form and ecological functions if key elements of the natural flooding regime can be restored with artificial watering. Other red gum forests are already changing, but may be able to be managed to retain some aspects of their structure and ecosystem functions, albeit in a different form. The most rapidly drying red gum forests will inevitably cease to be red gum forests, and be replaced by other vegetation communities.

The choice ahead is whether to let this decline take its course, or act to manage the forests to create new, more sustainable ecological, economic and social futures. To manage the forest ecosystems through such a transition will require significant water reform, new water-delivery infrastructure and ecologically based silvicultural systems designed to support long-term forest regeneration, health and sustainability.

Despite the decline in forest health, some red gum forests are large and diverse enough to sustain conservation values and be managed in ways that will maintain key ecological functions while also supporting a boutique timber industry. A sustainable forestry industry would make wise use of the available timber resources, marketing the distinctive character of red gum wood, and underpinning the resilience of local communities and a region facing the challenges of a drier future.

Key findings arising from the NRC’s assessment of the river red gum forests are:

1. Significant water reforms

Significant water reforms and closer collaboration in water and forest management between jurisdictions are needed to respond to the decline in forest ecosystem health.

2. Active interventions to manage forests

All river red gum forest ecosystems in the Riverina will need to be intensively and actively managed through the inevitable transitions of a drying climate. Active interventions such as ecological thinning and water-delivery infrastructure will be necessary in all forests, whether managed primarily for conservation or timber production.

3. Trans-border national parks with coordinated adaptive management

Managing key environmental assets and corridors as trans-border national parks and reserves is a sound conservation planning response to water scarcity and climate change as it should help to align flooding regimes and enhance the status of red gum forests, as key ecological assets under the pending Murray-Darling Basin Plan.

4. New funding models for forests

Sound reasons remain to manage some forests for multiple benefits and uses, such as timber production, conservation, tourism, and recreation, but new funding models must be developed to reflect the diversity of ecosystem services, products and values these forests support. Lower growth rates and increasing management costs are undermining the viability of a public trading enterprise managing the red gum forests of the Riverina on a commercial basis.

5. Engagement with local communities

Indigenous and other local communities maintain strong cultural links with red gum forests and should be engaged in the management of all forests, regardless of tenure.

6. Maintaining human and social capital

The Riverina region is deeply affected by the current drought as irrigated agriculture has reduced. The capacity of the Riverina communities to adapt to the challenges of a water scarce future depends on maintaining economic and social diversity, and investing in human and physical capital.

1.2 Summary and recommendations

Chapter 2 explains how the NRC developed its recommendations to respond to the declining resilience of the forests, forestry industry and local communities. The NRC has found it challenging to find a balance between some competing factors, such as:

- river regulation, over-allocation of water, drought and projected climate change are so profoundly changing the forests that the current forms of management and forestry harvesting are unsustainable
- major changes in flooding means both the rivers and the forests will continue to decline in health, yet the forests are so extensive and ecosystems in general are so dynamic that it is difficult to predict how the ecology of these floodplain ecosystems will change
- the forests support highly significant ecological values, yet the form of interventionist and adaptive management required to sustain these values may conflict with some stakeholders' expectations of conservation management
- while the future prosperity of the region is much more closely tied to the irrigation industry, the impact of a decline in the forestry industry will be concentrated and significant in some small communities
- the support and involvement of the local community is crucial to the ongoing management of such extensive and popular forests, yet there are strongly held and conflicting views across the community on how the forests should be managed.

The following sections summarise the NRC's rationale for its recommendations and document those recommendations. **Chapters 3 to 7** deal with these topics in more detail.

1.2.1 Water reforms to save the river red gum forests

The NRC calculates that approximately 54 per cent of the long-term, pre-development, mean annual flow at Yarrowonga (or 2,000 GL) needs to be dedicated to sustaining essential floodplain ecosystem processes along the Murray River system. Achieving this challenging target will require the Murray-Darling Basin Authority (MDBA) to set appropriate sustainable diversion limits and the Commonwealth Environmental Water Holder to recover and deliver to the Murray system appropriate amounts of environmental water.

Together, these two reform mechanisms need to ensure that an additional 1,200 GL of water is made available to enhance current environmental water entitlements on the Murray system. Current environmental water entitlements include 500 GL for the Murray River system as a whole under The Living Murray Program, 100 GL for the Barmah-Millewa forests and entitlements recently recovered by the Commonwealth Environmental Water Holder. Without large-scale mimicking of unregulated flood patterns these forest ecosystems will continue their current transformation to a less water dependent ecology.

The planned infrastructure project to improve water delivery to the Koondrook-Perricoota forests should continue as the forests are significantly drought affected. Without the infrastructure to provide for emergency watering in the near term, Australia will be in breach of its obligation to maintain the ecological character of this Ramsar-listed forest. More water-delivery infrastructure and eco engineering projects will be required to deliver appropriate flooding regimes to river red gum forests across the region.

Recommendation 1:

Undertake collaborative water reform

State and federal governments should collaborate on water reforms to save the red gum forests, including:

- increasing existing adaptive environmental water entitlements by 1,200 GL, targeting 54 per cent of the long-term, pre-development mean annual flow at Yarrowonga (or 2,000 GL)
- reforming carry forward rules to allow accumulation of environmental water year on year and delivery of water in line with floodplain forest ecosystem requirements
- building appropriate water-delivery infrastructure and funding eco engineering projects to deliver appropriate flooding regimes to river red gum forests across the region
- maintaining and improving expertise in water infrastructure management.

Recommendation 2:

Complete water delivery infrastructure at Koondrook-Perricoota

The planned infrastructure project to improve water delivery to the Koondrook-Perricoota forests should continue to provide for emergency environmental watering and meet Australia's obligations under the Ramsar Convention to maintain the ecological character of this wetland of international significance.

1.2.2 Active management of river red gum forests in a water-scarce future

River red gum forests are situated in a dynamic floodplain ecosystem. Future management in all forms of tenure must address the river floodplain ecosystem as a whole, which no longer receives sufficient flood flows or groundwater recharge to sustain some aspects of those ecosystems. Even with significant water reforms, the future of these forests will be drier than has historically been the case. Water scarcity, climate variability and projected climate change will continue to force changes in the structure and health of river red gum forests.

Changes to river red gum ecosystems will occur through ongoing ecological responses to water scarcity, climate variability and projected climate change. However, in many circumstances, targeted management interventions will be necessary to achieve outcomes that cannot be achieved simply by allowing ecological processes to run their course. Specific interventions may provide greater degrees of control over outcomes than can be achieved with non interventionist approaches. This applies across public and private land, and whether public lands are managed as national parks, other reserves or as State Forests.

In some forest areas, ecological thinning may provide an essential tool to enhance both conservation and production outcomes. However, little research has been undertaken on the ecological effects of different thinning techniques, and outcomes are subject to considerable uncertainty. Consequently, there is a strong imperative to develop robust, prudent management frameworks to guide ecological thinning in river red gum forests in both production and reserved areas.

The ongoing decline in red gum forest health makes this work a priority, and the NRC believes large-scale trials of ecological thinning should be initiated promptly in all main forest groups.

The NRC has developed a range of principles for managing river red gum forest ecosystems in a drying climate. These are summarised in **Chapter 4** below (and set out in full in **Chapter 11** of the final assessment report). Once codified into management plans or other formal agreements, the NRC considers that its forest management principles will promote resilient river red gum ecosystems and support community values across all tenures.

Recommendation 3: Implement forest management principles

The river red gum forests of the Riverina require active management. All forest managers on public land, including those managing forests as reserves, should implement the forest management principles developed in the NRC's final assessment report. In particular those principles cover appropriate implementation of:

- ecological thinning
- grazing by domesticated animals
- fire management
- silviculture
- firewood collection.

Recommendation 4: Trial ecological thinning on a large-scale

Government should task the Department of Environment, Climate Change and Water (DECCW) with conducting large-scale trials of ecological thinning across all main river red gum forest groups. These trials should be instigated promptly, applying the forest management principles in the NRC's final assessment report. They should be designed to investigate impacts of ecological thinning on conservation attributes so as to improve our knowledge of how to manage the consequences of ongoing drying on the ecological character and biodiversity values of river red gum ecosystems across the region.

Forest NSW's implementation of silvicultural practices (including Australian Group Selection) in the river red gum forests of the Riverina needs modification if it is to maintain the ecological character of the forests and protect matters of national environmental significance.

Based on the NRC's review of the relevant scientific literature, observation of harvesting practice, and expert opinion, the NRC believes that silvicultural systems involving 'gapping' (such as Australian Group Selection) are appropriate for red gum forests provided they are implemented following appropriate prescriptions for:

- closer timing between any gapping and expected flooding to promote regeneration
- permanent retention of adequate numbers of habitat trees across the forested landscape

- retention of appropriate amounts of coarse woody debris
- constraints on the proximate use of gapping and selective harvesting
- the intensity of gapping (gap size, distribution and frequency)
- monitoring to inform adaptive management.

Recommendation 5: Codify forest management operations

Government should codify all forest management operations by red gum forest managers on public land as a priority. In addition to developing an Integrated Forestry Operations Approval for remaining forestry operations, plans of management for new reserves should be completed to a similarly rigorous standard. This work should build on the principles for river red gum management in Chapter 11 of the NRC's final assessment report, and should be developed in consultation with relevant NSW, Victorian and Australian Government agencies.

Even with significant water reforms, the long-term decline in timber quality and growth rates, and increases in environmental management costs look set to continue. The river systems of the southern Murray-Darling Basin are not likely to be fully restored to pre-river regulation flood regimes. It is unlikely to be commercially viable for a public trading enterprise, which is intended to be profitable, to manage the multiple-use red gum forests.

A better institutional model is needed for red gum forests being managed to generate timber products in addition to providing conservation, recreational and cultural values. A governance and funding model must be developed to reflect the broad range of ecosystem services, values and products these forests can deliver.

Similarly, successful management of red gums as national parks requires interventionist and adaptive approaches to park management. Sustaining red gum ecosystem functions in wet refugia and corridors will require active management (including ecological thinning and the maintenance of existing and creation of new water delivery infrastructure). Addressing the local communities' concerns about ongoing access to the forests, recreational use within them, and bushfire management in a drying climate will require strong engagement of local communities in park management. Rebuilding sustainable local communities will require significant up front investment in new infrastructure and marketing to achieve the potential regional economic development opportunities from new national parks.

Some forests on the Edward and Wakool rivers contain isolated fragments of river red gums, but remain connected to larger remnants of red gum woodlands and black box woodlands on adjacent private land. These small public land forests are generally surrounded by larger forests on private land. Conservation initiatives by private landholders and catchment management authorities may be the most practical way to manage these forests as integrated landscapes.

A small number of state forests are in severely degraded condition due to acid sulfate soils and salinisation. The condition of these forests will continue to decline under river regulation, climate variability and change. More forest ecosystems could experience similar ecological collapse in the future. These sites need to be maintained in a way that contains the potential hazards while enabling managers to learn to rehabilitate them in the longer term.

Managing them will be expensive and the immediate returns to any landholder would be low. Partnership opportunities should be explored with universities and research bodies to bring appropriate scientific expertise and funding to bear.

Considerable uncertainty remains in the specific management that particular forests require, and the capacity of different groups of people and institutions delivering management outcomes will need to be enhanced over time. The NRC believes the most rapid way in which we can learn how to manage these forests well is to have different groups of people employing a diversity of management approaches across different forests and sharing the results of their efforts.

In **Appendix 2** the NRC has recommended priority management objectives for the eight main forest groups. The NRC has also recommended different tenures for the 83 current State Forests within these groups based on factors such as each State Forest's uses and values, size and location in the landscape, proximity to towns, and ease of required management. These are set out in **Appendix 2** and illustrated in **Figure 1** at the end of this chapter. These arrangements would see:

- DECCW managing the Barooga and Millewa groups of forests jointly with Victoria as 'trans-border', iconic national parks to enhance their status as environmental assets to be watered under the Murray-Darling Basin Plan, and to encourage ecotourism as a new opportunity to generate regional wealth from the forests.
- Forests NSW managing the Koondrook-Perricoota and Campbells Island forests as State Forests to support a consolidated forestry industry, and retain Forests NSW's expertise in designing and operating the planned water delivery infrastructure, which will be essential to maintain the ecological character of the Ramsar-listed forests.
- Indigenous communities managing the Werai forests in the central Murray region, and the Taroo group of forests (Lake Victoria, Wangumma and Moorna) on the Lower Murray River, ideally as Indigenous Protected Areas.
- DECCW managing some forests along the Lachlan and Murrumbidgee Rivers as national parks, using environmental water and water infrastructure to maintain wet refugia and establish riparian corridors.
- Private landholders managing former State Forests along the Edward and Wakool rivers as private land subject to conservation covenants, and aligned with conservation initiatives on private land implemented by the Murray Catchment Management Authority and adjacent private landholders.
- DECCW and local councils managing a number of forests near towns as regional parks, allowing more extensive recreational use (such as dog walking and extensive camping), domestic firewood collection and a more flexible range of locally significant uses.
- Government agencies, universities, and research bodies collaborating to manage some severely degraded sites, focusing on researching how to rehabilitate the sites over the long term. These might be managed under a Crown Lands Trust or as a new form of research and rehabilitation reserve created under the *National Parks and Wildlife Act 1974*.

In some cases, the ideal legal tenure for a forest may not fit with an existing classification under legislation, or may take some time to implement. For example, if it proves time consuming to establish Indigenous protected areas, a jointly managed national park may be a significant step towards this goal if the relevant Indigenous community supports this.

Recommendation 6: Employ a diversity of management approaches

Government should use a range of existing and novel reserve types and land tenures across major forest groups to provide a base for more rapid development of innovative responses, adaptive learning and novel management strategies. Red gum forest on public land in the Riverina should be managed consistent with the management objectives and tenures recommended in Appendix 2 and illustrated in Figure 1.

To be successful in this challenging environment, management arrangements will need institutional and governance structures that drive innovation in land management. Publicly available independently gathered information on performance is essential to build the trust with all stakeholders that the forests are being well managed. Evaluations at the scale of major forest groups and across the entire bioregion including NSW, Victorian and South Australian forests should be conducted every five years. Principles such as those developed to evaluate management effectiveness for the national reserve system¹ will assist this task.

Recommendation 7: Implement transparent governance

All red gum forest management should include transparent governance arrangements such as:

- **clear allocation and definition of roles and responsibilities**
- **spatially explicit targets and independent review of management plans**
- **independent audit and public reporting at five-yearly intervals of management outcomes at forest group and bioregional scales to ensure accountability**
- **monitoring and knowledge management systems to promote adaptive learning across different forests, tenures, river systems and the southern Murray-Darling Basin.**

The required levels of interventionist management and community engagement will unavoidably be more expensive than more passive management. This will need to be properly resourced on an ongoing basis. There may be scope to seek Australian Government contribution to some costs as 'action research' given the Ramsar-listed status of the wetlands and cross-border imperatives for management.

These forests pose such management challenges that the five-yearly reviews should ideally involve a monitoring program designed and overseen by a specialist review panel. Given the strong commitment in the National Reserve Strategy to recurrent evaluation of management effectiveness, national support and coordination of this function might be sought.

¹ Commonwealth of Australia, 2009, Australia's Strategy for the National Reserve System, 2009–2030.

1.2.3 Conservation outcomes

Collaboration between the NSW, Victorian and Australian Governments to create trans-border iconic national parks along the Murray River has the potential to strengthen the policy imperative to better align flooding regimes and enhance the management of ecological assets for the benefit of the Australian and international communities. This will be important in giving these forests the best possible chance of being adequately watered and managed under the Murray-Darling Basin Plan.

Due to the significant public investment required to restore water to the forests, it is crucial that their management delivers sufficient public benefits. In addition to the costs of recovering water for the environment, there will be significant infrastructure costs to deliver and exclude water from forests at different times. Operations and maintenance costs will also be significant given the real-time nature of water management. As taxpayers will fund these costs, it is appropriate that the forests be managed to maximise the potential public benefits to current and future generations.

This does not mean forestry operations should be excluded from all forests, and in fact the NRC has recommended that the Central Murray forests of Koondrook-Perricoota and Campbells Island should continue to be managed as State Forests. However, it does mean that conservation management should prevail if there is a significant trade-off with timber production. The private benefits from forestry and timber production are not sufficient on their own to justify the private opportunity costs (reduced irrigation development) and the public expense of reallocating water to the forests.

National parks, other reserves, and conservation zones within State Forests should be part of an integrated conservation strategy, establishing corridors and nodes which can be built on over time to enhance adaptation to climate change throughout the region.

Such a strategy would identify the preferred long-term states of these forest ecosystems. An initial priority would be to map and classify different red gum forest types on the basis of their trajectory of health under river regulation and projected climate change, and then establish permanent monitoring plots in each of the forest types. The success of different management approaches would be monitored across groups of plots, particularly those on different tenures and to which alternate management approaches were being applied.

Consideration should be given to using planning instruments such as a riparian zone State Environmental Planning Policy (SEPP), and incentive payments under catchment action plans should be developed as ways to improve ecological connectivity across public and private land into the future.

The importance of biodiversity corridors and improving connectivity was recently highlighted by the NSW Legislative Assembly Standing Committee on Natural Resource Management in its latest report, released December 2009.² Among other matters, it recommended actions to improve the connectivity across landscapes, noted the potential for review of management of travelling stock routes to enhance this, and called for adequate resourcing of the management of corridors.

Recommendation 8:

Prioritise additions to the National Reserve System

Government should add to the National Reserve System by establishing national parks and regional parks (under the *National Parks and Wildlife Act 1974* and Indigenous Protected Areas or jointly managed national parks as recommended in Appendix 2. These detailed recommendations would create:

- national parks and reserves covering the Barooga and Millewa groups of forests, and the riparian forests on the Lachlan and Murrumbidgee Rivers
- Indigenous Protected Areas or jointly managed national parks in the Werai forests and the Taroo group of forests (Lake Victoria, Wangumma and Moorna) on the Lower Murray River
- regional parks in forests with significant ecological values and recreational values near towns across the river systems of the region.

Recommendation 9:

Establish trans-border iconic national parks

The NSW, Victorian, South Australian, and Australian Governments should work towards establishing trans-border national parks and collaborative management in red gum forests along the Murray River. This will maximise the ecological and regional development benefits of larger-scale reservations, and enhance the 'key environmental asset' status of the red gum forests in the context of opportunities provided by water reforms. Appendix 2 to the recommendations report lists the individual State Forests that are suitable candidates for creation of such trans-border national parks.

Recommendation 10:

Implement an adaptive management strategy

Given the predicted impact of climate change and the need for active management of river red gum forests, the Government should ask DECCW to develop a conservation and adaptive management strategy for the red gum forest ecosystems of the bioregion. Specific management plans for all forest groups should be nested within this strategy, which should focus on:

- assessing and improving the resilience of the forests
- preserving wet refugia and riparian corridors on public land
- creating nodes on public land to build future ecological corridors across private land
- enhancing capacity to use water infrastructure to improve ecological outcomes
- establishing an adaptive management program, applying across the bioregion, including linking to Victoria and South Australia.

² NSW Legislative Assembly, Standing Committee on Natural Resources (Climate Change), *Return of the Ark: the adequacy of management strategies to address the impacts of climate change on biodiversity*, Report No. 5/54 – December 2009.

Recommendation 11: Enhance ecological connectivity

The NSW Government should work with the Australian Government to improve ecological connectivity across public and private land by funding Catchment Management Authorities to deliver incentive payments to private landholders. These incentive payments should be targeted under catchment action plans, and in particular to areas adjacent to red gum forest reserves.

1.2.4 A sustainable forestry industry

There are still sound reasons to manage some river red gum forests for multiple uses and benefits such as conservation, timber production, tourism, and recreation values. Some of these forests are large and diverse enough to sustain conservation values, and be managed in ways that will maintain key ecological functions and also support a boutique timber industry.

