



**Natural Resources**  
SA Murray-Darling Basin

# Natural resources management plan

**Volume A** | Strategic plan



**Government of South Australia**  
South Australian Murray-Darling Basin  
Natural Resources Management Board

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# Natural Resources Management Plan

## Volume A | Strategic Plan for the Region

I, Ian Hunter, Minister for Sustainability, Environment and Conservation, hereby adopt this Natural Resources Management Plan comprising Volume A; Strategic Plan and Volume B; Business and Operational Plan pursuant to section 80(3)(a) of the *Natural Resources Management Act 2004*.

A handwritten signature in black ink, appearing to read 'I. Hunter', with a stylized flourish at the end.

**Hon Ian Hunter**

Minister for Sustainability,  
Environment and Conservation  
10 January 2014









# Foreword



## **Sharon Starick**

*SA Murray-Darling Basin NRM Board Chair*

The landscape of the Murray-Darling Basin is one of national and international renown characterised by the mighty River Murray, Lower Lakes and Coorong, extensive native vegetation on public and private lands, Ramsar sites, rangelands and a huge diversity of native species.

The region is an important food bowl to the state, producing premium wine, food and fibre for the domestic and export markets and making a significant contribution to the State's economy. Healthy soils, good quality water and healthy bush are vital in sustaining this production.

The productive and natural environments are interlinked and dependent on each other. They support our local economy and make our region a great place to live.

No one entity or individual alone can deliver all that is needed to have a healthy, productive landscape. By working together we can secure a healthy environment that supports a diverse and flexible economy as well as the well-being of our communities, ecosystems, soils and water resources.

The people in our region are our most valuable asset. They have proven to be resilient and innovative during times of hardship such as drought. By continuing to embrace change and new approaches to business we will be ready to take on future challenges and opportunities.

Our communities will need to continue to drive innovation by embracing new technology, research and development and new approaches to business to access world markets, ensuring that we can overcome future challenges and be ready to take advantage of opportunities.

As a Board, we want our community to be excited about the management of natural resources, actively making a difference at home, in business, locally and region-wide. There is great potential for our community to be more involved in making decisions for the region. Working with and influencing the Board, government and business will create a better economic, environmental, social and cultural future for the SA Murray-Darling Basin.

# A message for our districts



**Monique White**

*Ranges to River NRM Group Chair*

This district has a deep appreciation for the range of productive opportunities provided by the diverse landscape of the Ranges to River. To maintain our vibrant community, we must protect and preserve the complex interconnected systems that provide life giving nourishment to the people who live here, work here and recreate in this landscape.

The natural connection that people have with their environment is central to the success of this region as an environmentally sustainable and productive landscape. Lessons learnt come from working with science, technology and agriculturally productive ventures, together with the individual passion of landholders and the broader community ensures this region's viability.

Healthy country means healthy people and together the people of the Ranges to River have made a commitment to their land, their communities and their futures. I encourage them to continue to be leaders in managing our natural resources.



**Roger Wickes**

*Mallee-Coorong NRM Group Chair*

Our region depends on a resilient and thriving landscape in order to succeed during good times and times of hardship. Our landholders embrace new agricultural techniques and farming practices while understanding that to sustain the land we must also ensure that there is a vibrant natural ecosystem flourishing in parallel.

As a community, the Mallee-Coorong embraces diversity and maintains a deep rooted and firm commitment to our past, present and future developments. Agricultural viability is this region's lifeblood. By embracing new technologies and research and development practices we will continue to maintain, improve and achieve our common goals of natural resources stewardship.

I commend everyone in the Mallee-Coorong for continuing their endeavours to achieve a balanced approach to managing natural resources.



**Jo Gebhardt**

*Rangelands NRM Group Chair*

The extreme landscapes that exist in the Rangelands present both challenges and opportunities for communities to embrace and drive innovation, excellence and successful adaptation principles.