Some ongoing logging of the Central Murray forests is possible even with Australia's obligations under the Ramsar Convention, provided that logging is consistent with 'wise use' as specified in the Convention and with sustainable harvesting and management of the forest.

The current forestry industry is based on a mix of log qualities and product lines, but has a strong preference for increasing the proportion of timber going into value-added products such as furniture and veneers. However, the quantity and quality of the timber produced is declining due to river regulation and a drying climate, and the current scale of the value-adding industry is no longer viable. Sustainable yields of quota-quality sawlogs will decline substantially.

There is likely to still be a significant supply of logs of various qualities from remaining multiple-use forests (and from private land), albeit at a lower scale and a lower average quality than in the past.

There may also be an increase in the supply of lower-quality wood and residue from public land as densely stocked red gum forests struggle in a drying climate. For example, ecologically focused management of forests could produce significant amounts of low-quality timber from reserves being managed for conservation. Principally this would be from ecological thinning or partial recovery of dead and dying trees. These activities would be conducted to achieve conservation objectives such as accelerating the development of particular habitat values or enhancing structural diversity across the forests.

Some new form of forestry industry will emerge to make good use of whatever river red gum wood resources are available. Some form of industry strategy may be helpful in supporting the forestry industry to adapt to lower sustainable yields more rapidly. However, a new funding model needs to be developed for red gum forests to reflect the diversity of ecosystem services, products and values these forests support.

Recommendation 12: Find a new way to govern and fund multiple-use forests

Government should ask the Department of Industry and Investment to explore alternate institutional and funding arrangements for forests managed for timber production such as Koondrook-Perricoota and Campbells Island forests. Governance arrangements should continue to ensure 'wise use' for multiple values including maintenance of the ecological character of the forests under the Ramsar Convention. Funding arrangements will require methods to raise revenue to reflect the broad range of public and private values and benefits these forests can sustain.

Recommendation 13: Provide exit assistance and support the industry to adapt

Government should assist some mills and mill workers to voluntarily exit the industry to reflect the drop in sustainable yields of high-quality quota timber, and should ask the Department of Industry and Investment to work with the forestry industry to prepare an industry development plan. The plan should assist the industry to transform to make best use of the declining volumes of high-quality saw logs, lower long-term yields, and relatively higher volumes of poorer quality saw logs and residue.

1.2.5 Sustainable futures for local communities

Strong Indigenous interests exist in all red gum forests, and Indigenous communities should be actively engaged in the management of all forests. However, there is considerable work remaining to identify and properly engage appropriate Indigenous interests because there are diverse views across Indigenous communities.

The NRC believes that the Werai forests on the Edward River and the Taroo (Lake Victoria) forests on the Western Murray River should be prioritised in efforts to move to Indigenous management of red gum forests. The Yarkuwa Indigenous Knowledge Aboriginal Corporation and Deniliquin Local Aboriginal Land Council have worked with Forests NSW for some time towards greater Indigenous involvement in managing the Werai forests. As such there is significant Indigenous community capacity to participate in management of the Werai forests, which can be built upon. Work remains to be done as the Wamba Wamba people and the Barapa Barapa people both have strong connections to the land. In the Taroo forests, people of the Barkindji Nation have longstanding connection to the land and interest in managing it.

In the other Central Murray forests of Millewa and Koondrook-Perricoota the Indigenous nations of the Yorta Yorta and the Bangaranga have not yet been able to agree who has a right to speak for Country, and so an appropriate engagement process with all groups seeking involvement should be undertaken. There are also relatively more complex management considerations of biodiversity conservation, forestry production values and recreational values in these forests.

It will be important that Government explores a range of options for engaging Indigenous communities in forest management as there are advantages and disadvantages of the various models. These range from Indigenous Protected Areas under Commonwealth legislation, to co-management or Indigenous management under

NSW legislation. Australian Government involvement and possible financial assistance in negotiating and establishing Indigenous management of forests should be explored.

Non-Indigenous communities also have deep and ongoing cultural engagement with the forests, with many forestry industry families working in and enjoying recreational access to the forests for many generations. Many also have a deep mistrust of government management of national parks, and this needs to be overcome for the benefit of both the community and the management of any new parks.

A central issue raised by many submissions was the local communities' wish to retain the freedom of open access to the forests. Domestic firewood collection was also raised. Forestry industry workers and some local community members are concerned about the potential of risk of bushfire increasing if drying red gum forests are not actively thinned. In particular they are concerned that forestry workers will not be able to continue to rapidly assist in fighting forest fires because this will be restricted under national park management rules. These and related issues will need to be addressed early in the development of plans of management for new parks and reserves.

Recommendation 14: Engage communities in managing forests

Government should establish processes to engage Indigenous and non-Indigenous communities in the management of all forests regardless of tenure. Issues of particular community concern such as bushfire hazard reduction, open access camping and domestic firewood collection must be explicitly addressed early in the development of management and community engagement strategies.

Recommendation 15: Empower Indigenous communities to manage some forests

Government should prioritise investment of time and resources in engaging Indigenous communities in directly or jointly managing the Werai forests, and the Taroo (Lake Victoria) forests on the Western Murray River, as part of the national reserve system.

The Riverina region is deeply affected by drought and climate variability, and will continue to be so as water reforms reset the balance between extractive use and the environment. While forestry is a small part of the regional economy, the loss of or decline in the forestry industry on public land threatens a considerable impact on some smaller towns. A sustainable future for these smaller communities will require town-specific proposals to offer redeployment of forestry workers in park management and other roles.

More generally, a sustainable future for the region will depend on regional development focused on less water-dependent industries. The decline in irrigated agriculture has already had a large impact on the region, and the future of the regional economy will ultimately depend on the transformation of the agricultural sector to a future with less water.

The NRC believes it is important to create new ways of generating wealth from the forests. The Barmah-Millewa forests and the Barooga forests upstream of the choke should be marketed as wetland forests of international importance. The choke has uniquely created Australia's largest river red gum

floodplain forest. Its wealth generation potential for the region is considerable if it can be appropriately marketed regionally, Australia wide and internationally.

The current tourism industry is centred on the river, riverboats, specific towns and open camping access to the forests. Careful accommodation of existing uses within any new parks is important to ensure that any tourism boost from park-based tourism is not offset by significant reductions in existing open-access camping and related uses.

Priorities for regional development spending will include boosting:

- all-weather access to forests, including during flood times
- bushfire fighting infrastructure and duplicating access roads to improve safety
- transport and tourist information infrastructure to capitalise on new national parks
- opportunities for new private sector investment in tourist accommodation, ecotourism ventures (including in national parks) and regional events.

Recommendation 16: Identify and fund regional development opportunities

Government should ask the Department of Industry and Investment to work with local communities and Regional Development Australia to identify regional development opportunities and possible funding sources. This should also include engaging DECCW in regional development opportunities to capitalise on trans-border, iconic national parks.

1.3 Map of proposed forest tenures

Figure 1 illustrates the different forest tenures the NRC recommends for the 83 current State Forests which contain red gum forests in the Riverina bioregion.

Finer-scale maps of the eight main forest groups are contained **Appendix 2**. These summarise the key issues relevant to deciding how each group of forests should be managed and what legal tenure is appropriate for the State Forests within that forest group.

1.4 Structure of this report

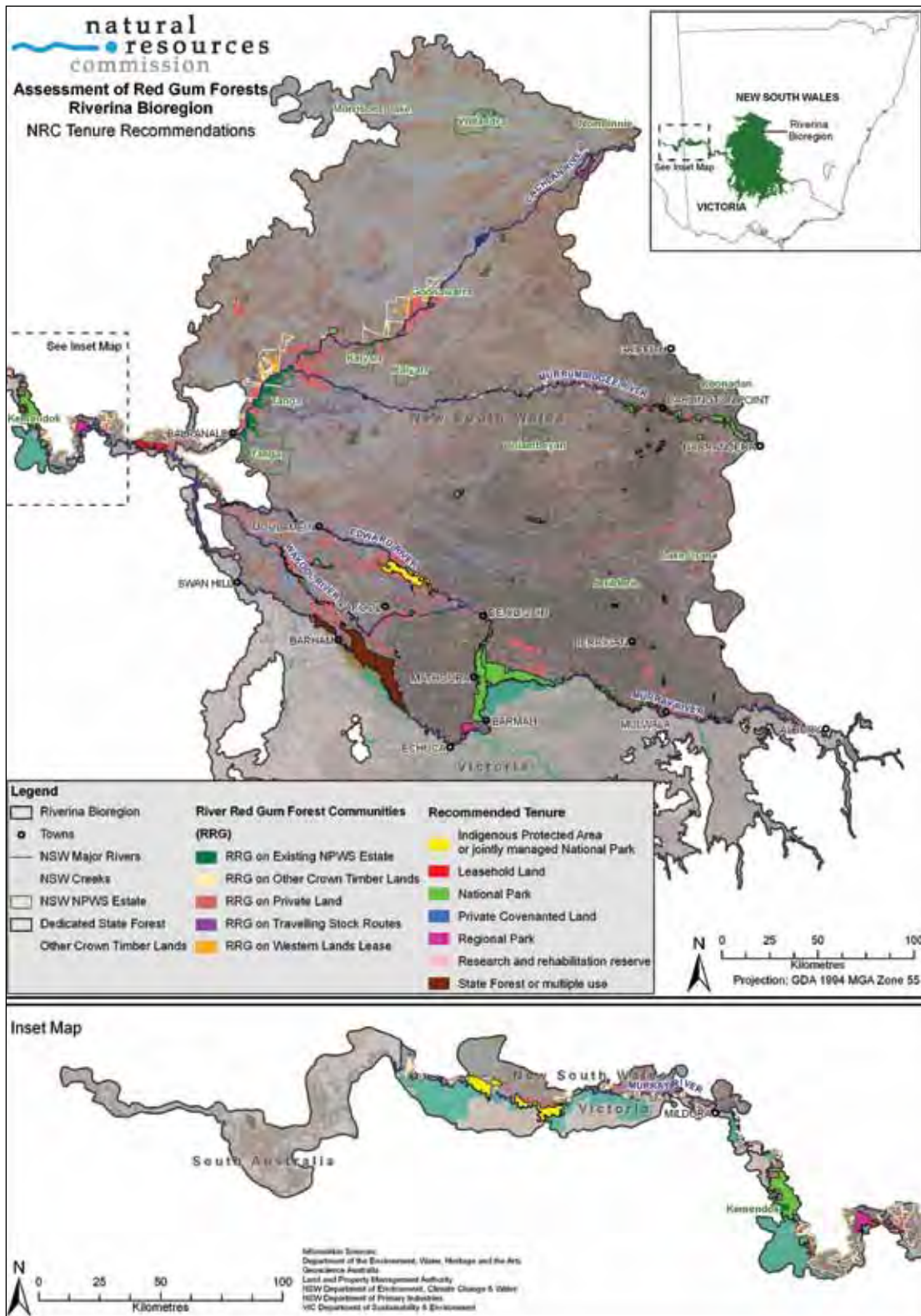
The remainder of this report outlines the NRC's process for determining its recommendations to Government in more detail as follows:

- **Chapter 2** summarises the landscape and policy context for assessing the forests and explains how the NRC developed its recommendations on management of the forests
- **Chapter 3** explains the importance of water reforms in saving the forests
- **Chapter 4** gives more detail on how the NRC recommends river red gum forest ecosystems by actively and adaptively managing in a water scarce future, including the appropriate institutional arrangements to ensure this happens in all forest tenures

- **Chapter 5** sets out the NRC’s recommended conservation priorities within the forests
- **Chapter 6** outlines how reductions in sustainable yield require significant reforms to put the forestry industry on a more sustainable footing
- **Chapter 7** discusses the challenges and opportunities for a more sustainable future for local communities.

In addition, **Appendix 2** supports Step 6 of the NRC’s analytical framework by providing tables summarising information, commentary and recommendations on the appropriate priority of management objectives and tenure for each of the 83 river red gum State Forests in the bioregion.

Figure 1: NRC Forest Tenure Recommendations



2 How has the NRC determined its recommendations?

The physical landscape of the river red gum forest ecosystems is as complex and dynamic as the policy environment which will determine their future. A sustainable future for the forests depends on coordinated policy and community action across the Murray-Darling Basin and along the length of the Murray River system.

This chapter:

- summarises information from the assessment report to explain the landscape context of the forests
- reviews aspects of the national and state policy context for the red gum forests and explores how the local community values these unique forests
- argues that under variable and changing climatic conditions an approach based on resilience thinking can enhance our management of the forests and their possible uses
- explains the methodology the NRC has used to develop its recommendations on management priorities and hence land tenures for the main forest groups.

The chapter supports Step 5 of the NRC's analytical framework by describing how it has considered the synergies and trade-offs between competing uses of the forests.

2.1 What makes river red gum forest ecosystems unique?

The iconic river red gum forests of the Riverina bioregion have evolved as a result of landscape processes over millennia. Tectonic movement, flooding regimes, Indigenous habitation and, most recently, river regulation and forest management have all created the forests we recognise today.

River red gum forests depend on reliable access to surface or groundwater. The forests are also an important component of a much broader and dynamic river floodplain ecosystem. They are potentially the main drivers of ecosystem processes in the floodplain.

The forests are located where they are because of underlying geologic and geomorphic processes that dictate the form of the present day landscape. For example, the Cadell Fault near Echuca causes a major constriction in channel capacity of the Murray River at this point, the Barmah Choke. This results in more frequent flooding and a fan of small streams that flow westward, off the uplifted landscape. This in turn has helped establish the most extensive stand of river red gums in the country.

Frequent and extensive flooding in the pre-European environment provided moisture to soils, deposited alluvial material, recharged aquifers and drove important nutrient cycling between the core river channels, wetlands and higher floodplain areas. These underlying physical processes supported the development of robust ecosystems including forests, woodlands, grasslands and reed beds.

Settlement by Europeans in the region in the mid-19th century initiated a demand for water to supply the expanding agricultural industry and associated towns. The extensive river red gum forests were seen as a key local resource. Initially it supplied firewood for the paddle steamers in the second half of the 19th century. Then it provided the resources to establish a significant regional timber industry. Extensive development of irrigation in the 20th century has made the Riverina region one of the most productive and profitable farming regions in Australia.

Regional settlement, water development and direct forest intervention have highly modified these landscapes. The forests observed today are largely regrowth resulting from river regulation and active silviculture practices.

The region's current agricultural systems and social networks and capacities have evolved in a wet period. The current drier period, and increasingly likely continuation of drier times under climate change, means the region's social, economic and ecological systems are under tremendous stress, and are increasingly unsustainable.

The red gum forests are suffering the impacts of major water storages and consumptive water demands, and these impacts are being exacerbated by the effects of the shift to a warmer, drier future. A review of the CSIRO's 'median' climate change forecasts for future flows in the Murray River at Yarrowonga show a complete absence of large 'landscape-restoration' floods (floods in the order of 100 GL/day) (see Chapter 3). Prior to river regulation, these floods occurred about once a decade. Large floods drive many of the biophysical process that sustain the forests.

What is clear from documented research and direct observation is that these landscapes are transforming. They are transforming primarily due to extensive river regulation and intensive and increasing water use over the last century. In addition, it is clear that they are now being heavily affected by a drier climate attributable to climate variability or long-term climate change.

While we are confident that these landscapes are changing, we cannot predict their exact future form. There will be less water in the river system, but water recovery, clever engineering solutions to artificially flood forests, and ecological thinning may provide sufficient water to sustain key parts of the landscape. We need to envisage a future where we do more with less.

This transformational change goes well beyond the forests themselves. The challenges of rapidly adapting to a reduced water future are being faced by the irrigation industry, by towns and by communities throughout the bioregion. The changes are sufficiently broad and deep that they are affecting the social fabric of the region. Long-term solutions are needed that rebuild and sustain the vitality of these communities. Tenure and management paradigms are needed where the individual components of the landscape are viewed as inter-related geographic, biological, social and physical systems.

2.2 Policy context and stakeholder values

The following sections outline some the relevant statutory, policy and stakeholder values relevant to determining a sustainable future for the red gum forests.

2.2.1 Matters of national environmental significance

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Australian Government's key legislation protecting matters of national environmental significance. Of the seven matters of significance listed in the EPBC Act, three are directly relevant to this assessment and are covered in the final assessment report:

- wetlands of international importance (Ramsar-listed)
- listed threatened species and ecological communities
- migratory species protected under international agreements (JAMBA, CAMBA and ROKAMBA)

Under the EPBC Act, actions that have, or are likely to have, a significant impact on a matter of national environmental significance requires approval from the Federal Minister for the Environment, Heritage and the Arts.

While the NRC has considered these specific legislative requirements it is also conscious of both the wider significance and the relative importance of key assets, and their respective health trajectories. For example, do all key values have a viable future? What are we willing to pay to secure the future key values? Which management interventions provide the greatest likelihood for a combination of preservation of key values and maximising the value of future landscapes? What are the priorities for the use of increasingly scarce resources?

Acknowledging that the Riverina landscape is in an advanced state of transition requires a rethink of how it should be conserved and managed. While some approaches to the conservation of key species have historically served Australia well, they may not provide the broad-scale resilience required in a changing climate.

Conservation management will need to focus on a landscape mosaic approach that maintains well functioning, existing ecosystems while actively transforming degraded ecosystems. A representative array of ecosystems should be managed that provide the greatest diversity and (hopefully) resilience to the changes that lie ahead.

The matters of national environmental significance have been a key input in formulating the NRC's recommended management approach. Priority sites have been identified that have high intrinsic values and support key values (migratory birds). These sites may need proactive interventions such as eco-engineering in the form of the construction of regulators and channels that can deliver artificial floods to the forests. This will require considerable investment in the form of infrastructure at relevant sites and the recovery of water for environmental purposes.

These sites can be further supported by connecting conservation efforts across the landscape, particularly connecting forests managed for conservation along riparian zones and across public and private land.

2.2.2 Biodiversity conservation strategies

The river red gum forests of the Riverina bioregion support a wide variety of biodiversity values. These include wetlands of international significance, significant breeding habitat for colonial and migratory wetland bird species listed under international migratory bird agreements, and various vegetation types which are habitat to more than 60 terrestrial animal species and 40 plant species listed as threatened (under Commonwealth and/or NSW legislation). In addition, river red gum forests in the region provide habitat to several other species which are not listed as threatened, but which are in decline (NRC, 2009).

National targets for river red gum forest reserves in NSW

The NSW National Parks and Wildlife Service (NPWS), part of the DECCW, currently manages a network of nearly 800 individual reserves in NSW, occupying 6.7 million hectares or nearly 8 per cent of the state. The central role of these reserves is to conserve the biodiversity values in NSW, including the ecosystems, economic worth, intrinsic and aesthetic values and the cultural and spiritual meanings associated with biodiversity in the state.

In addition, the reserve network provides a series of other benefits, including:

- the maintenance of water quality
- protection of Indigenous and historical heritage and artefacts
- resources for scientific study and education
- recreational opportunities and public access to a diverse range of landscapes
- improved amenity.

The reservation level of the river red gum forests within the NSW portion of the Riverina bioregion is currently low, with only 7.6 per cent of river red gum stands in NSW protected in the NSW formal reserve system. Much of this area is in Yanga National Park. Recent decisions in Victoria have increased the area of river red gum reserved in the Riverina bioregion as a whole (in NSW and Victoria combined) to 21.1 per cent.

The bioregion is identified as a priority by the 2008 NSW National Parks Establishment Plan due to its current low level of reservation.³ Priority areas identified include unrepresented ecosystems and habitats, wetlands, floodplains, lakes and rivers along the Darling, Murray and Murrumbidgee Rivers, important landscape corridors and culturally important areas.

The NSW and national reserve systems are based on the principles of a comprehensive, adequate and representative reserve system. The reserve design principles developed by JANIS and the guidelines for establishing a national reserve system are generally applied in NSW.⁴

³ DECCW (2008) *New South Wales National Parks Establishment Plan 2008: Directions for building a diverse and resilient system of parks and reserves under the National Parks and Wildlife Act*, Department of Environment, Climate Change and Water, NSW.

⁴ Commonwealth of Australia (1997) *Nationally Agreed Criteria for the Establishment of a Comprehensive, Adequate and Representative Reserve System for Forests in Australia*, a report by the Joint ANZECC/MCFFA National Forest Policy Statement Implementation Sub-committee.

These principles include⁵:

- protected area boundaries with strong ecological integrity, such as catchments
- large protected areas preferable to smaller ones (however a range of sizes may be appropriate)
- boundary-area ratios should be minimised and linear-protected areas avoided where possible
- protected areas should be developed across major environmental gradients
- reserve design should aim to minimise the impacts of threatening processes
- protected areas should be linked across the landscape through a variety of mechanisms.

The nationally agreed targets developed through the JANIS criteria are guidelines rather than mandatory targets.⁶ They include the reservation of 60 per cent of the remaining extent of vulnerable vegetation types, which in the case of the Riverina bioregion includes all river red gum forest types. In total the 60 per cent target would require in excess of 200,000 hectares of river red gum forest and woodland within the bioregion to be reserved with an additional 200,000 hectares of black box woodland to also be placed into conservation reserves.

However, the NRC has proposed a set of principles to identify priority areas for conservation within the bioregion. The principles applied to the design of this reserve system must consider a wide variety of factors to ensure the longevity of the reserves, the habitats within and the species and populations that rely upon them. They must also consider potential social and economic impacts and the principle of imposing the least cost on the community when creating reserves.⁶

Most importantly, the design of the reserve system must adequately address the issues of water availability and climate change, both of which will impact on river red gum ecosystems into the future. Sustaining the health of a reserve system sufficient to meet the 60 per cent JANIS target would require vastly more environmental water than is likely to be available in the future.

Climate change impacts on reserve design

A recent strategic assessment of the vulnerability of Australia's biodiversity to the impacts of climate change completed for the Natural Resource Management Ministerial Council⁷ advocated a more explicit consideration of ecological resilience in conserving biodiversity.

In particular, the assessment proposed the following principles for use in conservation planning:

- Maintaining ecosystem services through a diversity of well-functioning ecosystems, some of which may have no present-day equivalent range, form or structure.
- Giving ecosystems the best possible chance to adapt by enhancing their resilience via:
 - managing appropriate connectivity of fragmented ecosystems
 - enhancing the national reserve system
 - protecting key refugia
 - implementing more effective control of invasive species
 - developing appropriate fire and other disturbance management regimes
 - ecological engineering in some instances.
- Risk assessments to identify especially vulnerable species and ecosystems, and risk-spreading conservation strategies, coupled with active adaptive management.
- Integrated regional approaches tailored for regional differences in environments, climate change impacts and socio-economic trends, which may require reorientation of policy and legislative frameworks, and reform of institutional and governance architecture.

2.2.3 The pending Murray-Darling Basin Plan

The Murray-Darling Basin Authority (MDBA) is currently developing the first Basin Plan for the water resources of the Murray-Darling Basin under the Commonwealth *Water Act 2007*. The first Basin Plan is due to commence in 2011 and is intended to:

- set and enforce environmentally sustainable limits on the quantities of surface water and groundwater that may be taken from Basin water resources
- set Basin-wide environmental objectives, and water quality and salinity objectives
- develop efficient water trading regimes across the Basin
- set requirements that must be met by state water resource plans
- improve water security for all uses of Basin water resources.

Three core tasks in preparing the Basin Plan will include setting 'sustainable diversion limits' on the amount of water that can be taken from the Basin's water resources, and preparing two sub-plans on how to supply water to key environmental assets, and how to manage water quality and salinity.

The Basin Plan is intended to identify key environmental assets and ecosystem functions of water resources that must be protected. It is intended to identify risks to the condition or continued availability of Basin water resources and provide strategies for managing those risks.

⁵ DECCW (2008) *New South Wales National Parks Establishment Plan 2008: Directions for building a diverse and resilient system of parks and reserves under the National Parks and Wildlife Act*, Department of Environment, Climate Change and Water, NSW

⁶ Commonwealth of Australia (1997) *Nationally Agreed Criteria for the Establishment of a Comprehensive, Adequate and Representative Reserve System for Forests in Australia*, a report by the Joint ANZECC/MCFFA National Forest Policy Statement Implementation Sub-committee.

⁷ Biodiversity and Climate Change Expert Advisory Group (2009), *Australia's Biodiversity and Climate Change: a strategic assessment of the vulnerability of Australia's biodiversity to climate change*.

The NRC believes the river red gum forests are key ecological assets of the Murray River system, and that the assessment report has identified these forests' watering requirements. There is an opportunity to enhance this status by the creation of trans-border national parks, whereby the red gum forests in NSW, Victoria and potentially South Australia would be managed as integrated red gum floodplain ecosystems.

2.2.4 Principles to identify priority areas for conservation

Overall, the NRC believes that the design of any new reserves should consider the JANIS and comprehensive, adequate and representative principles, but should prioritise conservation planning around the following landscape features:

- areas with the greatest potential to retain or enhance ecological values, notwithstanding changing climate
- core water-dependent refugia to which governments can provide water security
- significant habitat for threatened and migratory species
- ecosystems poorly reserved in bioregions and subregions
- nodes that could form part of spatial and functional connections between refugia and key habitat across public and private land
- areas of existing good condition, or areas able to be managed to improve condition
- important sites of Indigenous heritage
- unique geological features
- recreation opportunities for the public
- replication of reserves of key habitat and species across river systems to spread risks.

2.2.5 State targets and regional Catchment Action Plans

The NSW State Plan, Investing in a Better Future for NSW 2009, sets a vision for NSW across a broad range of issues and targets in areas that include transport, health, safety and the environment. Many of these targets relate to values within the Riverina bioregion.

The natural resources targets for biodiversity, water, land and community themes in the State Plan were originally recommended by the NRC as contributing to an aspirational goal of "resilient, ecologically sustainable landscapes functioning effectively at all scales and supporting the environmental, economic, social and cultural values of communities".

Within the region, the Murray, Murrumbidgee and Lachlan Catchment Management Authorities have catchment action plans which provide strategic direction for investment in natural resource management for their catchments. The programs within the catchment action plans align with the 13 State Plan targets and incorporate additional local priorities.

As the scale increases from local and individual sites to regional and state scales, the relative importance of values and management issues changes. Management must ultimately

broaden from a focus on a site to an appreciation of the site's place in the overall ecological functioning of the catchment and bioregion. The challenge across existing institutional and regulatory frameworks is to ensure that macro-scale change is being considered in the management of landscapes. Individual sites should be managed as a component of a broader geographic, biological, social and physical system.

What does the forecast reduction in future surface water availability and generally warmer and drier conditions mean for the irrigation districts of the region? What will these changes mean for regional demographics? How might these demographic changes impact on future opportunities and threats?

Local communities are crucial in playing a key role in the ongoing adaptive management of regional landscapes and the values which they contain. Opportunities for 'win-wins' should be sought such as incentive and stewardship payments to conserve foraging habitat on private land and assist movement of species across the landscape.

2.2.6 Indigenous community values and aspirations

There is a rich cultural heritage associated with the Riverina bioregion that reflects both the historical and continuing interactions between Indigenous communities and the forests.

In submissions to and discussions with the NRC, Indigenous people expressed some common issues, including the importance of:

- ongoing access to the forests to reinforce Indigenous cultural identity
- improved protection of Indigenous cultural heritage sites in the forests
- cultural water allocations to allow for culturally-determined watering of forests
- opportunities for forest-related employment, training and economic self-determination.

Through their connection with Country, Indigenous people can offer considerable insight into important management decisions. Their culture and way of life have been exposed to long time-scale variability in landscape processes. They have managed to adapt to changes in water, food and other resource availability. Their experiences and insights are valuable inputs to determining long-term management solutions for the landscapes of the Riverina bioregion.

Future forest and landscape management agreements should involve extensive consultation with Indigenous communities in order to identify possible opportunities, aspirations and desired outcomes for Indigenous people. A process of long-term engagement is required to build an atmosphere of trust and respect.

Access to Country is paramount for Indigenous people. Indigenous people across the region maintain different interests and concerns, reflecting their different relationships and values related to the landscape. Solutions must be sufficiently diverse to accommodate a range of contemporary uses, values and aspirations.

2.2.7 Non-Indigenous community values and aspirations

The Murray and its tributaries, with their floodplain forests, are dominant in the landscape and are an equally dominant cultural backdrop to the communities who have grown along their floodplain boundaries. The rivers are major physical features of the region and an intrinsic component of its human geography. The forests are important for Riverina communities on many levels, providing environmental, economic, cultural, community and personal benefits.

Many people have worked in the forests all their lives, and others enjoy the strong connection they have through recreational activities. Current generations feel that same close connection to this landscape as their great-grandparents did. They want the same sense of 'place' for their children and they want to see viable, secure and rewarding futures for future generations in their home towns.

For communities such as Koondrook-Barham, Barmah, Barooga, Balranald, Darlington Point, Deniliquin and Mathoura, these forests are places to relax, reconnect and spend time with family and friends. The forests are also a destination for people from outside the region, in particular visitors from Melbourne.

2.3 Resilience: linked social, economic and ecological systems

The science of ecological resilience has been developing since the 1970s, and is emerging as a useful way of thinking about dynamic, interlinked systems of humans and nature (social-ecological systems).⁸ There is an emerging literature⁹ and practice¹⁰ on applying resilience thinking, which may be of some use in developing principles for future management of the river red gum forests.

Resilience thinking as applied to landscapes is the capacity to visualise a landscape as a complex system that reorganises itself in response to internal and external influences. Farms, catchments, businesses, governments, forests and fisheries are all complex systems in their own right but they are also interconnected components of the broader landscape and region. A system's resilience is its capacity to "absorb disturbance and reorganise while retaining a similar identity including structure, function and feedbacks".¹¹

Complex systems such as landscapes are configured by a small number of slow controlling variables (population levels, native vegetation cover, nutrient levels, flood frequencies). Thresholds are levels in underlying controlling variables at which feedbacks in the rest of the system change. Exceed the threshold and the system (landscape) begins to function in entirely different ways, often with dire consequences for those dependent on it. When this happens the landscape is said to have undergone a regime shift to have shifted to an alternative state.

One of the controlling variables of the river red gum forests has been the frequency of large 'landscape-restoration' floods. These are no longer experienced and are not likely to return. As a consequence, the NRC believes that these landscapes have undergone a regime shift and behave in a different way. Once the forests could sustain a forest industry, attract tourism, and harbour a range of animals and plants and still regenerate, despite a highly variable climate. Now the flooding regime has been fundamentally changed, which has altered floodplain processes and feedback loops to such an extent that the forest ecosystems and forestry industry are in decline.

To understand what makes a system resilient (or lacking in resilience), resilience thinking treats the social, ecological and economic domains of the system as interdependent and dynamic. It encourages an integrated analysis of the social, economic and environmental domains that make up the system, while at the same time identifying the 'slow' variables that constrain it.¹²

One way of defining a system's resilience is its capacity to avoid crossing a threshold and entering a new regime. Considering the river red gum forests as a system in a resilience framework requires an understanding of their social, economic and environmental domains (and how they are connected over multiple scales of time and space). The resilience of this system relates to the capacity of its managers to maintain a once in a decade large flood as this sustains and revitalises the floodplain and the river red gums.

A combination of river regulation, over extraction of water and a drying climate has removed this flooding regime. The demise of this flooding regime mirrors a decline in the landscape's resilience. It has now crossed a threshold and is in a new regime, having moved from a historically wetter landscape to the current much drier landscape.

Figure 2 illustrates the historic, current and possible future states of the social, economic and ecological systems associated with these floodplain forests ecosystems. The horizontal axis represents the extent, duration and seasonally-appropriate timing of flood inundation. The vertical axis represents the health of the floodplain ecosystem functions at different scales; from the smallest scale of individual forests stands, up through forest groups in different water management units, and finally up to the Basin and river system scale.

In their pre-development state (at **point 1** on the top right of the figure), the forest ecosystems were created by the natural flooding regimes across the river systems. There was limited harvesting or silviculture development. This is the period in which the largest red gum stands germinated and the main forest stands were formed.

⁸ Walker, B. and Salt, D. (2006) *Resilience thinking: sustaining ecosystems and people in a changing world*.

⁹ See *Journal of Ecology and Society*.

¹⁰ The Resilience Alliance (2007) *Assessing resilience in socio-ecological systems: a scientists' workbook*. Available online at <http://www.resalliance.org/3871.php>. See also Walker et al (2009) "Resilience, Adaptability, and Transformability in the Goulburn-Broken Catchment, Australia". *Ecology and Society*, 14 (1): 12.

¹¹ Refer to Resilience Alliance definition, cited in Walker et al (2009).

¹² Refer to Resilience Alliance definition, cited in Walker et al (2009).

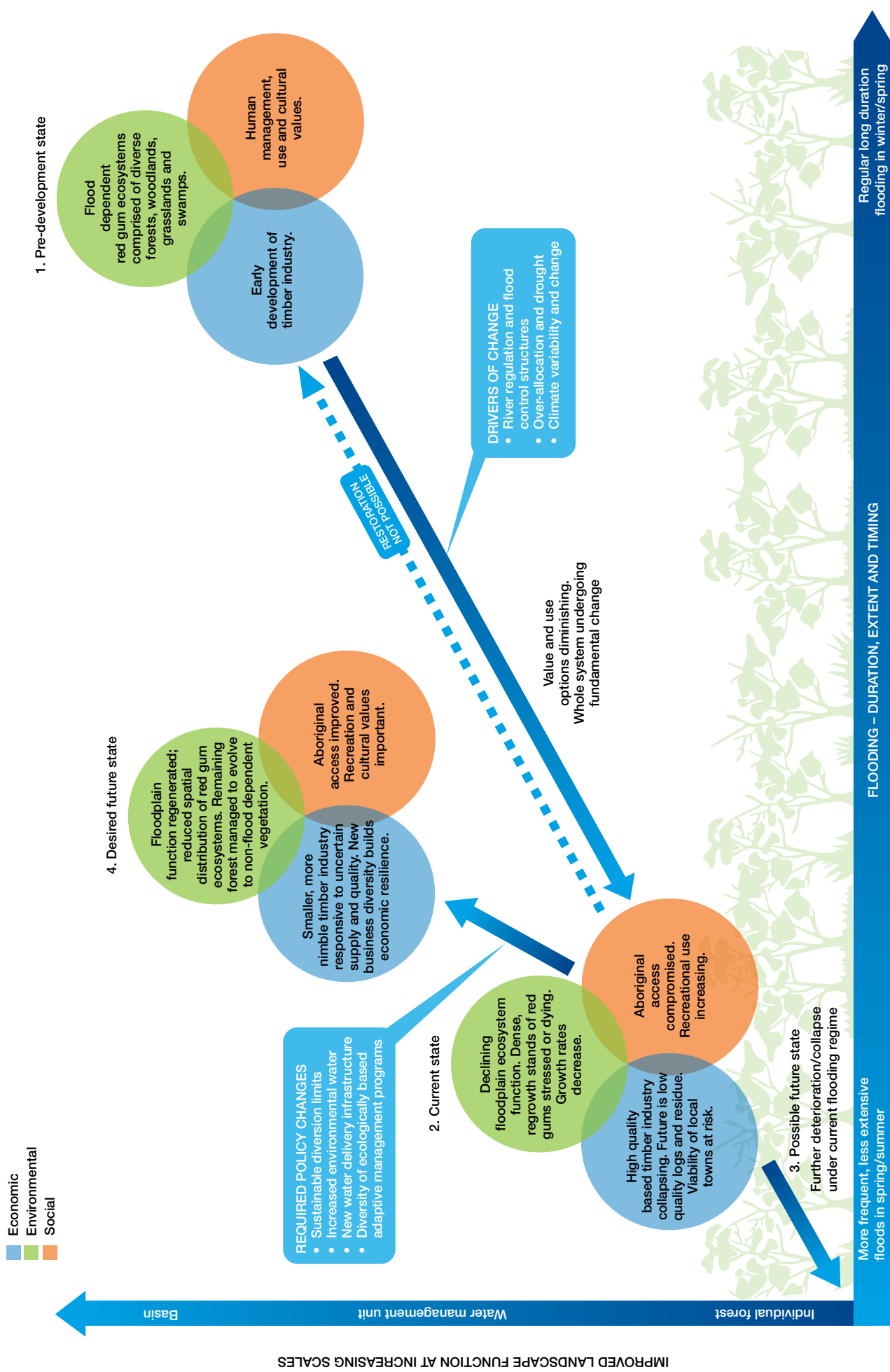


Figure 2 : Landscape change in the river red gum ecosystems of the Riverina bioregion.

Over time the extent and duration of floods has declined with river regulation, flood control structures, and extraction of water for irrigated agriculture. Seasonality of flooding was also reversed, with flows maximised within bank capacity in summer to deliver water for irrigation and urban water supply. Overbank flooding was reduced to improve reliability of supply for extractive uses. High summer flows also increased the extent of unseasonal summer flooding from rain rejection events (where irrigation was planned and ordered, but cancelled due to summer rainfall).

Forest stand development under silvicultural practices has also changed the structure of the forests, promoting denser stands of regrowth to improve timber quality. Grazing and forestry practices also further reduced native ground cover, understorey and habitat complexity. Broad-scale clearing of native vegetation and irrigation development in the surrounding region have mobilised salt in the landscape, causing in-stream and dryland salinity problems.

More recently, the extended drought and long-term climate variability has brought matters to a head (at **point 2** on the figure) as floodplain ecological processes have further reduced, forest growth rates have continued to decline, and forest regeneration after harvesting has been very limited. All forest values are in simultaneous decline because of the absence of the large, long-duration 'landscape restoration' floods. River regulation now restricts the previously natural flows from multiple river systems in NSW and Victoria which would have flooded these floodplains and recharged the large aquifer systems.

The choice we all now face is whether to let the system continue to decline along a path from **point 2** to **point 3**, or whether we can manage the transition to a new resilient future at **point 4** by tackling the water reform and reform of social and economic systems which are required across the Basin.

To achieve this reform will require improved governance at multiple scales. Successful decisions at the Basin scale are crucial to creating opportunities for success at the scale of river systems. Similarly, successful decisions at the river system scale are crucial to creating opportunities for success in the various forests within water management units. Interaction between scales means we need strong links between planning, implementation, monitoring, accountability and adaptive responses across scales.

In practice there will be a suite of management interventions at different scales in the landscape. Some will acknowledge the fundamental transformation occurring and seek remediation outcomes, while others will work hard to preserve key sites, assets and functions, moving back along a rehabilitation pathway.

2.4 Methodology for recommending forest management priorities and tenures

In developing its recommendations, NRC has sought to analyse the forest ecosystems at three inter-connected scales. The dominant scale is the macro-scale of the Murray-Darling Basin, the Murray River system as a whole and the Riverina bioregion. It is at this macro-scale that the scope of possible futures for all the red gum forest ecosystems is ultimately being set.

Below this, the NRC has sought to analyse the potential future management of each group of forests across the main water management units to which water can separately be directed. It is possible and in many cases desirable to manage each water management unit separately as the ecosystem health and values that can be supported vary considerably. These main water management units are described in more detail in the final assessment report, and key aspects of them are paraphrased along with maps in **Appendix 2** to this recommendations report.

Lastly, each forest ecosystem needs to be understood at the scale of individual forests and the floodplain processes within each main water management unit. Each has distinct values today and different possible futures. The possible uses, values and priority of management objectives across distinct forests can be separately determined. But each possibility falls within the scope determined by the management of the surrounding water management unit, river system, and the Basin.