Acknowledging and celebrating the differences in the landscape across the region has resulted in a strong and connected community of landholders and conservationists who work collaboratively to build and maintain a viable local economy.

Accepting the best science, utilising historical knowledge and monitoring past, present and future farming practices is one of the unique characteristics of the Rangelands. This characteristic will ensure its economic and environmental productivity continues.

I congratulate the Rangelands community on their resilience and encourage them in their endeavours toward sustainable farming practices.



**Ken Stokes**

*Riverland NRM Group Chair*

The growth and success of agricultural and economic productivity in the Riverland is linked with our strong and connected community that recognises the importance of enhancing and protecting our natural resources.

In order to maintain and increase productivity we must manage the land within the limits our environments present, embrace science and technology, and learn from the knowledge and lessons of others. The spiritual connection and well being of our people and community is fundamentally linked to the sustainable management of our natural resources.

I encourage the Riverland community to continue to foster the region's natural drive for excellence that will lead to economically sustainable and viable agricultural and environmental landscapes.

# Recognition of Aboriginal people

The SA MDB NRM Plan seeks to enable partnerships built upon mutual respect and trust between Traditional Owners, the SA MDB NRM Board and other stakeholders. In order for this to happen, the rights, interests and obligations of Traditional Owners to speak and care for their traditional lands needs to be recognised and respected. This includes providing opportunities for Traditional Owners and Aboriginal people to be involved in natural resources planning and implementation processes.

There are differences between Traditional Owner groups and other Aboriginal people in the region and their preferred approaches for engagement. The Ngarrindjeri, represented by the Ngarrindjeri Regional Authority, have entered into the Kungun Ngarrindjeri Yunnan Agreement with the Government of South Australia. The First Peoples of the River Murray and Mallee Region were recognised as native title holders and have entered into an Indigenous Land Use Agreement. Both of these agreements outline a preferred consultation and negotiation framework that aims to strengthen collaboration between the parties.

The SA MDB NRM Board respects these agreements and recognises the important role of Traditional Owners and Aboriginal Peoples in the conservation and ecologically sustainable use of the region's biodiversity.

# Acknowledgements

This business and operational plan recognises the valuable contribution that many committed individuals and organisations have made to the South Australian Murray-Darling Basin Natural Resources Management (SA MDB NRM) region over many years. Special thanks go to the individuals, whose expertise, guidance, general assistance and advice has been pivotal throughout the review and amendment of this plan and includes:

- Community members that provided feedback using the on-line survey, attended workshops, provided feedback on the Concept Statement and Draft Plan.
- Regional Outcomes Report workshop participants that evaluated Management Action Targets.
- RCT review workshop participants that evaluated Resource Condition Targets
- SA MDB NRM Board for strategic direction
- Natural Resources SA MDB staff for technical advice and administration support
- Community at the Centre Collective for engagement advice
- Department of Environment, Water and Natural Resources (DEWNR) staff from the Science Monitoring and Knowledge Branch for expert and technical advice
- DEWNR staff within the Knowledge Management Unit for Geographic Information System information and support
- DEWNR staff within the Office of the Group Executive Director Partnerships and Stewardship, and Conservation and Land Management Branch for technical advice
- SA MDB NRM Board members, Ranges to River NRM Group members, Mallee-Coorong NRM Group members, Rangelands NRM Group members, Riverland NRM Group members, Department of Environment, Water and Natural Resources (DEWNR) staff, Ngarrindjeri Regional Authority, First Peoples of the River Murray and Mallee, NRM Council, River Murray Youth Council, Goolwa to Wellington LAP, Nature Conservation Society of SA, Conservation Council of SA, Mid Murray Council, Alexandrina Council, The Rural City of Murray Bridge, and The Barossa Council who participated in workshops, provided comment, technical input or shared their knowledge and values.