At these three scales, the NRC has reviewed the ecological functioning, current trajectory and possible transformations of these ecosystems under 'business as usual' river and forest management, and predicted climatic conditions. This is covered in considerable detail in the final assessment report.

The current trajectory of each system is a result of a range of factors including:

- past disturbances, their effects on ecosystem dynamics and impact of broader landscape issues such as changes in irrigated agricultural systems and declining rural populations
- the range and scale of ecological, economic and social values currently supported by different groups of forests
- the capacity of those forests to continue to support those values given the forests' health, ecological trajectory and likely 'end state'.

The NRC has then sought to gauge the feasibility of using alternative management approaches to change the trajectory of condition in particular water management units and forest groups, and the values they might continue to support into the future.

On the basis of its assessment of current trajectory and possible changes to that trajectory, the NRC has proposed a priority of management objectives for each group of forests after considering:

- opportunity cost is of managing for different value types. For example, what is the extent of trade-offs or synergies in pursuing wholly conservation, wholly production, wholly recreational or social uses, or practical combinations of these?
- evidence of societal preferences for different value mixes within the feasible constraints and trajectories for different forest groups. For example, what current and possible uses are made of the forests? What are Government's policy and statutory requirements to meet reserve criteria and protect listed species?

At a broader level, the NRC also considered the available community and organisational capacity to fund, implement and manage the risks of particular management objectives over time. This places limits on, and presents opportunities for, how forests can be managed in practice. Similarly, the capacity of feasible institutional arrangements to cater for the evolution of community values, new knowledge in ecology, and climatic uncertainty is another relevant consideration in deciding on the appropriate tenure to pursue particular management objectives in particular forest groups.

These two global considerations have generated some recommendations on appropriate institutional and management arrangements for forest groups covered in **Chapter 1** of this recommendations report.

This overall assessment process has required the NRC to consider a great deal of scientific information, along with the information arising from its tours of the forests, public meetings, consultations with stakeholder groups, and submissions received in response to the preliminary assessment report.

In the final result, the NRC has recommended a pattern of forest tenures across the main forest groups and main water management units of the region. The NRC believes these are the best land tenures by which to implement the recommended management priorities for each group of forests. The NRC has favoured a diversity of tenures to promote innovation and novelty of adaptive responses, given the extent of uncertainty.

Looking at the region as a whole, the NRC has also recommended that Government overlay a broader conservation and adaptive management strategy to ensure lessons are successfully shared across the bioregion on how to manage the forests successfully through the coming changes. This should include accountability and integrative systems for all forest tenures.

In the final assessment report, the NRC developed ideas on regional scale conservation and reservation initiatives to maximise diversity of adaptive management responses, and cross-scale interactions of species. It also estimated the realistic remaining resource base for the forestry industry and has recommended a more sustainable future for the forestry industry.

Lastly the NRC has speculated on some options for building social networks and community capacity to respond to the impact of drought and climate change in this region, including regional diversification away from water-dependent industries. Investment in park-related tourism infrastructure will be important in providing a base for new social networks and community capacity.

3 Water reforms to save the red gum forest ecosystems

Prior to water resource development, out-of-channel flows regularly connected the river to the floodplain, renewing the function of the floodplain and its dependent forests, wetlands and grasslands. Water flowed onto the floodplain, and some ultimately flowed back to the river. During flood events many essential ecosystem services were provided, including improved water quality, nutrient cycling, regeneration of micro-organisms, habitat and foraging for fauna and the germination and vigour of native flora including river red gums.

Today, the health of the river red gum forests is still dependent on healthy, functioning floodplains and enough water being delivered to flow through the forests. Inundation of large areas of floodplain ecosystems will require large volumes of water. Properly managed, diversions for floodplain watering will not be lost from the river system. Floodplain water returning to the river provides a range of ecosystem services, as well as being available for use downstream for a combination of environmental and consumptive purposes.

Modelling by Water Technology indicates that 35–45 GL/day at Yarrowonga for at least 60 days is required to achieve the Icon Site Management Plan objective for the Barmah-Millewa Forest (55 per cent inundated). Allowing for conveyance water, this equates to a total of 1,500–2,000 GL entering the forest. A considerable proportion of this water will return to the river. Whilst difficult to estimate and dependent on a number of factors, it is expected that this would amount to 50–80 per cent of the total volume (750–1,600 GL), which is available for re-use downstream.

Small quantities of water will not flow through the forest and will not improve overall system health. It is uncertain that any emergency watering will achieve the ecological functions fundamental to lowland floodplain-river interactions. River red gum forests are important functional components of the broader floodplain. Without the allocation and delivery of large volumes of water, these forests will continue their well-progressed transformation to a less water-dependent ecology. If that happens, many ecosystem services and current uses will be lost.

3.1 Findings from the final assessment report

In **Chapters 7 and 8** of the final assessment report, some of the NRC's key findings on river regulation and climatic impacts on water availability and flooding are:

- River regulation has fundamentally changed the flow regimes of the major rivers in the bioregion. The future health of the river red gum forests depends fundamentally on the success of COAG water reforms in restoring water to these stressed and over-allocated floodplain river ecosystems.
- A further substantial reduction in the magnitude, frequency and duration of floods can be expected under climate change for the majority of forest stands, particularly the larger forests of Millewa, Koondrook-Perricoota and Werai. Large 'landscape-restoration' floods are unlikely to occur. However, the delivery of environmental water to the Millewa forests and intervention works at the Koondrook-Perricoota forests will assist in maintaining some moderate-sized floods.
- A further reduction in flood extent, duration and frequency can also be expected under climate change for forests associated with the Murrumbidgee and Lachlan rivers, and riparian zones along the Edward, Wakool and Murray rivers downstream of Koondrook-Perricoota forests.
- The forests along the Upper Murray River are more resilient as local rainfall towards the east is comparatively higher and may increase. These forests can also access local shallow groundwater systems recharged by river levels kept high during summer to supply water for irrigation.
- Some river red gum communities are likely to be highly dependent on groundwater. There is evidence that river red gums in the Riverina bioregion use groundwater opportunistically as a water source in prolonged dry periods and times of water scarcity. Flooding is a significant recharge mechanism in some areas of the bioregion.

3.2 Reduced flooding due to river regulation and climate

The river red gum forests of the Riverina bioregion were established over thousands of years of unregulated flooding. River regulation and irrigation established over the past 120 years have dramatically altered these historic flooding regimes. Analysis of the flood data at Yarrowonga on the Murray River upstream of the Millewa forests shows that the regular flooding required to sustain large tracts of healthy red gums no longer occurs naturally with sufficient frequency. Flows onto the floodplain have reduced by approximately 50 per cent in comparison with pre-development flows. Modelling in the final assessment report indicates such large floods will not return under projected climate change.

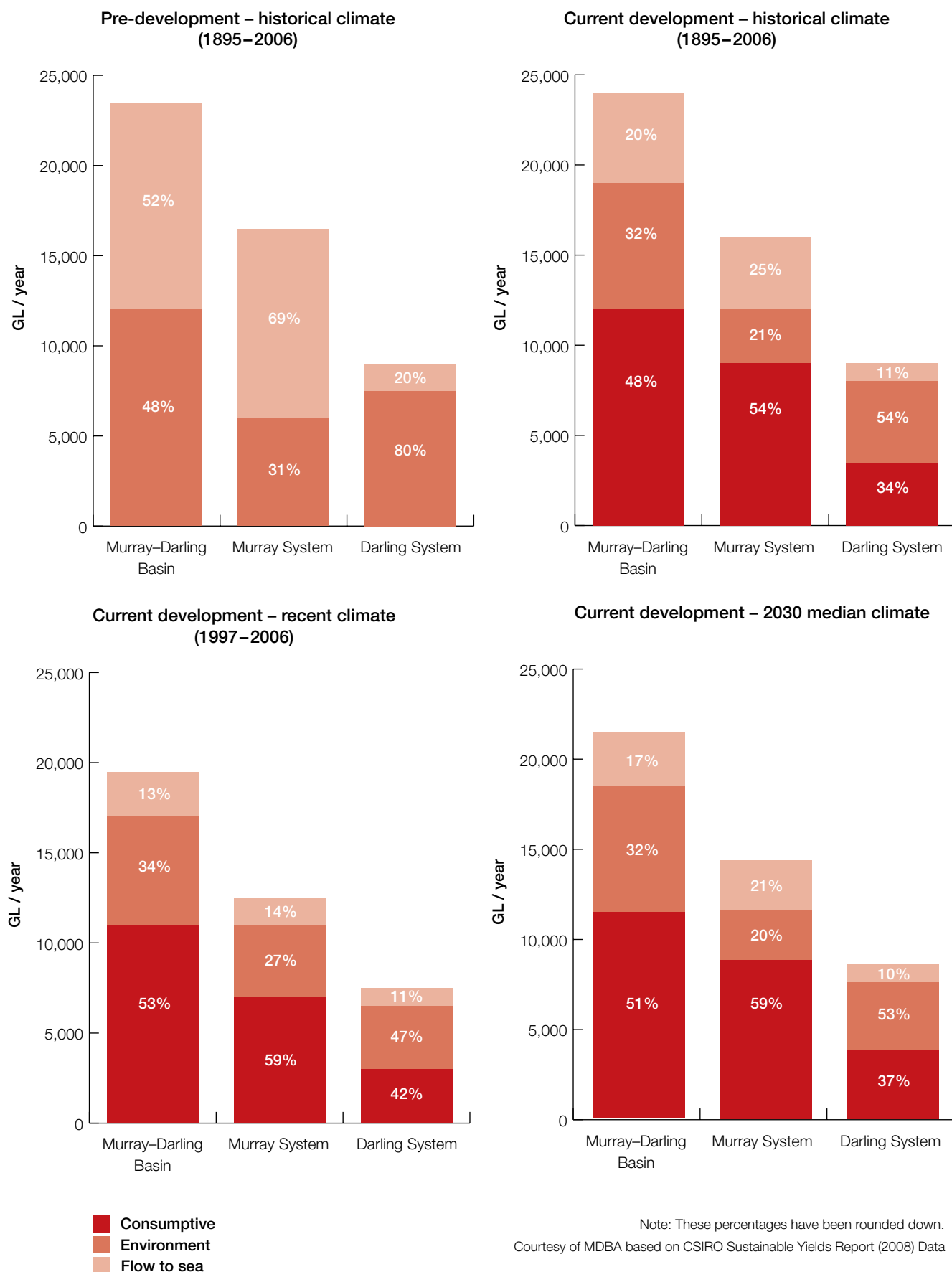
River regulation has had a profound impact on the flows within the Murray-Darling Basin. Total flow at the Murray mouth has been reduced by 61 per cent compared with pre-development conditions. The Murray ceased to flow to the sea 1 per cent of the time prior to water resource development, compared with 40 per cent of the time currently.

Figure 3 shows the change in water availability in the Murray-Darling Basin over a number of scenarios and the change in the proportion of water for different uses. The top two panels show how river regulation and water resource development have dramatically altered the relative proportions of river flow going to extractive water use, the river floodplains and wetland, and the end-of-system lakes, estuaries and marine environment respectively. The bottom two panels show how the two climate change prediction scenarios (continuation of the recent climate and median 2030 climate) may exacerbate this situation.

The figure demonstrates the greatest impact upon water used for the environment was the commencement of current development (river regulation) rather than climate change scenarios or the recent drought.

As can be seen in **Figure 3**, average consumptive water use in the Murray system under the current development and historic climate conditions is approximately 8,600 GL/year, or 54 per cent of the average annual water available. MDBA's modelling indicates that the impact of the current drought and projected (median) climate change are disproportionately felt by the environment, with consumptive diversion remaining substantially unchanged.

Figure 3: Murray-Darling Basin annual water availability, consumptive diversion, flow to floodplains and wetlands, and flow to lakes, estuaries and marine environment over four climate and water resource development scenarios (courtesy of MDBA based on MDBSY Project data)¹³



¹³ CSIRO (2008) *Water Availability in the Murray-Darling Basin*, a report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project, Australia.

The Intergovernmental Panel on Climate Change has published four comprehensive assessment reports reviewing the latest climate science in 1990, 1995, 2001 and 2007. As the reports have progressed, they have become increasingly certain of projected climate changes. The latest report stated that “warming of the climate is unequivocal and will continue for centuries due to the timescales associated with climate processes and feedbacks, even if greenhouse gas concentrations were to be stabilised”.

The CSIRO's *Water Availability in the Murray-Darling Basin*¹⁴ presents two key findings in relation to the current health of the Riverina red gum forests and the future for the region more generally:

- Water resource development has caused major changes in the flooding regimes that support nationally and internationally important floodplain wetland systems in the Murray-Darling Basin.
- The impacts of climate change by 2030 are uncertain; however surface water availability is more likely to decline than increase, with a median decline of 13 per cent in the south of the Basin (covering the Riverina bioregion).

3.3 Basin water reform

The *Water Act 2007* established the MDBA, which in turn must develop the Murray-Darling Basin Plan to sustainably manage water resources in the Basin. The central legal requirement of the Basin Plan is to set environmentally sustainable limits on the amount of water that can be diverted for consumptive use.

Sustainable diversion limits must be set at a level that the MDBA determines can be taken from a water resource without compromising key environmental assets, key ecosystem functions, key environmental outcomes or the productive base of the water resource. The MDBA states that “given the stresses on the Basin environment, it is likely that the Basin-wide sustainable diversion limit will be set at a level below the current level of use”.

The Basin Plan and the establishment of the Commonwealth Environmental Water Holder to recover significant volumes of water for the environment present an opportunity to improve flooding of the forests. The NRC believes the river red gum forests are key environmental assets of the Murray River system, and that the assessment report has identified these forests' watering requirements.

There is an opportunity to enhance this status by the creation of trans-border national parks, whereby the river red gum forests in NSW, Victoria and potentially South Australia would be managed as integrated floodplain ecosystems. Collaborative management arrangements combined with infrastructure investment could preserve and restore key ecological values of the river red gum forests.

The setting of sustainable diversion limits in the Basin Plan will provide considerable clarity for the amount of water likely to be available for consumptive purposes in the future. With the benefit of this certainty, it will be important for Governments to invest in helping the irrigation industry and regional communities adjust to a drier future.

3.4 Environmental watering to support red gum forest health

The Central Murray forests, which include the Millewa, Koondrook-Perricoota and Werai forests, are Ramsar-listed, support numerous key species, and directly and indirectly drive much of the health of the region.

The forests are heavily stressed and undergoing broad-scale change because river regulation has reduced the available water and the frequency and magnitude of flooding. The effects of climate variability and climate change will further reduce the water available to these ecosystems. Survival of the river red gum forests depends on successful water reform.

Without water reform, the river red gum forests will continue to transform to ecological communities that are less water dependent. Allowed to proceed unchecked, this transformation is likely to have profound implications for the river and the broader environmental health of the bioregion.

3.4.1 Ecological functions

Unconfined, meandering, lowland rivers like the Murray River at Yarrowonga frequently flow out of their channels. Typically, the channel capacity of such rivers evolves to carry a one in two year flood event. Flows greater than this tend to spill onto the floodplain. As a result, the ecology of the river channel and floodplain adapt to and are reliant upon this interaction. Flooding is essential in maintaining the character, diversity and resilience of lowland river ecosystems in channels, wetlands and forests.

River red gum forests function as an important component of the broader floodplain ecosystem. For example, they produce organic carbon and other nutrients in the form of forest litter which is distributed across the floodplain in flooding events. River red gum forests are potentially the key driver of river floodplain ecosystems. They support and drive the productivity of other ecosystem processes in the floodplain.

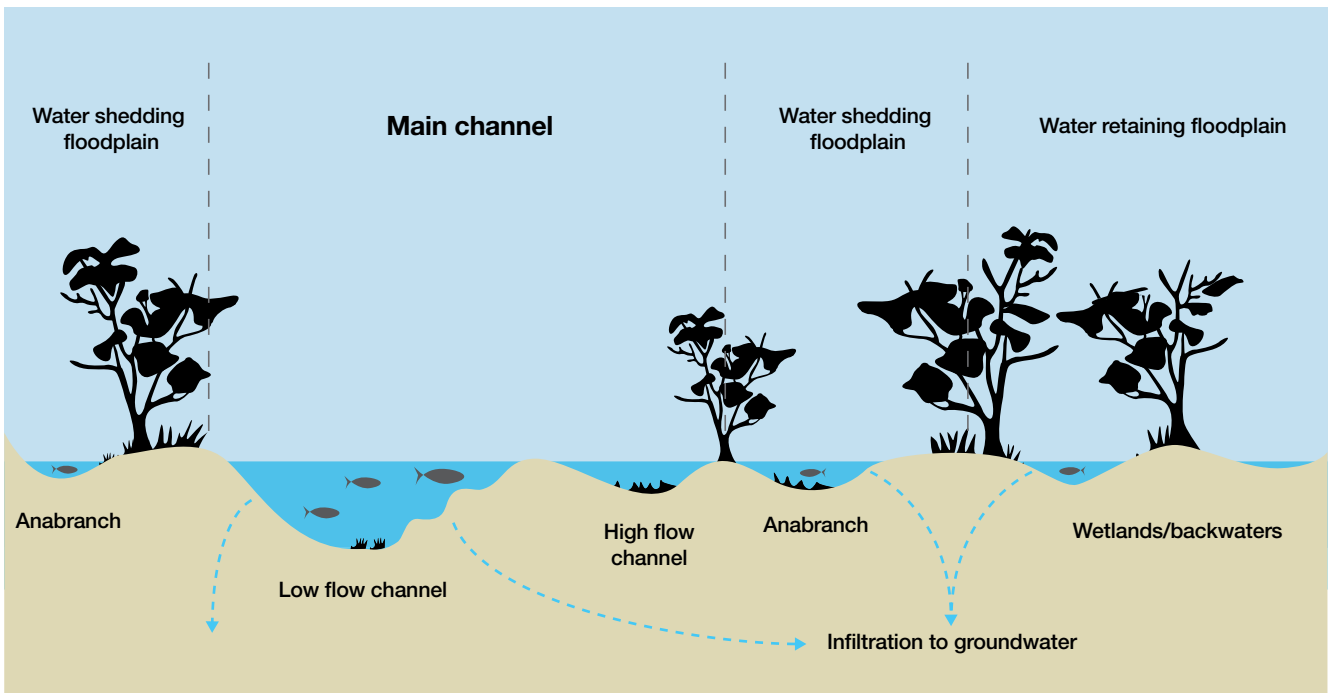
Hillman (unpub. 2009) has discussed the different components of the river system and the different phases of an inundation event:

- **River system components** – water-shedding floodplain (in this case eucalypt forest, mainly red-gum), water-retaining floodplain (wetlands, backwaters, lakes), and channel (main stream and free-flowing anabranches)
- **Inundation event phases** – initial inundation, flooded period, receding inundation, post-inundation.

The different components and phases play key roles in ecological processes within forests and in the forest playing its role across the broader riverine landscape. **Figures 4 and 5** shows schematically the interaction of different parts of the riverine landscape and their ecological processes during the phases of a flood event.

¹⁴ CSIRO (2008) *Water Availability in the Murray-Darling Basin*, a report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project, Australia.

Figure 4: Cross section view of ecological functions and the hydrology of red gum forests



Flood waters connect the main channel and floodplain and drive ecosystem processes

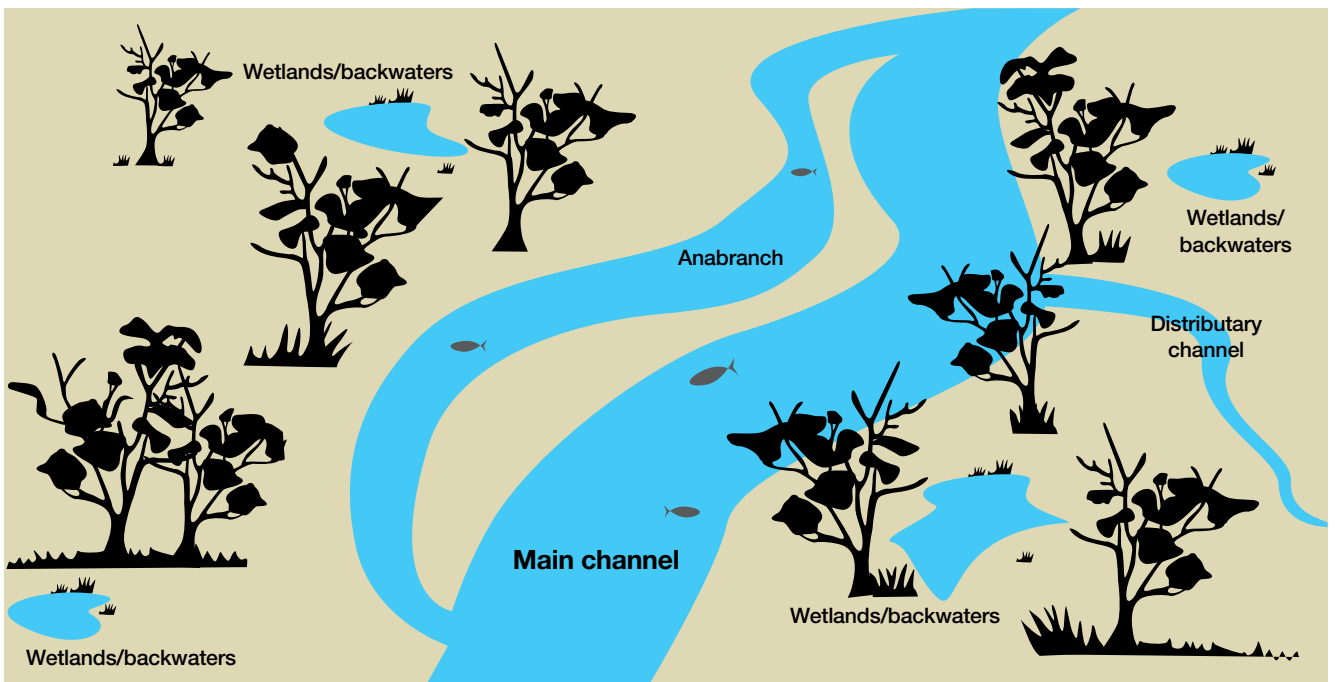


Figure 5: Oblique view of ecological functions and the hydrology of red gum forests

3.4.2 Water reform and environmental water requirements

Median flows in the Murray River at Yarrowonga prior to water resource development were approximately 7,000 GL/year. Water resource development has seen a very large change to in-channel flows.

An analysis of total flows at Yarrowonga on the Murray River over a 111 year flow record is shown in **Table 1**. This analysis involved the summation of flows less than, and in excess of, 10,400 ML/day. The Murray River channel capacity at the Barmah Choke is 10,400 ML/day, as gauged at Yarrowonga, and for this purpose serves as an indication of in-channel versus floodplain flows in the region of Barmah-Millewa forests. The analysis indicates the significant effect of river regulation in reducing floodplain flows to Millewa forests. It also shows how climate change will exacerbate this effect.

In Scenario B (a ‘step change’ climate with current water resource development), whilst total flows past Yarrowonga gauge are halved from those pre-development (Scenario P), in-channel flows (less than 10,400 ML/day) remain virtually unchanged, while flows onto the floodplain (greater than 10,400 ML/day) have reduced by 80 per cent.

As can be seen in **Table 1**, even under a continuation of current climate and development conditions, on average, there is 1,822 GL/year less water flowing onto the floodplain compared with pre-development conditions. It is the predevelopment conditions of large, regular flooding that established the river red gum forests and it is the dramatic decrease in this flooding (magnitude, frequency and duration) that is causing the forests to be stressed.

The science that informed The Living Murray process in 2002 stated that 1,500 GL would give the Murray a ‘moderate chance’ of being ecologically healthy. This same science stated that in the order of 4,000 GL would be required to provide a high likelihood of a healthy river system to return key indicators of health to two-thirds of their natural level.

The ‘First Step’ of The Living Murray program involved the recovery of 500 GL. The Living Murray progress report notes that the “current suite of projects will deliver 485 GL or 97 per cent of the 500 GL target over coming months”. Of the 485 GL, the MDBA Annual Environmental Watering Plan 2009–10 is currently forecasting a total of 6 to 10 GL available in spring 2009 and 31–73 GL available in autumn 2010.

Recent modelling by Water Technology has shown that in the order of 35–45 GL/day (at Yarrowonga) for at least 60 days is required to achieve broad scale inundation of Barmah-Millewa forest sufficient to achieve the First Step ecological objectives for the site. Based on this information, the NRC calculates that to maintain the ecological character these forests require at least:

- smaller floods once every two years of around 20 GL/day for between 60 to 150 days (i.e., total volumes of between 1,200 GL to 3,000 GL every two years)
- a larger landscape-restoration flood once in 11 years of 35 GL/day for 90 days, plus a peak of 45 GL/day for 15 days (i.e., about 3,825 GL every 11 years).

Table 1: Analysis of total flows at Yarrowonga gauge over four climate and water resource development scenarios

Flows at Yarrowonga gauge – MDBSY data (CSIRO 2008a)	Scenario P Pre-Development – Historic Climate (1985 – 2006)	Scenario A Current Development – Historic Climate (1985 – 2006)	Scenario Cmid Current Development – 2030 Median Climate Change	Scenario B Current Development – Recent Climate (1997 – 2006)
Total flow (ML)	717,788,611	548,037,588	473,884,187	397,464,071
Flows less than 10,400ML/day (in channel) (ML)	308,538,913	340,997,285	332,205,352	315,326,942
Flows greater than 10,400ML/day (out of channel) (ML)	409,249,698	207,019,503	141,658,035	82,137,129
Reduction in total (111 years) of flood on floodplain (GL)		202,230	267,592	327,113
Mean per annum reduction in flows on floodplain (GL)		1,822	2,411	2,947
Percentage of total flow compared with ‘pre development’		76%	66%	55%
Percentage of total flow less than 10,400ML/d compared with ‘pre development’		111%	108%	102%
Percentage of total flow greater than 10,400ML/d compared with ‘pre development’		51%	35%	20%

As a result, the NRC calculates that approximately 54 per cent of the long-term, pre-development, mean annual 'floodplain' flow at Yarrowonga (or 2,000 GL) needs to be dedicated to sustaining essential floodplain ecosystem processes along the Murray River system.

The Commonwealth has earmarked \$3.1 billion for water recovery, which based on the average purchase price to date of \$1.5m/GL (\$1,500/ML) would buy in the order of 2,000 GL of water entitlements. To achieve the target of 54 per cent of median flows for the environment, NSW and Victorian Governments should urge the Commonwealth Environmental Water Holder to recover and assign to the Murray system an additional 1,200 GL of water. This should be used to enhance current environmental water entitlements which include 500 GL for the Murray River system under The Living Murray, 100 GL for the Barmah-Millewa forests, and entitlements recently recovered by the Commonwealth Environmental Water Holder.

While inundation of large areas of floodplain every two years will require significant volumes of water, it should be recognised that flows for environmental watering are not 'lost' from the river system. A considerable proportion of floodwaters return to the river. It is expected that between 50–80 per cent of floodplain flows return to the river following a flood event. Actual return flows would be site specific and depend on flood duration and antecedent conditions, amongst other factors.

3.5 Environmental engineering projects and water infrastructure

The planned infrastructure project to improve water delivery to the Koondrook-Perricoota forest group should continue, as the forests are significantly affected by changes to the natural flooding patterns and more recently drought. Without the infrastructure to provide for emergency watering in the near term, Australia will be in breach of its obligation to maintain the ecological character of this Ramsar-listed forest. The project is already funded at a cost of \$56 million from The Living Murray Program, is well advanced and is scheduled for completion by mid-2011.

Logging of this and other Central Murray forests is consistent with Australia's obligations under the convention, provided that logging is consistent with 'wise use' and in line with the management of the forest when it was listed. NRC has recommended parameters of improved silviculture practices, taking into account lower growth rates and higher tree mortality under drought and climate variability or change.

Significant ongoing investment in water infrastructure and eco engineering projects will be required to deliver appropriate flooding regimes to river red gum forests across the region.

4 Forestry ecosystem management in a water scarce future

The river red gum floodplain ecosystems of the Riverina bioregion are under high stress, and in some cases are transitioning to alternative states. They will require various levels of direct intervention if they are to continue to provide ecosystem services that the community values. We need to learn as we go by setting clear management objectives, trialling and testing different approaches, and building on what works for these ecosystems.

In the final assessment report, the NRC has proposed a set of principles to guide management of all river red gum forests. They apply equally whether the forests are managed for conservation, wood production or some combination of outcomes. If codified into management plans or formal agreements, they will protect the ecological character of the river red gum forests, and drive adaptive management.

4.1 Interventionist management of red gum forest ecosystems

River red gum forests are situated in a dynamic floodplain. Future management in all forms of tenure must address the river floodplain ecosystem as a whole, which no longer receives sufficient flood flows or groundwater to sustain some aspects of those ecosystems. Even with significant water reforms, the future of these forests will be drier than in the past. Climate variability and change will continue to force changes in the structure and health of river red gum forests.

Changes to river red gum ecosystems will occur through naturally occurring processes. However, in many circumstances, targeted management interventions are likely to achieve outcomes that cannot be obtained from naturally occurring processes. Specific interventions may provide greater degrees of control over outcomes than can be achieved with non interventionist approaches. This applies across public and private land, and whether public lands are managed as reserves or as State Forests.

In some forest areas, ecological thinning may provide a useful tool to enhance both conservation and production outcomes. However, little research has been undertaken on the ecological effects of different thinning techniques, and outcomes are subject to considerable uncertainty. Consequently, there is a strong imperative to develop robust and prudent adaptive management frameworks to guide ecological thinning in river red gum forests in both production and reserved areas.

The NRC has developed a range of principles for managing river red gum forest ecosystems in a drying climate. These are set out in **Chapter 11** of the final assessment report and in broad terms would require forest managers to:

- sustain large-scale hydrological and geomorphological processes
- maintain connectivity between communities, habitats and ecological processes across the bioregion

- implement a range of management strategies across different spatial, temporal and institutional scales to spread risk
- implement active management regimes within both protected and production areas
- maintain forest complexity within production forest areas, including stand complexity, large trees and coarse woody debris, and variability across space and time
- establish a comprehensive, adequate and representative series of reserved areas
- enable environmental stewardship by individual and groups on private land
- involve local communities in strategy development and implementation to ensure greater success in achieving identified goals
- implement adaptive management to enable learning over time.

4.2 Australian Group Selection harvesting technique

Forests NSW's implementation of silvicultural practices (including Australian Group Selection) in the river red gum forests of the Riverina needs modification if it is to maintain the ecological character of the forests and protect matters of national environmental significance.

Based on the NRC's review of the relevant scientific literature and observation of harvesting practice, the NRC believes that a 'gapping' technique, such as Australian Group Selection, can be an appropriate silviculture technique for a light-intolerant species such as river red gum provided it is accompanied by appropriate prescriptions for:

- closer timing between any gapping and subsequent flooding to promote regeneration
- permanent retention of adequate numbers of habitat trees in appropriate forest locations
- retention of appropriate amounts of coarse woody debris
- alternate use of gapping and selective harvesting at different times in the growing cycle
- rotation timing and overall intensity of harvesting.

The NRC has worked with Forests NSW and independent scientists to develop some new principles for river red gum silvicultural practices, which if codified into an Integrated Forestry Operations Approval will protect and conserve environmental values, including matters of national environmental significance. These are set out in **Chapter 11** of the final assessment report.

4.3 A diversity of forest tenures to encourage innovation

The NRC has recommended that Government establish a range of different forest tenures to provide a richer base for adaptive learning and the more rapid development of novel tenures and management strategies.

This range of tenures should include:

- National parks in wet refugia and riparian corridors, such as the Barooga group of forests, Millewa forests, and the riparian forests on the Lachlan and Murrumbidgee.
- Regional parks where significant ecological and recreational values exist near towns.
- Engaging Indigenous communities in management or co-management of all forests, prioritising those such as Werai and Taroo (Lake Victoria) forests where significant Indigenous community capacity exists to participate in forest management.
- Exploration of alternate institutional models for governance for 'wise use' for multiple values under the Ramsar Convention for Koondrook-Perricoota and Campbells Island forests which retain suitable timber resources, and readily identified and managed habitat values.
- Converting river red gum forests on isolated public lands to private land, subject to appropriate conservation covenants, and as part of conservation initiatives on surrounding private land.
- Research and rehabilitation reserves for some degraded forests. These should be managed with a focus on researching how to rehabilitate the sites in the long-term.

The NRC has recommended that governments work towards establishing some trans-border national parks to better align flooding regimes, management of ecological assets and promotion of reserves of national icon status for the Australian public.

Managing key environmental assets and corridors as national parks is a sound conservation planning response to river regulation and climate change. However it will require active interventions to trial different methods of management, including thinning within new ecologically focused silvicultural systems.

Drought and climatic changes are affecting small forestry-dependent towns most rapidly, as forest growth rates and wood supply dwindle. Mills in towns such as Darlington Point are experiencing the scale of reductions now that will come to towns in the Central Murray system. These reductions have come on top of reduced activity from irrigated agriculture. To respond, communities will need to diversify into less water dependent economic activity, and create new social networks.

A small number of state forests are in severely degraded condition due to acid sulphate soils and salinisation. Under climate change, the condition of these forests will continue to decline, and more forest ecosystems could experience ecological collapse. A new land tenure is required to manage these lands in a way that contains the potential hazards, and conducts research and rehabilitation to restore their health in a new ecological form in the longer-term.

4.4 Independent audit and public reporting of results

Saving these forest ecosystems and achieving a balance of values will require much more flexible and adaptive management practices and significant cultural change in forest managers. Key to this will be establishing new institutional and governance arrangements to drive the cultural change that is required.

To create public confidence in forest management, and drive the learning and cultural changes required, all red gum forest ecosystem management should include new governance arrangements:

- clear allocation and definition of roles and responsibilities
- independent review of plans of management and spatially explicit targets
- independent audit and public reporting at five-yearly intervals of management outcomes at forest group and bioregional scales to ensure accountability
- monitoring and knowledge management systems to promote adaptive learning across different forests, tenures, river systems and the southern Murray-Darling Basin.

5 Conservation planning and priorities

Significant conservation benefits can come from conservation planning and water reform to deliver conservation outcomes across floodplain ecosystems and habitat corridors on public and adjoining private land.

Red gum forests with higher rainfall and more natural flooding regimes will continue to support more complex floodplain forest ecosystems and richer biodiversity. However, some parts of the larger forests are dense red gum regrowth, with no understory or native groundcover and relatively clearly identified habitat corridors.

Key reservation priorities for red gum forest ecosystems are wet refugia to preserve existing biodiversity, corridors across public and private land that could allow adaptation to climate change, and drier forest ecosystems which are under-represented in the national reserve system.

5.1 Findings from the final assessment report

In **Chapters 4 and 9** of the assessment report, the NRC's key findings on conservation outcomes and the projected impacts of climate change are:

- River red gum forest ecosystems provide significant remnants of forest vegetation in a heavily cleared and modified bioregion, and provide refugia to support a diversity of ecological processes and species assemblages in a changing climate.
- The condition of river red gum within State Forests and elsewhere in the bioregion is generally in decline, largely as a result of poor health from substantially reduced river flows and altered flooding regimes. The threat status of the river red gum forests is assessed as vulnerable.
- A total of 68 fauna species listed as threatened under Commonwealth or NSW legislation are known to utilise river red gum forests, including a number that are matters of national environmental significance. Many other declining species also use these forests as preferential or supplementary habitat.
- Reduced flooding is a major threat to the environmental values of river red gum forests of the bioregion. Twenty-three listed species are considered to be at moderate to high risk of regional population decline as a result of the predicted impacts of climate change and river regulation on flooding regimes.
- Many river red gum vegetation communities are expected to change as a consequence of river regulation and climate change. Likely changes are the incursion of river red gum onto the periphery of some wetlands; the transition of some river red gum tall forests into river red gum open woodlands; and the transition of some river red gum and river red gum-box woodlands to derived shrublands and grasslands.
- The forest ecosystems function as an important component of a broader floodplain ecosystem and provide a variety of valued ecosystem services. Major floods will be required to maintain the resilience of the forest ecosystems, and the floodplains they are a part of, so that they can continue to provide these services.
- The Millewa forests are likely to transform into a river red gum woodland stand over the long-term. However, they are large and heterogeneous and therefore more resilient to the impacts of climate change compared with other river red gum forests in the Riverina bioregion. They are likely to be a future refuge for threatened species such as superb parrot, barking owl, fishing bat and brush-tailed phascogale.
- The Koondrook-Perricoota and Campbells Island forests are also likely to transform into a river red gum woodland stand over the long-term. Around 20 per cent of the river red gum community could transition to a derived scrub on the outer floodplain in the absence of future floods. However, like Millewa, these forests provide further habitat security for threatened species.
- The Werai forests are likely to be the most degraded by reduced flooding and water scarcity. Over 40 per cent of the river red gum stand and associated wetlands could be lost within 50 years if current conditions persist. The overall area of functional habitat may not be sufficient to support threatened species such as the barking owl and white-bellied sea-eagle.
- The Murrumbidgee river red gum forests are likely to continue to decline with the loss of major wetlands fed by the Murrumbidgee River. Tall river red gum forests will contract to areas regularly flooded and with access to sub-surface aquifers. Some stands will also be lost on the outer floodplain.
- The Lachlan forests are under severe stress and are likely to continue to decline. Key species, such as the blue-billed duck, freckled duck and superb parrot may disappear from these forests over coming decades.
- The Barooga group (and other State Forests immediately west of Albury) is least likely to change in terms of vegetation type or species composition (fauna and flora) due to relatively high water availability.
- The Wakool and Edward forests are likely to transform into a river red gum woodland stand over the long-term with up to 40 per cent of river red gum woodland transitioning from red gum to derived copperburr or grassland in the next 50 years.
- The implication of ecosystem changes for species such as the regent parrot in the western river red gum stands is very unclear. The present range of the superb parrot in this area could decline by more than 99 per cent, unless it is able to respond by moving east.

5.2 Creation of trans-border, iconic national parks

A collaboration between the NSW, Victorian and Australian Governments to create trans border iconic national parks along the Murray River would have the potential to create a policy imperative to better align flooding regimes and enhance management of ecological assets for the benefit of the Australian and international communities. A cross-border approach is needed to justify the significant public investment required to build sustainable futures in the region.

Governments should aim to establish an adaptively managed and internationally significant chain of national parks and reserves along the riverine corridors protecting Ramsar wetland values, forest ecosystems, and providing habitat for migratory and threatened species as well as cultural heritage values.

Overall management imperatives for parks and reserves include:

- collaborative management with Victorian authorities
- appropriate involvement of relevant Indigenous community representatives
- Australian Government oversight of Ramsar wetland sites
- action research to test 'ecological thinning' and other uncertainties.

There is significant potential to manage these forests in collaboration with regional interests (such as catchment management authorities and surrounding private landholders) and Basin and national interests (such as the MDBA and the Commonwealth Environmental Water Holder). Any forest tenures should be designed to optimise these synergies by articulating how water, land and biodiversity are managed across the region.

The potential should be recognised for a Kosciuszko to the Coorong corridor as a 'National Landscape' that can be promoted nationally and internationally as a tourist destination and offers 'River Red Gum Trails' products such as:

- forest ecosystem and history tours with knowledgeable local guides
- specialist bird watching tours focused on iconic species such as the superb parrot, regent parrot and Gilbert's whistler
- Indigenous cultural heritage tours and camping experiences guided by Indigenous community representatives responsible for country along major rivers
- guided and self-guided canoe trail tours and cycle trail tours.