Project management and administration:

- Amy Goodman, Danielle Witham and Phil McNamara





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# 1 Introduction

## 1.1 Purpose of the Regional Natural Resources Management Plan

The *Natural Resources Management Act 2004* creates a regulatory framework for the management of the water, soil and biological assets of each natural resources management region. It requires each regional Board to work with their community to prepare a Regional NRM Plan that outlines the policies it will use to protect the environment and interests of the region. The SA MDB Regional NRM Plan (Volumes A and B) aims to support ecologically sustainable development in the region and achieve an appropriate balance between environmental, social, economic and cultural outcomes through the use of natural resources. It seeks to foster a landscape approach to managing natural resources where social and ecological systems are considered together. The Regional NRM Plan has been developed in line with the plans, policies, strategies and priorities of the NRM community and by listening to the values of our community.

The purpose of the Regional NRM Plan is to:

- assess the current state and condition of the region's natural resources, the current and likely future processes that threaten them, and opportunities for their protection and management
- set long-term targets (referred to as Resource Condition Targets) for the desired state and condition of the region's natural resources and describe the broad strategies and actions required to achieve them
- provide a sound basis for investing in the management of the region's natural resources by a range of funding investors, including the Commonwealth and Government of South Australia
- guide the approach of the region's stakeholders to managing natural resources, including all-of-government, industry groups, community groups and individuals
- communicate a shared vision and the goals for managing natural resources in the region.







## 1.1.1 Volumes of the Regional Natural Resources Management Plan

The SA MDB Regional NRM Plan is comprised of a strategic plan and a business and operational plan. These plans are supported by a regional action plan.

### Volume A: Strategic Plan (10 years)

The Strategic Plan guides future investment decisions and actions of all stakeholders in the region. This is outlined in the vision, goals and resource condition targets (the long-term outcomes sought). The plan also describes the state, condition and trends of natural systems in each of the four NRM districts (Mallee-Coorong, Rangelands, Ranges to River and Riverland) and informs the Board's Business and Operational Plan.

### Volume B: Board's Business and Operational Plan (3 years)

The Business and Operational Plan outlines the contribution the SA MDB NRM Board will make in implementing the Strategic Plan and Regional Action Plan. This includes information about priority programs for investment and the funds required from various sources, including the NRM Levy. The plan also presents the regulations and policies that the Board will use to underpin the implementation of the Strategic Plan and to fulfil its obligations under the *Natural Resources Management Act 2004*.

### Supporting Document: Regional Action Plan (5 years)

The Regional Action Plan describes the actions and investment needed within each of the four NRM districts in the next five years in order to achieve the Strategic Plan. This includes priority actions, targets and information about where stakeholders are already investing resources and where there are gaps. The plan may be updated within the five year period as needs change to ensure that the region continues to deliver on the priorities outlined in the Strategic Plan.

### 1.1.2 How was the Regional Natural Resources Management Plan developed?

The inaugural SA MDB NRM Plan was developed in July 2009 and has since guided the management of natural resources in the region. The 2009 Regional NRM Plan was developed in open partnership with primary stakeholders, including local action planning groups, conservation groups, Aboriginal groups, local governments, state and Australian government agencies, industry groups, farmer groups, other primary producers, and research and development institutions. In addition to following the statutory obligations for consultation outlined in the *Natural Resources Management Act 2004*, an intensive and extensive consultation process was carried out to garner feedback from the general community.

The *Natural Resources Management Act 2004* requires the SA MDB NRM Board review the Regional NRM Plan once every five years. The review involved adapting and updating information gathered from the 2009 Regional NRM Plan and consulting with key stakeholders and community members to ensure community values, issues and priorities have been included. It has been updated with the best available information incorporated into the planning process.

#### Preliminary review

A preliminary review of the plan in early 2012 identified a number of areas for improvement, including adopting a landscape approach, being responsive to emerging issues in managing natural resources, reviewing targets, and being clear about roles and responsibilities for the implementation and achievement of strategies and actions in the plan.