Locally significant regional parks adjacent to communities such as Deniliquin and Euston would maintain or enhance quality of life and community wellbeing, providing for a range of recreational activities including, picnicking, cycling and walking dogs.

5.3 Active management of red gum forest reserves

Ecological management goals should not focus on historical stand structures, but instead seek to maximise biodiversity outcomes under expected declines in water availability. Conservation outcomes will require active forest ecosystem management by ecologically-based but at times experimental use of:

- thinning to relieve water stress, favour hollow-bearing trees, and create habitat diversity and corridors
- disturbance by fire
- strategies for pest and weed management which may include selective grazing.

Forest managers should be experimenting with what is the best use to society of those forests that will not have a natural flooding regime restored. In some cases this will be timber production, in others recreational use, and in others it might be remediation to new ecosystems with sufficient biodiversity in a new form to make the management costs worthwhile.

Environmental management is expensive and getting more so. It requires recovery or purchase of environmental water, construction of water infrastructure, fire management, real-time bird breeding support by habitat manipulation and watering, and maintenance of access and safety in fire and wet times. It also requires considerable local knowledge of issues such as micro water management, prediction of fire response, and experimentation with adaptive environmental management. Any change in management must be able to meet this cost and continue to access the local knowledge and rapid attendance by locals to address issues such as bushfires. Considerable expertise in managing the forests resides in the staff of Forests NSW and should be carried over to any subsequent forest managers.

5.4 A regional conservation and adaptive management strategy

National parks or reserves should be part of an integrated conservation strategy, establishing corridors and nodes which can be built on over time to enhance climate change adaptation capacity throughout the region.

Such a strategy would identify the preferred long-term states of these forest ecosystems. An initial priority would be to map and classify different red gum forest types on the basis of their trajectory of health under projected climate change, and then establish permanent monitoring plots in each of the forest types. The success of different management approaches would be monitored across groups of plots, particularly those on different tenures and to which alternative management approaches were being applied.

Planning instruments such as a riparian zone SEPP and incentive payments under Catchment Action Plans should be developed as ways to improve ecological connectivity across public and private land into the future.

6 A sustainable future for the forestry industry

The red gum forestry industry in the Riverina is facing a big transition. Forest growth rates have been in long-term decline but quotas have not been revised down (other than for forests on the Murrumbidgee River). The sustainable wood yields are simply not there to sustain the current scale of the sawmill industry, and have not been there for some decades.

Forests NSW has progressively harvested the standing stock of commercially mature trees that germinated in the extensive flooding which occurred prior to regulation of the rivers (substantially in the 1880s). The Central Murray forests of Koondrook-Perricoota and Werai are substantially exhausted of the best examples of this cohort of trees. Similarly, there is little larger timber remaining in the smaller riparian strip forests on the Lachlan, Murrumbidgee and Lower Murray River.

The Millewa group of forests holds sufficient trees of high commercial value to continue harvesting for some years, but ultimately this harvesting rate is unsustainable due to river regulation and a drying climate.

6.1 Findings from the final assessment report

In **Chapters 5 and 10** of the assessment report the NRC's key findings on the forestry industry under a changing climate are:

- The forestry industry related to red gum forests on public land in the bioregion makes a relatively small contribution to the economy at regional level (less than 1 per cent).
- It is a significant employer for a number of towns in the region, employing 304 full-time equivalent (FTE) staff directly related to timber from public land. Commercial operations with licences to harvest timber from public land employ 274 FTE employees and Forests NSW employs 30 FTE employees.
- Of the 274 FTE employed in commercial forestry operations, 149 FTE staff work in mills which source higher quality timber from public land. A further 43 FTE work with mobile mills which produce sleepers as a primary product. The remaining 82 FTE work in firewood operations.
- Long-term sustainable yields of quota and ex-quota sawlogs are expected to be reduced by up to 70 per cent due to the combined effects of river regulation, enhanced silvicultural prescriptions, the current drought and climate change. The quality and size of sawlogs is also likely to decline.
- Evidence clearly suggests that higher yields are possible if more favourable flooding regimes can be achieved. It would also be possible to continue higher levels of harvesting in the near term, for a defined period of time, as part of a deliberate transitional strategy.
- Short-term increases in volumes of low quality timber and firewood may be realised if ecological thinning, consistent with the principles identified in **Chapter 11** of the final assessment report, is applied in some areas of the red gum forests. This may benefit businesses that are able to utilise this resource.

- A viable future forestry industry is likely to be smaller than the present industry. Only one, or perhaps two, sawmills are likely to be supported by long-term sustainable yields of sawlogs from public land under assumed likely flooding regimes. The wood supply situation in the short to medium term is likely to favour flexible operations able to respond to variability in both supply volume and quality.
- There is potential for the establishment of new forestry-based industries given a sufficiently high carbon price, technology development and industry innovation. New energy generation technologies and appropriately sited forest plantations for carbon sequestration are two possible examples.

6.2 Sustainable yields and timber resources

Chapter 10 of the final assessment report explains in some detail how the NRC has estimated the sustainable yield of red gum forests under river regulation and predicted climatic conditions. In particular, **Table 10.12** summarises the range of predicted sustainable yields based on different future watering scenarios.

The most likely scenario is that long-term sustainable yield from the Millewa, Koondrook-Perricoota and Campbells Island group of forests will be around 13,000 m³/year. This is about 30 per cent of the 41,000 m³ quota and ex-quota base timber allocations from these forests in 2008–09. Reductions of a similar order of magnitude are likely for other forest groups.

There will continue to be a supply of logs of various qualities from remaining multiple-use forests (and from private land), but it will be at a substantially lower scale and lower average quality.

Ecologically-focused management of forests should also produce significant amounts of low-quality timber from reserves being managed for conservation. Principally this would be from ecological thinning or partial recovery of dead and dying trees. This would be done to achieve conservation objectives such as accelerating the development of particular habitat values or enhancing structural diversity across the forests.

6.3 What form of forestry industry will be sustainable?

There are still sound reasons to manage some forests for multiple uses such as conservation, timber production, tourism, and recreation values. Koondrook-Perricoota and Campbells Island forests are large and diverse enough to be managed in ways that will maintain key ecological values and also support a boutique timber industry.

Some ongoing logging of these Central Murray forests is possible even with Australia's obligations under the Ramsar Convention provided that logging is consistent with 'wise use' as specified in the Convention and in line with sustainable harvesting and management of the forest.

A sustainable forestry industry would be focused on making wise use of the available timber resources, marketing the distinctive character of red gum wood, and supporting the resilience of local communities facing the challenges of a drier future.

The current forestry industry is based on a mix of log qualities and product lines, but has a strong preference for increasing the proportion of timber going into value-adding like furniture and veneering. However, the quantity and quality of the timber produced is declining due to river regulation and a drying

climate, and the current scale of the value-adding industry is no longer viable.

Historic volumes of quality river red gum timber are very low by Australian hardwood forest standards, with insufficient throughput to develop and supply more than boutique markets. Emerging veneer technologies hold some promise, but require access to larger logs, the supply of which is dwindling. New technologies may also help recover greater value from smaller and poorer quality logs, and partially offset the decline in the traditional high quality log resource.

In a more certain environment some new form of forestry industry will emerge to make good use of whatever resources are available. There is likely to be an increase in supply of lower quality wood and residue for some time as densely stocked red gum forests struggle in a drying climate.

NSW should keep its options open for private enterprise to continue in forestry-related industries as there may be new opportunities if the industry can adapt to:

- value-adding from lower quality logs (including from private land)
- operating under less security of supply by using wood generated by ecologically focused management of forests in transition (such as ecologically-based thinning to favour hollow-bearing trees or structural diversity for habitat values).

Governance of any forests managed for multiple conservation and production values would need a new institutional and funding model. To be viable, this model would need freedom to experiment with a wider range of products and services and income streams. This would allow it to better support a range of public and private benefits from the forests across conservation, forestry industry, tourism and recreation sectors. One example might include opportunities for forestry-related cultural history tourism.

Government needs to create initiatives to support a diverse array of regional industries which are innovative and flexible, taking advantage of the region's assets and strengths.

Possible initiatives might include:

- government support for value-adding investments in the timber industry
 - small business opportunities for tour operators, accommodation and transport service providers
 - research, development and application of practical technologies related to contamination containment and rehabilitation of land degraded with acid sulphate or salinised soils.
-

7 Sustainable futures for local communities

Strong Indigenous interests exist in all forests. Non-Indigenous communities also have deep and ongoing cultural engagement with the forests, with many forestry industry families working the forests for many generations.

The region is deeply affected by drought, climate variability and will continue to be so as water reform resets the balance between extraction and the environment. Forestry is a small part of the regional economy, and retaining or losing such an industry will impact most on some smaller towns.

Sustainable futures for the local communities need to be built around a diversity of less water dependent industries. Regional development around the forests is possible if significant investment is made in developing the ecotourism potential of new trans-border national parks while accommodating the existing open access recreational uses and tourism operations.

7.1 Engaging communities in managing forests

In **Chapter 6** of the assessment report the NRC's key findings on cultural values are:

- Indigenous communities have a strong spiritual connection to the forests. Access to the forests and the ability to visit special places, and continue practices such as hunting, fishing, collecting foods, and telling stories is critical for cultural survival. Like environmental flows, cultural water flows are also highly valued by Indigenous communities.
- Local Indigenous communities have highlighted that a role in forest management, supporting greater self-dependency and improving employment opportunities were their primary concerns. Irrespective of future land use decisions, it is important that the process of increasing the understanding of the aspirations of Indigenous people in the Riverina bioregion continues.
- Non-Indigenous cultural heritage of the region is encapsulated in the connections between local communities, the timber industry and the forests.
- For Riverina communities and towns, the river red gum forests are the areas where they live, work and play. The forests and the associated heritage form a strong part of people's connection to place and their personal identity.
- Future land managers, irrespective of tenure, need to continue to engage with both Indigenous and non-Indigenous communities to better map cultural and heritage uses, values, aspirations and concerns.

7.1.1 Indigenous local communities

Strong Indigenous interests exist in all red gum forests, and Indigenous communities should be actively engaged in the management of all forests. However, there is considerable work remaining to identify and properly engage appropriate Indigenous interests because there are diverse views across Indigenous communities.

As a result of feedback and submissions from Indigenous people, the NRC believes the Werai forests on the Edward River and the Taroo (Lake Victoria) forests on the western Murray River should be prioritised in efforts to move to Indigenous management of red gum forests.

In the Werai forests, the Wamba Wamba people and the Barapa Barapa people both claim strong connections to the land, and a process to ascertain the genealogical connections is required. In the Taroo forests, the Barkindji Nation clearly identify their connection to the land and interest in managing it.

In the other Central Murray forests of Millewa and Koondrook-Perricoota the Indigenous nations of the Yorta Yorta and the Bangaranga do not agree on who has a right to speak for Country, and so an appropriate engagement process with all groups seeking involvement should be undertaken. There are also relatively more complex management considerations of biodiversity conservation, forestry production values, and recreational values in these forests.

It will be important that Government explores a range of options for engaging Indigenous communities in forest management as there are advantages and disadvantages of the various models. These range from Indigenous Protected Areas under Commonwealth legislation, to joint-management or Indigenous management under NSW legislation. Australian Government involvement in establishing Indigenous management of forests holds some additional prospect of ongoing financial assistance.

7.1.2 Non-Indigenous local communities

Non-Indigenous communities also have deep and ongoing cultural engagement with the forests, with many forestry industry families working in, and enjoying recreational access to, the forests for many generations.

Many also have a deep mistrust of government management of national parks, and this needs to be overcome for the benefit of both the community and the management of any new parks.

7.2 Socio-economic values in the region

In **Chapters 5 and 10** of the assessment report, the NRC's key findings on socio-economic values are:

- Seven towns within the region have close ties to the red gum forestry industry reliant on public land. The twin towns of Barham-Koondrook have the highest number of forestry industry employees. Other commercial operations are located in the towns of Mathoura, Deniliquin, Merbein (in Victoria), Balranald and Darlington Point.
- In general, these towns are being impacted by the ongoing drought which is driving a decline in the agricultural industries which form the basis of their economies.
- Grazing and apiary on public land provides important source of additional income to farmers and beekeepers in selected years when grasses or flowering shrubs and trees are plentiful.
- State Forests and national parks within the region support very different recreational and tourist activities, and tend to attract different types of visitors.

- While forestry based industries are a small part of the regional economy, the potential decline in the size of the current red gum forestry industry would have a considerable impact on some smaller towns.
- The twin towns of Barham-Koondrook, and the town of Mathoura have less capacity to adapt to changes in climate than other towns, and have the highest reliance on the red gum forestry industry. Conversely, Deniliquin appears to exhibit the greatest resilience to potential climate change impacts, with lower vulnerability to change, a greater degree of industry diversity, and low reliance on the red gum forestry industry.
- The capacity of industries in the region and their dependent communities to adapt to changes in climate could be supported through a variety of approaches. These include information provision, skills and capacity development, and investment in infrastructure and programs to support regional development.

7.3 Regional development opportunities

The Riverina region is deeply affected by drought, climate variability and will continue to be so as water reforms reset the balance between extraction and the environment. While forestry is a small part of the regional economy, the loss of or decline in the forestry industry would have a considerable impact on some smaller towns. A sustainable future for these smaller communities will require town-specific proposals to offer redeployment of forestry workers in park management and other roles.

More generally, a sustainable future for the region will depend on regional development focused on less water-dependent industries. The decline in irrigated agricultural industries has already had a large impact on the region, and the future of the regional economy will ultimately depend on the transformation of the agricultural sector to a future with less water.

The State Forests of the Riverina bioregion have a long history of use by surrounding communities and visitors to the bioregion. Tourism values are connected to the river, beaches, trails and natural surroundings of the bioregion. The most popular sites are the weir pools and the white sandy beaches found at the bends of the Murray River, both having high aesthetic value. Many generations of families have spent time experiencing and enjoying visits to these areas and participating in the activities they support.

The Murray, Murrumbidgee, Edward and Lachlan Rivers provide a focus point for many outdoor activities, while the adjoining State Forests provide access and complementary facilities. Good access, water and close proximity to urban areas have ensured the bioregion's continued popularity for tourism activities associated with the red gums, rivers and wetlands.

Chapter 5 of the final assessment report provides information on tourism in the region. The current tourism industry is centered on the river, riverboats, specific towns and open camping access to the forests. Activity is centred along the Murray River and the eastern central Riverina region. The region received 4.3 million visitors in 2008, with 6 million visitor nights. Many stay in caravans or camp, reflecting the importance of the natural environment in general and the red gum forests in particular.

Careful accommodation of existing uses within any new parks is important to ensure that any tourism boost from park-based tourism is not offset by significant reductions in existing open-access camping and related uses.

Priorities for regional development spending will include boosting:

- all weather access to forests, including during flood times
- bushfire fighting infrastructure and duplicating access roads to improve safety
- transport and tourist information infrastructure to capitalise on new national parks
- opportunities for new private sector investment in tourist accommodation and events.

Government needs to create initiatives to support resilient communities focused on innovative approaches to addressing the challenges and opportunities of a water constrained future. Possible initiatives might include:

- establishment and operation of a red gum forests interpretative centre with education programs on forest values and history
- enhanced access and visitor facilities at key points of interest along 'Red Gum Trails'
- online booking and visitor information service, possibly modelled on the Bibbulman Track Foundation in WA
- community engagement in management of parks and reserves maximizing the use of local knowledge and on-ground experience in forest management
- enhanced water management infrastructure, such as the cutting to more effectively deliver water to the Koondrook-Perricoota forests
- enhanced fire management infrastructure and support for local rural fire service brigades
- volunteer programs facilitating community involvement in environmental asset management, including weed and feral animal management, and landscape rehabilitation
- expanded calendar and profile for special events celebrating the values and history of the red gum forests.

Appendix 1:

Terms of reference



Premier of New South Wales Australia

Terms of Reference

Assessment of Riverina Red Gum Forests

The New South Wales Government intends to make a forest agreement with respect to the river red gum and woodland forests within the NSW Riverina IBRA and the South-Western Cypress State Forests in order to determine conservation outcomes and a sustainable future for the forests, the forestry industry and local communities in the region.

To inform that agreement and in accordance with section 13 (1)(e) & (g) of the *Natural Resources Commission Act 2003*, I request that the Commission:

1. Carry out a regional forest assessment of the scientific bioregion:
 - a) for the purposes of section 15 of the *Forestry and National Park Estate Act 1998* including an assessment of the following: environment and heritage values (including Indigenous heritage), economic and social values, ecologically sustainable forest management, and timber resources; and
 - b) otherwise such that the assessment will also meet the requirements of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth).
2. Recommend conservation, protection, economic and ecological sustainable use of public land in the bioregion.
3. Recommend water management and flooding requirements to sustain the forests and identified values and uses under the range of projected impacts of climate change.

The Commission should have regard to the following as they relate to the bioregion:

- nationally agreed criteria for a comprehensive, adequate and representative reserve system;
- other complementary methodologies for protecting conservation values;
- the impacts of drought and climate change on the forests and communities;
- opportunities for ongoing and future employment within affected local communities;
- appropriate forest management practices in order to promote long term productivity and forest health;

- international or intergovernmental obligations, agreements or arrangements;
- NSW Government policies, programs and Catchment Action Plans;
- opportunities for Indigenous involvement in forest management;
- appropriate access for commercial, recreational and community uses; and
- the existing science and body of knowledge about the region.

The Commission should consult with relevant NSW agencies including the Department of Environment, Climate Change and Water, the Department of Industry and Investment, the Land and Property Management Authority, the Treasury, the Department of Premier and Cabinet. The Commission should also consult with relevant Traditional Owners, Local Aboriginal Land Councils, Elders groups and local government. The Commission should liaise with officers from the Commonwealth Department of the Environment, Water, Heritage and the Arts to inform the design and conduct of the assessment.

The Commission should undertake public consultation to inform the assessment.

The Commission is to deliver the assessment in two phases:

1. The Commission is to deliver in relation to the Riverina IBRA:
 - an assessment under term of reference 1 by 30 September 2009; and
 - a report on terms of reference 2 and 3 by 30 November 2009*.
2. The Commission is to deliver in relation to the South-Western Cypress State Forests:
 - an assessment under term of reference 1 by 31 December 2009*; and
 - a report on terms of reference 2 and 3 in relation by 28 February 2010*.

* Reporting dates have been extended

Recommended management priorities and tenures for forests

Millewa forests	36
Koondrook–Perricoota forests	38
Murrumbidgee forests	40
Barooga forests	42
Lachlan forests	44
Weraí forests	46
Lower Murray forests	48
Edward and Wakool forests	50



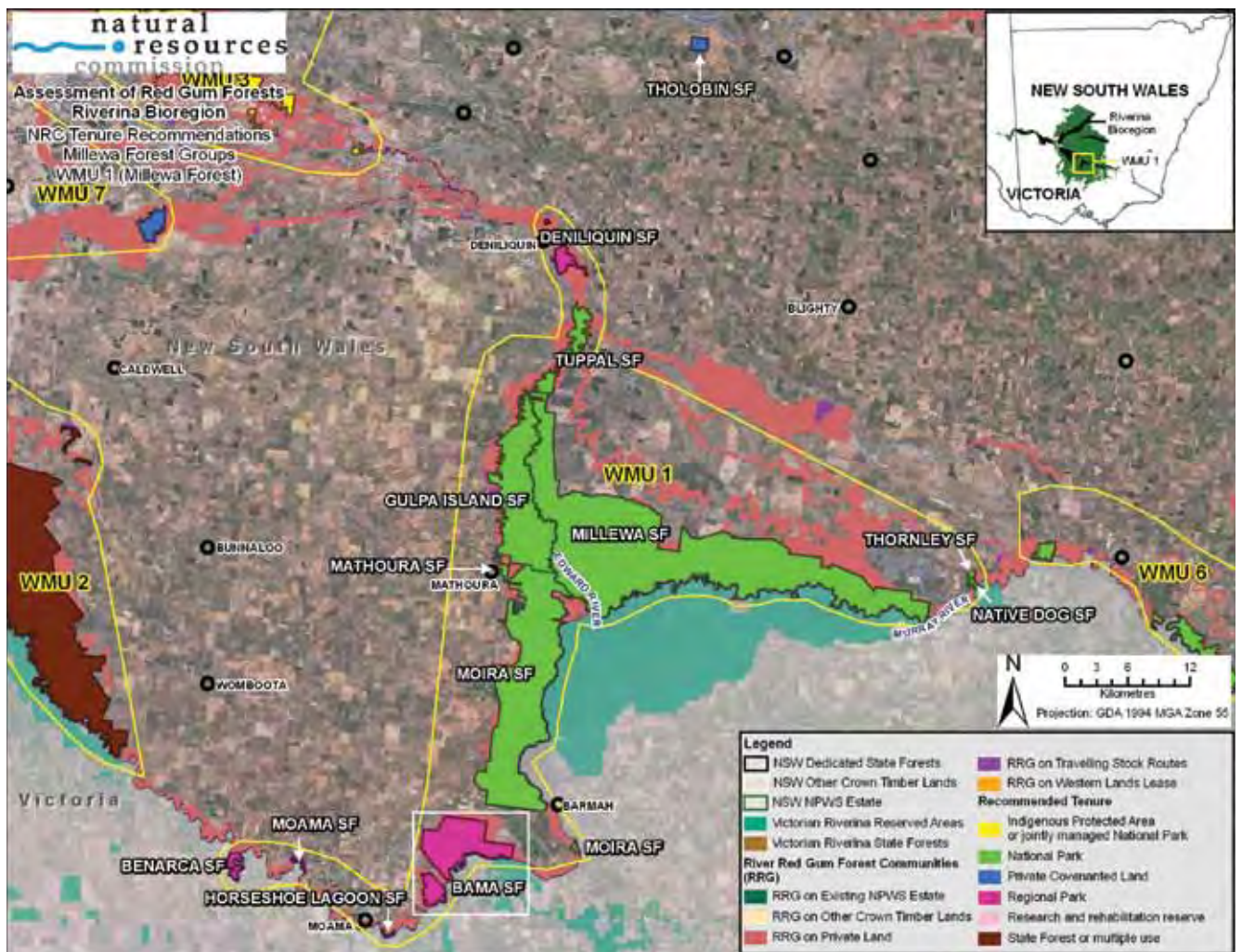
Millewa forests

Current condition and values	Trajectory	Management considerations at different scales			Priority of management
		Basin/bioregion scale	Water management unit scale	Local scale	
<ul style="list-style-type: none"> Heterogeneous forests in poor to moderate condition with only 20 percent of red gums remaining in healthy condition Large source of high quality logs; 66% of all quota timber; 86% of all grade 1 timber in Riverina bioregion High recreational and cultural values. Easy access. Significant ecological asset under The Living Murray Program Ramsar listed and supports high biodiversity values including globally threatened species 	<ul style="list-style-type: none"> Arguably more resilient to water scarcity than other forests but expected to transition to a generally drier, less flood-dependent ecology Reduced timber yields (19% of SQ1 and 2 will be flooded under current water management) Mathoura has less adaptive capacity to change compared to Deniliquin and Barham Approximately 10% of forest expected to be lost over next 50 years under current flooding regime 	<ul style="list-style-type: none"> Opportunity for trans-border national park which could enhance status as 'key environmental asset'; promote joint management with Barmah Victorian National Park; and promote regional development value of forests Ramsar listed international ecological values High economic, recreational and cultural values – crucial to future of each Icon Site Management Plan ecological objectives is to flood 55% of forest 	<ul style="list-style-type: none"> Complex water regulation structures and plan in place and relatively easily watered Capacity to manage as multiple sub-WMUs Own water allocation, but insufficient to maintain ecosystem services 	<ul style="list-style-type: none"> Differential values across ecosystem already in forest management zones Good knowledge base to manage for multiple values Significant opportunity cost of favouring one value set over others Required public investment in water and management is justified by potential for conservation benefits and increased tourism 	<ol style="list-style-type: none"> Ecological (habitat) Economic (eco-tourism) Social (local access, recreation, tourism and indigenous cultural)

State Forest	Area	Recommended tenure
Tuppal	984	Consolidated Millewa National Park
Gulpa Island	5,478	
Millewa	21,001	
Thornley	69	
Native Dog	49	
Moira	10,600	
Mathoura	1	Current State Forest Depot
Deniliquin	428	Regional parks with appropriate recreational access and uses
Benarca	212	
Bama	3,198	
Horseshoe lagoon	18	
Moama	38	
Tholobin*	197	Private covenanted land or public conservation reserve

* Located outside the defined Millewa Forest Groups. Contains River Red Gum – Box Woodland

Millewa forests

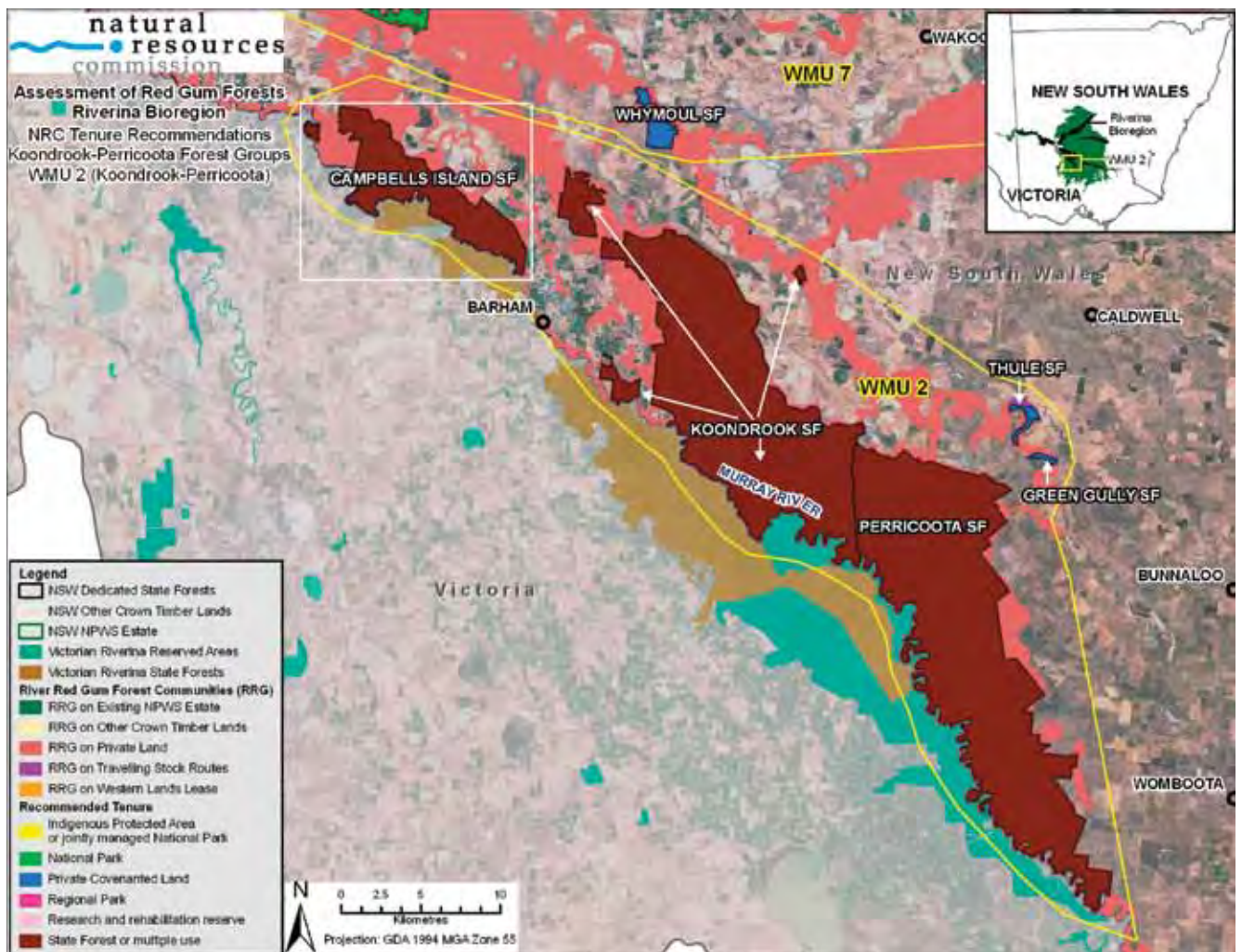


Koondrook-Perricoota forests

Current condition and values	Trajectory	Management considerations at different scales			Priority of management
		Basin/bioregion scale	Water management unit scale	Local scale	
<ul style="list-style-type: none"> In general the condition of the forests is poor and continuing to decline. Campbells Island is in moderate condition which is attributed to access to groundwater High recreational and cultural use. Easy access Significant ecological asset under The Living Murray program Ramsar listed and supports high biodiversity values including globally threatened species 	<ul style="list-style-type: none"> Koondrook-Perricoota forest group will continue its well-advanced transition to a drier, less flood-dependent ecology without management intervention Possible loss of 20-25% of forest over next 50 years Expected 70% reduction in saw logs. 	<ul style="list-style-type: none"> Adjacent Gunbower forest, primarily VIC State Forest Ramsar listing-international ecological values Current flooding regime insufficient to achieve interim ecological objectives for this TLM Icon Site Opportunity for existing FNSW management to continue as diversity of management approaches 	<ul style="list-style-type: none"> Difficult to water without cutting required to maintain Ramsar-listed wetland values. TLM has made commitment to fund cutting and make water available from 500GL Forest NSW have expertise required to complete and operate cutting 	<ul style="list-style-type: none"> Radical transformation without infrastructure and e-water Local mill has veneering technology Barham highly dependent on industry Opportunity for ongoing multiple use forest with new governance and funding model 	<ol style="list-style-type: none"> Economic (forestry) Ecology (habitat) Social (recreation)

State Forest	Area	Recommended tenure
Campbells Island	3,819	State Forest (or new institutional model for multiple use)
Koondrook	15,153	
Perricoota	16,891	
Thule	131	Private covenanted land or research and rehabilitation reserve
Green Gully	48	

Koondrook-Perricoota forests



Murrumbidgee forests

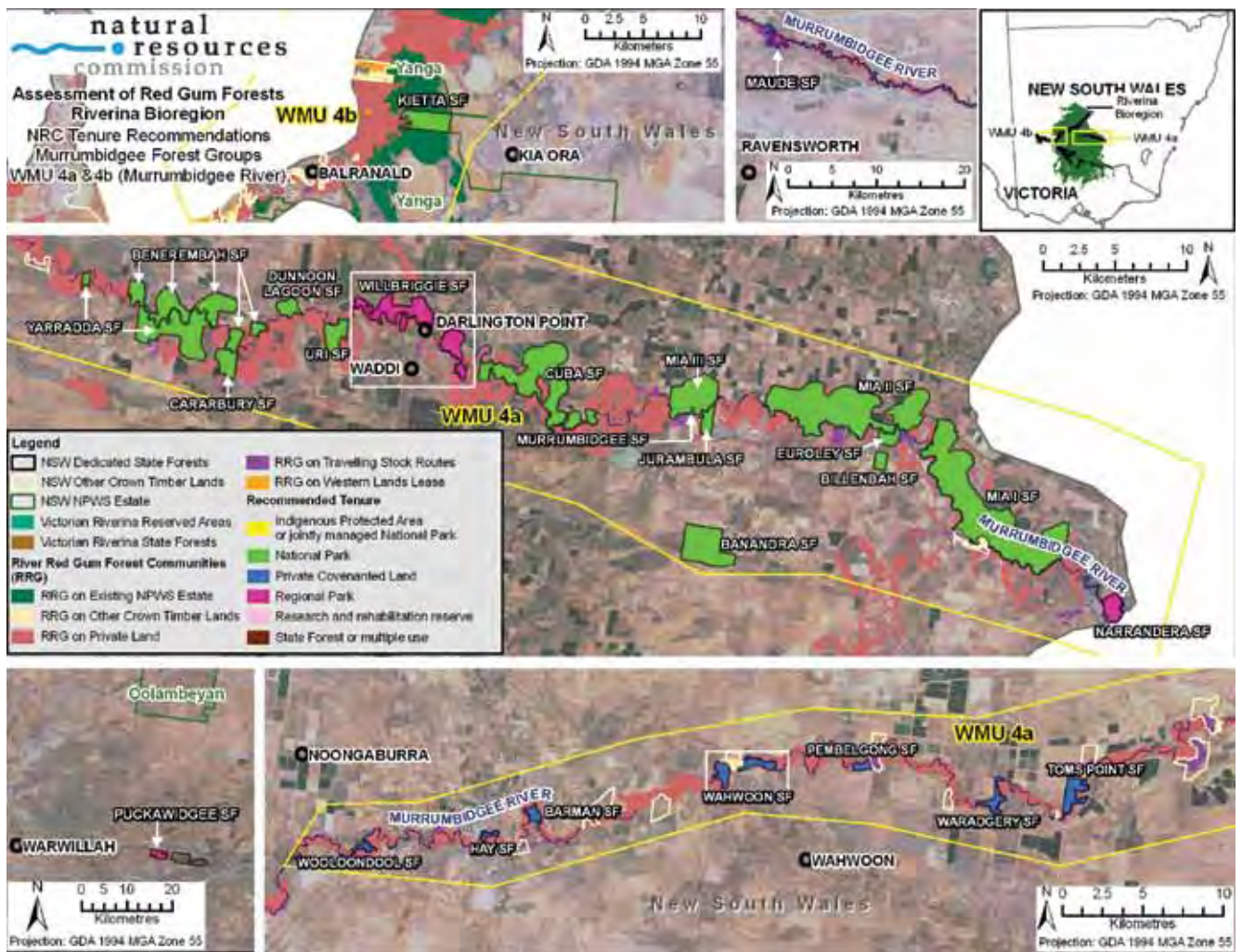
Current condition and values	Trajectory	Management considerations at different scales			Priority of management
		Basin/bioregion scale	Water management unit scale	Local scale	
<ul style="list-style-type: none"> Murrumbidgee wetland areas have declined appreciably over the past 50 years but some areas still in moderate condition Includes nationally significant wetlands Significant habitat values and threatened species Forests around Darlington Point provide sawlog and lower grade timber resources for a mill and a few smaller mobile residue operations High recreation use, easy access and significant Indigenous cultural values 	<ul style="list-style-type: none"> Declining trend due to regulation, drying, loss of wetland areas, but relatively more easy to flood than some Continued loss of the extent of the major wetlands fed by the Murrumbidgee 	<ul style="list-style-type: none"> Existing DECCW presence to build on - Yanga National Park at the downstream end of the system means that environmental water is more likely to be secured and delivered on the Murrumbidgee than in some other areas Some cross-scale habitat connectivity Opportunity for diversity of management approaches 	<ul style="list-style-type: none"> Significant storages in the upper parts of the Murrumbidgee catchment provide good opportunity for the establishment of environmental water allowances Linear nature of the riparian forests also means that small volumes of environmental water can be used sequentially for multiple forests and associated values as water travels downstream 	<ul style="list-style-type: none"> Opportunity for ecology, recreational, tourism and cultural values to prevail at low opportunity cost to industry Learning opportunity as partial transition is a precursor to others 	<ol style="list-style-type: none"> Adaptive ecological management Recreation

State Forest	Area	Recommended tenure
Mia I	3,187	Consolidated national park along riparian corridor
Mia II	2,544	
Billenbah	98	
Euroley	134	
Banandra	762	
Jurambula	138	
Mia III	739	
Murrumbidgee	9	
Cuba	1,642	
Uri	267	
Dunnoon Lagoon	155	
Carabury	237	
Benerenbah	1,130	
Yarradda	1,021	

State Forest	Area	Recommended tenure
Maude	167	Regional parks near towns
Willbriggie	944	
Narrandera	196	
Toms Point	190	
Waradgery	116	Private covenanted land or public conservation reserve
Pembelgong	51	
Wahwoon	198	
Barman	67	
Hay	30	
Wooloondool	47	
Packawidgee*	427	
Kietta	628	National park (add to Yanga National Park)

* Located outside the defined Murrumbidgee Forest Groups. Contains River Red Gum Tall Open Forest

Murrumbidgee forests

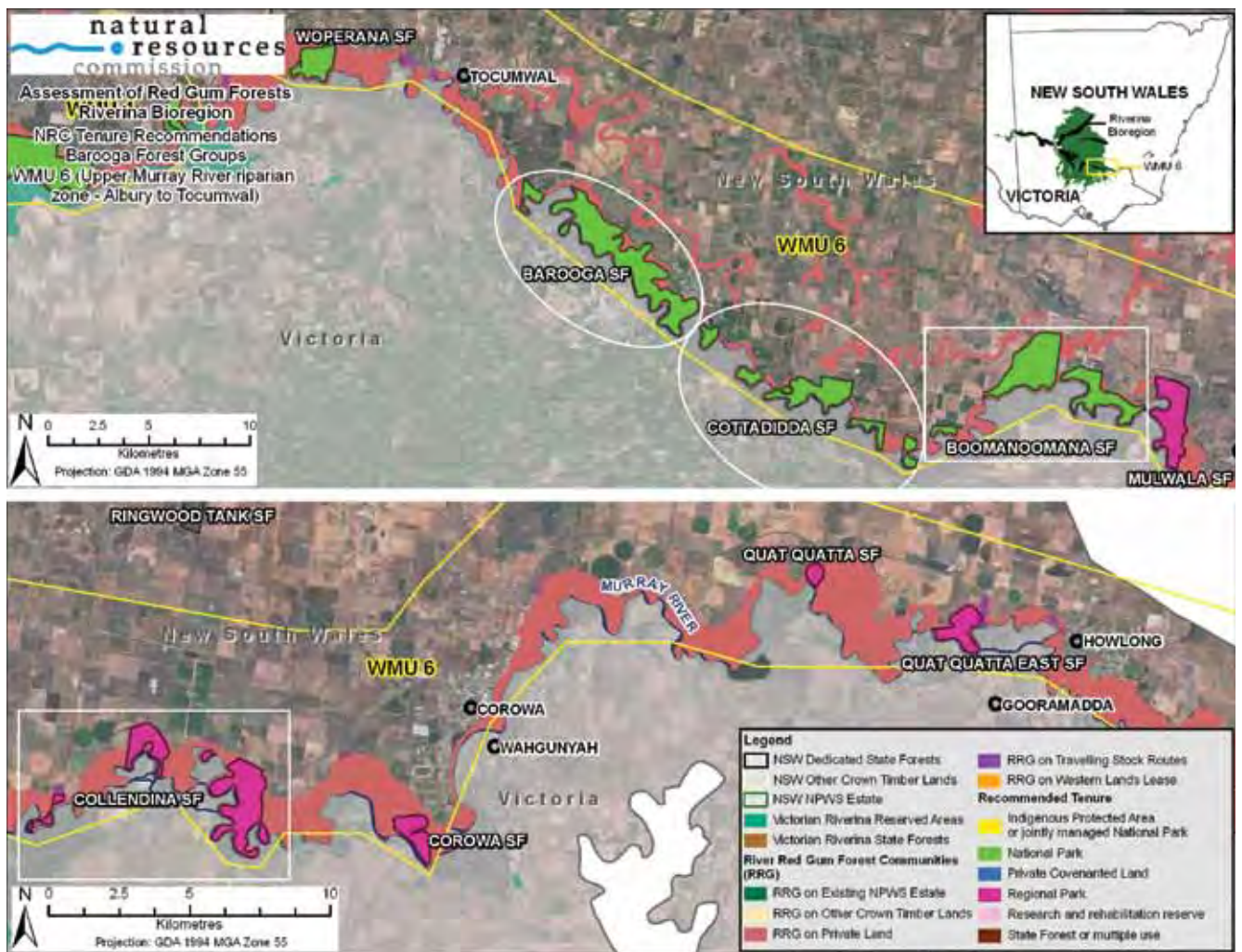


Barooga forests

Current condition and values	Trajectory	Management considerations at different scales			Priority of management
		Basin/bioregion scale	Water management unit scale	Local scale	
<ul style="list-style-type: none"> • Almost entirely river red gum • Good condition, mostly healthy, understorey present, diversity of structure, habitat • Regulation has increased the proportion of total flow passing down the river channel from about 88 percent to 94 percent. • Recreational values and easy access 	<ul style="list-style-type: none"> • Slight increase in foliage cover over last ten years. Some regeneration. • Flow variability has decreased • Least likely to change in terms of vegetation type or fauna and flora species composition due to relatively high water availability 	<ul style="list-style-type: none"> • Good east-west cross-scale habitat connectivity • Recreational and tourism opportunities from proximity to towns and cities 	<ul style="list-style-type: none"> • More frequent watering because straddles Yarrowonga weir and upstream of all other Murray forests 	<ul style="list-style-type: none"> • Site provides a high level of flexibility and security for future water delivery in the form of regular flooding. • Strong and growing tourism (Lake Mulwala) • Opportunity for local ecological and recreational tourism to prevail at low opportunity cost to forestry 	<ol style="list-style-type: none"> 1. Ecological (habitat) 2. Tourism