#### Concept Statement

The preliminary review informed the development of a Concept Statement which outlined in general terms a revised structure for the plan, matters to be investigated and proposals for consultation. The draft Concept Statement was released for public comment in October and November 2012. The Concept Statement was completed in January 2013.

#### Drafting the amendments to the Plan

The 2009 SA MDB Regional NRM Plan provided the foundation for developing the proposed amendments to the plan. These amendments were prepared by drawing on scientific information collected in the last five years and the outcomes of a series of projects and workshops in late 2012 and early 2013 that were designed specifically to incorporate the community's values.

#### Consultation on the draft amendments

A period of broad community consultation followed the initial drafting of the amendments to the plan. The engagement process was designed to ensure any member of the community that would be affected by decisions had an opportunity to have their say. All sectors of the community were encouraged to contribute their ideas and opinions by commenting on the draft plan.

### 1.1.3 Who is the Regional Natural Resources Management Plan for?

The Regional NRM Plan applies to the entire SA MBD region but is specifically aimed at our NRM community. The NRM community is diverse and includes local, state and federal governments, local and regional networks, non-government organisations (including local action planning groups), landcare groups and conservation bodies, Traditional Owners, industry groups, education and research institutions, and individuals. Our NRM community also extends beyond our borders to other regional NRM bodies that we have a close working relationship with. The Regional NRM Plan supports state-wide policy objectives identified in the State NRM Plan and the SA Strategic Plan (Figure 1.).

### 1.1.4 Who will implement the Regional Natural Resources Management Plan?

The Regional NRM Plan will be implemented through the actions of all NRM stakeholders. The Strategic Plan (Volume A) sets the direction and long-term targets for natural resource assets in the Region. The actions and investment required to meet the long-term targets and how the NRM community will contribute to this will be captured in the Regional Action Plan. While each NRM stakeholder has their own vision and responsibilities, the plan aims to bring this together to achieve a common direction. The plan is also designed to support the achievement of state-wide plans and strategies.



Figure 1 Relationship between local, regional and state-wide contribution to natural resources management



## 2 Guide to the Strategic Plan

### 2.1 The Strategic Plan for the SA Murray-Darling Basin NRM region

The Strategic Plan is the shared vision for natural resources in our region. This vision is underpinned by a set of goals and resource condition targets (the long-term outcomes sought) that provide direction for the management of natural resources in the SA MDB NRM region for the next 15 years. The review of the NRM Strategic Plan incorporates principles of resilience thinking and adaptive management to consider the environmental and the socio-economic elements within the SA MDB NRM region. A systems-based approach for reviewing the SA MDB NRM Strategic Plan has been adopted to provide a fresh perspective and avoid the constraints associated with the development of previous strategies. There is a strong focus on applying adaptive management <sup>(1)</sup> <sup>(2)</sup> <sup>(3)</sup> and the importance of monitoring and evaluation to this process. These concepts, methods and approaches are described in more detail in Chapter 5.

The Strategic Plan describes the natural systems and natural resource assets of the region's four NRM districts (Ranges to River, Mallee-Coorong, Rangelands and Riverland). This includes information about the state and condition of natural systems, community values and socio-economic trends that may impact on their condition and management. The information in the Strategic Plan informs the Regional Action Plan and it is through the Regional Action Plan that we will ensure proposed actions and investments are locally relevant. By taking a landscape and socio-ecological approach we aim to make sure our region's natural resource assets are managed in an integrated way and are more resilient, whilst taking into consideration the community's capacity to undertake natural resources management. It provides a sound basis for the direct investment in natural resources management in the region by the Australian and South Australian Governments. It guides the approach to NRM (including investment decisions and actions) of all the region's stakeholders including the SA MDB NRM Board, local government, industry groups, community groups and individuals.

### 2.2 Taking a landscape approach

The approach to solving complex natural resources management problems has matured in recent times. In the 1980s the focus was on managing individual threats such as vegetation loss and soil erosion. In the 1990s a more integrated catchment management approach was adopted with biodiversity decline and water quality becoming a key concern. The 2000s heralded a more holistic approach to managing our natural resources, with efforts focussing on maintaining clean water, productive soils and habitat connectivity. Now the focus is on understanding whole landscape systems <sup>(4)</sup>.