State Forest	Area	Recommended tenure
Mulwala	501	Regional parks near towns
Quat Quatta East	141	
Quat Quatta	38	
Corowa	123	
Collendina	562	
Boomanoomana	1,026	Consolidated national park
Cottadidda	672	
Barooga	1,190	
Woperana	258	

Barooga forests

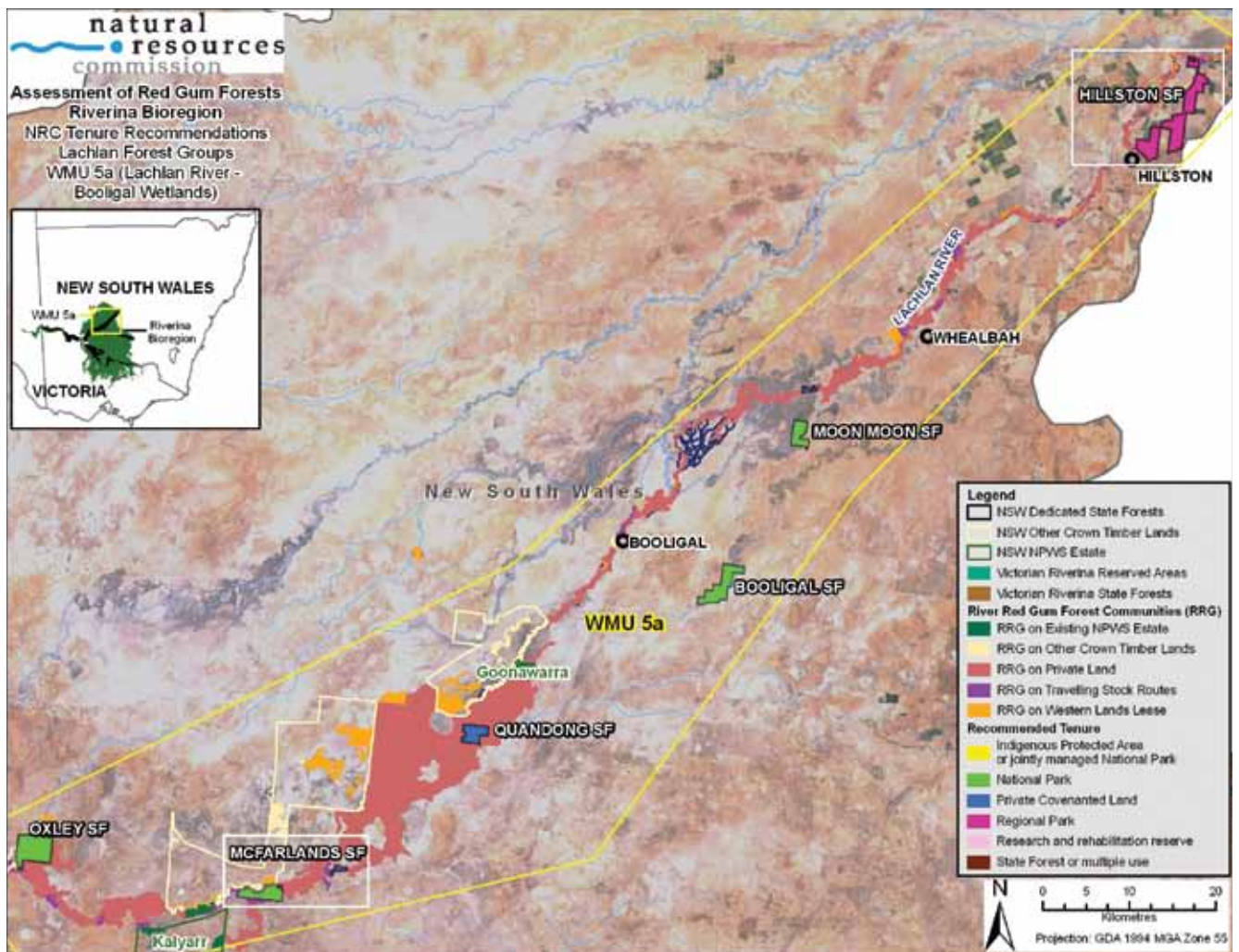


Lachlan forests

Current condition and values	Trajectory	Management considerations at different scales			Priority of management
		Basin/bioregion scale	Water management unit scale	Local scale	
<ul style="list-style-type: none"> Poor state of health due to reduced flood frequency, volume and duration Includes wetlands of national significance Fauna and flora values are largely unknown Provides timber resources for a mill at Merbein, as well as a number of residue or firewood operators Timber from public lands is sourced primarily from Western Land Leases Indigenous cultural values. 	<ul style="list-style-type: none"> Forests will continue to transform to a vegetation community dependent on a significantly reduced frequency of inundation Decreased flooding impacting negatively on water bird breeding 	<ul style="list-style-type: none"> Most under represented subregion in national reserve system in the bioregion Unlikely priority for watering, so favour local interests Some cross-scale habitat connectivity Opportunity for diversity of management approaches 	<ul style="list-style-type: none"> River flow low/ stopped – crisis Water isn't going to be made available Distinct unit, no connection to Murray or Darling Rivers 	<ul style="list-style-type: none"> Opportunity for recreational and cultural values to prevail at low opportunity cost to other value sets Learning opportunity as transition is a precursor to others 	<ol style="list-style-type: none"> Adaptive ecological management Recreation and access

State Forest	Area	Recommended tenure
Hillston	2,204	Regional park
Moon Moon	514	National park to secure connectivity nodes
Booligal	865	
Mcfarlands	698	
Oxley	1,236	Private covenanted land or public conservation reserve
Quandong	497	

Lachlan forests

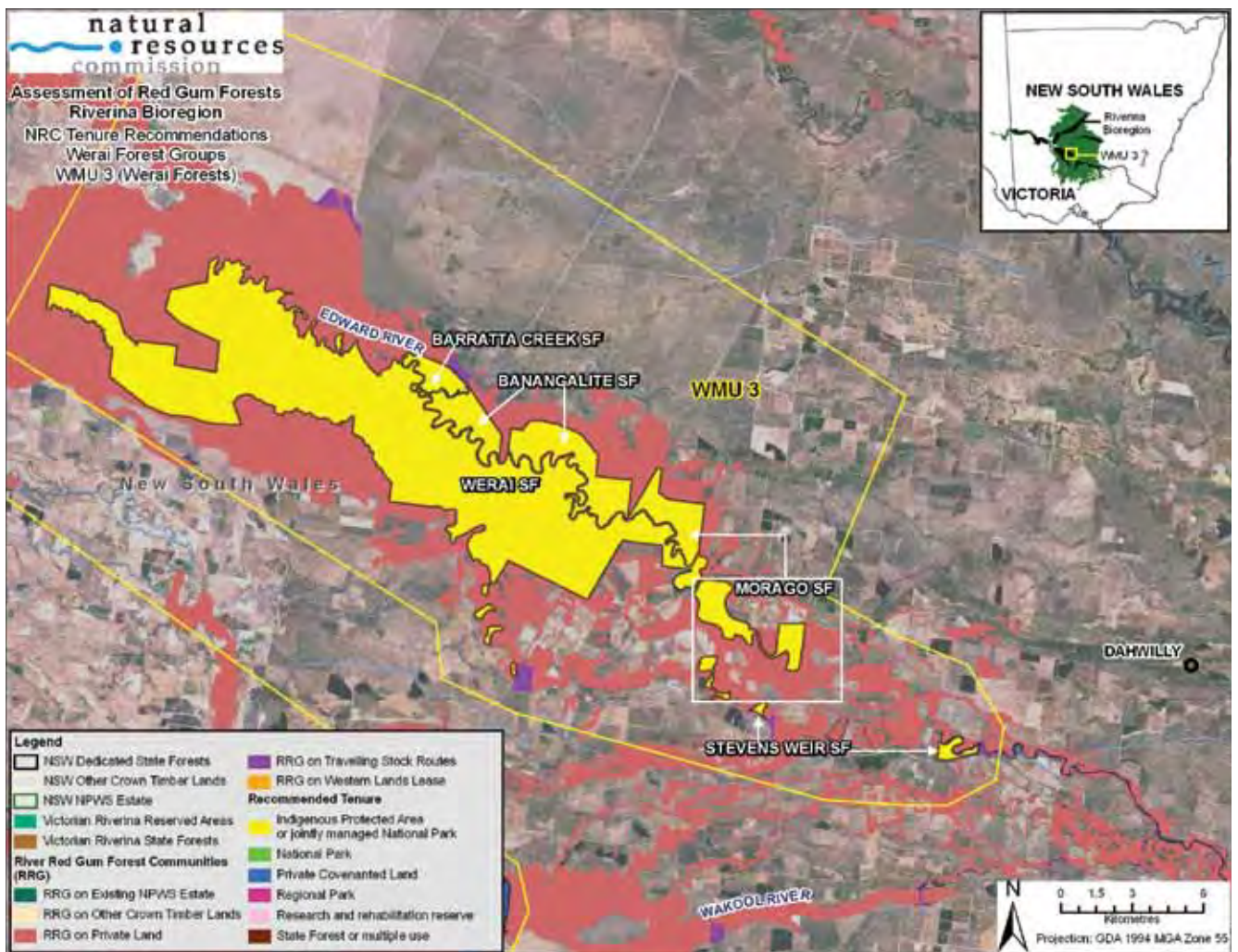


Werai forests

Current condition and values	Trajectory	Management considerations at different scales			Priority of management
		Basin/bioregion scale	Water management unit scale	Local scale	
<ul style="list-style-type: none"> • General condition of the forests is very poor with “92 percent highly stressed, near dead and dead” • Flooding frequency has been dramatically reduced as a result of river regulation and water resource development • Provides a very small amount of sawlog timber to a mill at Deniliquin. However, the primary sources of timber in the Murray region are the Millewa and Perricoota-Koondrook forests. • Significant ecological asset under The Living Murray program – Ramsar listed • High Indigenous cultural values. Easy access. 	<ul style="list-style-type: none"> • Current poor condition of the group is unlikely to improve • Over 40 per cent of river red gum stands and associated wetlands could be lost within 50 years if current conditions persist 	<ul style="list-style-type: none"> • Clear opportunity for indigenous (joint) management in region • Some cross-scale habitat connectivity • Current flooding regime insufficient to maintain Ramsar-listed values 	<ul style="list-style-type: none"> • Dependent on Millewa/Murray, but harder to water – unlikely though that the volumes would be sufficient and supported by eco-engineering works to have a major beneficial impact on the health of the Werai group • Eastern lower parts and riparian zone most likely to flood • No environmental water allocation or water management plan in place. • Indigenous management may create additional driver to gain water 	<ul style="list-style-type: none"> • Opportunity for indigenous interests to prevail at low opportunity cost to recreation or forestry • Learning opportunity as partial transition of already drier system 	<ol style="list-style-type: none"> 1. Indigenous cultural 2. Adaptive ecological management

State Forest	Area	Recommended tenure
Stevens Weir	98	Indigenous Protected Area, jointly managed national park, or private covenanted land
Morago	1,040	Indigenous Protected Area or jointly managed national park
Banangalite	1,295	
Werai	9,464	
Barratta creek	239	

Weraí forests

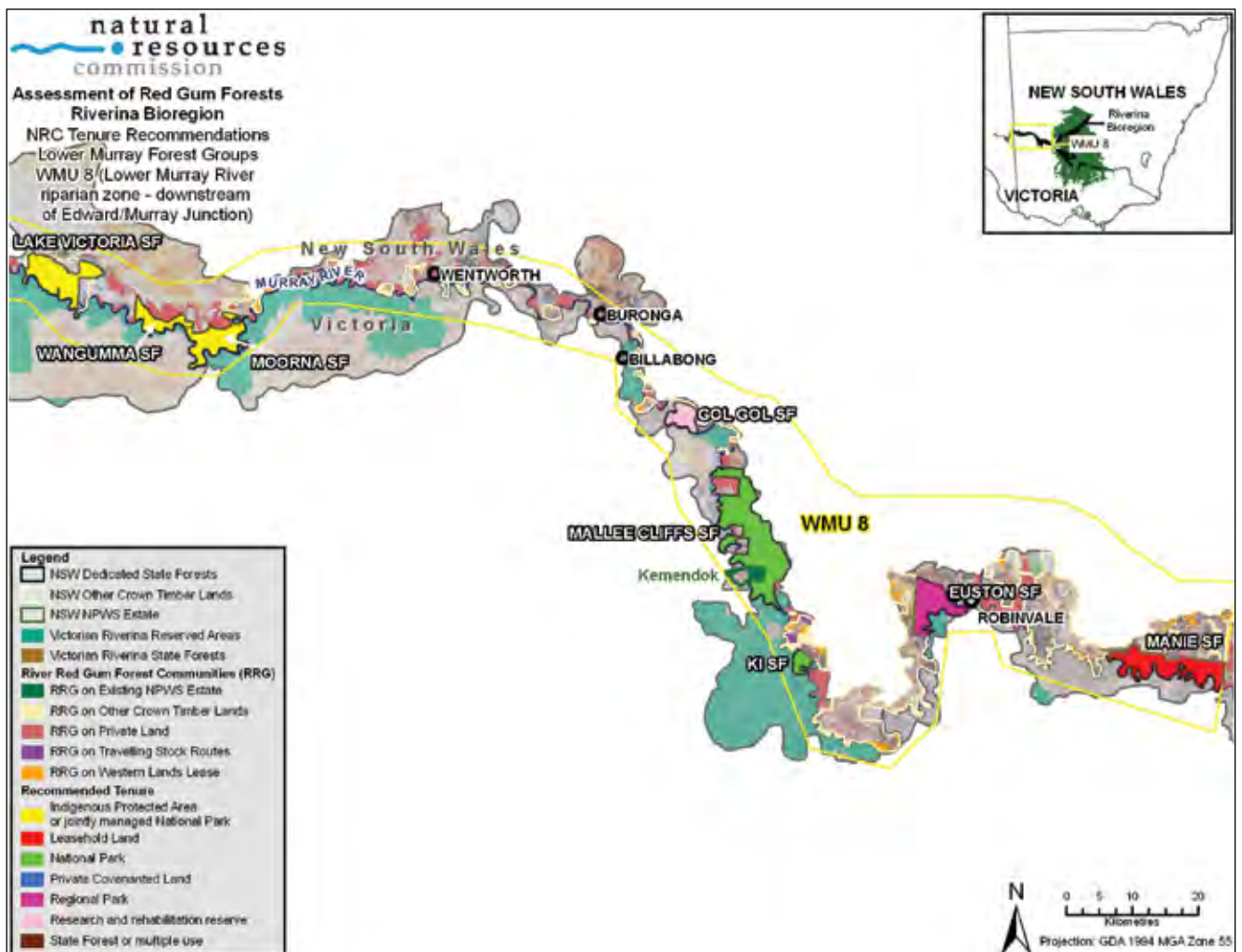


Lower Murray forests

Current condition and values	Trajectory	Management considerations at different scales			Priority of management
		Basin/bioregion scale	Water management unit scale	Local scale	
<ul style="list-style-type: none"> • General condition of the forests is very poor • Provides timber from public land to a mill at Merbein and to residue/firewood operators. • High recreational use. Mixed ease of access • High ecological value with a number of species unique to the Western group • High Indigenous cultural values 	<ul style="list-style-type: none"> • Well advanced to a drier, less flood-dependent ecological form and will continue on this trajectory without direct management intervention 	<ul style="list-style-type: none"> • Recreational value • Connectivity as part of Murray system • Possible AG and multi-state interest in basin scale connectivity • Opportunity for diversity of management approaches 	<ul style="list-style-type: none"> • Most downstream in NSW and driest because of upstream water use • Existing locks and weirs support recreational values 	<ul style="list-style-type: none"> • Opportunity for recreational and cultural values to prevail at low opportunity cost to other value sets • Learning opportunity as transition is a precursor to others 	<ol style="list-style-type: none"> 1. Adaptive ecological management 2. Recreation and tourism 3. Indigenous cultural

State Forest	Area	Recommended tenure
Manie	5,074	Leasehold land
Euston	3,269	Regional park
Ki	722	Add to Mallee Cliffs National Park
Mallee Cliffs	9,458	
Gol Gol	1,396	Research and rehabilitation reserve
Moorna	3,290	Indigenous Protected Area of jointly managed national park
Wangumma	1,635	
Lake Victoria	4,431	

Lower Murray forests



Edward and Wakool forests

Current condition and values	Trajectory	Management considerations at different scales			Priority of management
		Basin/bioregion scale	Water management unit scale	Local scale	
<ul style="list-style-type: none"> • Low natural flooding under current river regulation • General poor condition – some better remnants in forests nested into private land • Does not provide significant timber resources • Low recreation use. Mixed ease of access. 	<ul style="list-style-type: none"> • Reduced flooding due to climate change • Drier, non flood-dependent ecology • Most of the very tall and tall open river red gum forest assuming a structure and productivity of open river red gum woodland over the long term, and up to 40 per cent of river red gum woodland transitioning from red gum to derived copperburr or grassland in the next 50 years. 	<ul style="list-style-type: none"> • Relatively low in the catchment and are thus susceptible to low water allocations, as water is fed downstream for irrigation and domestic supply, or is absorbed upstream for irrigation or environment • Significant flows when Murray floods only • Good north-west habitat connectivity • Potential node for connectivity with private land conservation initiatives 	<ul style="list-style-type: none"> • Engineering works on Koondrook-Perricoota is likely to reduce water from natural and adaptive flooding events 	<ul style="list-style-type: none"> • Opportunity for local ecological and recreational tourism at low opportunity cost to forestry 	<ol style="list-style-type: none"> 1. Adaptive ecological management 2. Recreation

State Forest	Area	Recommended tenure
Noorong	1, 875	Consolidated national park
Niemur	1,642	
Wetuppa	1,003	
Benjee	147	Private covenanted land or public conservation reserve
Berambong	244	
Woorooma	32	
Woorooma East	33	
Whymoul	387	
Yallakool	506	
Liewa	427	Regional park
Kyalite	572	

Edward and Wakool forests