Landscape systems are the variety of land-cover types that provide ecosystem services and development opportunities that address the needs of a range of stakeholders <sup>(5)</sup>. A landscape systems approach looks across large, connected geographic areas to identify natural resource conditions and trends that may not be evident when managing smaller localised areas.

In the SAMDB NRM region, land managers, administrators and policy makers face increasing conflicts over the demands and values being placed on the region's natural resources. Resolving these conflicts will be easier if we understand how the natural systems operate and the impact of different uses on these systems. A landscape approach seeks to understand these dynamics in order to identify the interventions and policies that will achieve the stated goals of stakeholders.

### 2.3 Considering a resilient approach

A resilient landscape is able to resist, tolerate and recover quickly from disturbance without collapsing into a different state <sup>(6)</sup>. These disturbances can be naturally occurring, such as flood events, or man-made, such as deforestation or the introduction of pest plants and animals. Reduced resilience of a system increases its vulnerability to smaller disturbances that it could previously cope with. For example, gradually changing conditions, such as habitat fragmentation or nutrient loading, can pass threshold levels that trigger a rapid system response. When resilience is lost or has decreased the system is at high risk of shifting into a different state. The new state of the system may be undesirable. For example, productive soils may become eroded, salinised or acidic.

The fundamental component to having resilience in socio-ecological systems is diversity. Biodiversity is pivotal as it provides redundancy in systems <sup>(6)</sup>. For example, there are several different species of sedge that filter nutrients in waterways, each responding differently to climatic events. This means that even though some species may be lost when the climate becomes unfavourable, the process of filtering nutrients continues. Similarly, when regions have economic diversity derived from different industries, they are buffered from global and national drivers that may impact on local economies and employment. At a local level, diversified farming practices are considered resilient because they rely on several sources of income at different times of the year.



## 2.4 Considering a socio-ecological approach

A socio-ecological approach recognises that humans (socio-economic systems) are embedded within the environment (ecosystems). They depend on and influence the function of the ecosystem components and vice versa <sup>(7)</sup>. For example, the geography of an area shapes its economy, human habits and cultural characteristics. The environment dictates the lifestyle of the individual and the economy of a region. In turn, these attributes influence the condition of the natural resources in a region. Socio-ecological systems contain distinct characteristics such as combinations of social structure, vegetation and land uses that are distinct from other systems. A socio-ecological systems approach can be used as a basis for future planning, engagement, decision making and on-ground action.

### 2.4.1 Community capacity

Community capacity is the degree to which a community or individual land manager can undertake a change in how they manage natural resources <sup>(8)</sup>. Maintaining and improving the capacity of the community within the SAMDB NRM region underpins the resilience approach described earlier. Complex factors such as economic, social and biophysical elements play a strong role in changing land management practice. This approach is a relatively new area, however, a number of studies have been undertaken in the last 10 years that help us understand what influences the capacity of the community or individual. There is considerable agreement in recent literature that the adaptive capacity of a community is positively related to the wealth of resources available <sup>(9)(10)</sup>. A common way of describing these resources is to classify them as various forms of capital, namely built, human, natural, social and financial capital <sup>(10)</sup>. The five capitals commonly discussed at the community scale are:

- Human capital - labour and influences on the productivity of labour including education, skills and health
- Social capital - claims on others by virtue of social relationship
- Natural capital - land, water and biological resources
- Physical capital - produced by economic activity including infrastructure, equipment and technology
- Financial capital - savings and credit.

The community capacity of the four districts is discussed in section 3 of this plan.



*Joe Keynes telling board members and guests about water management issues on his property*



*Andy Cole giving pasture management tips at a SAMDB NRM Board sponsored farm walk*

## 2.4.2 Social and economic profile

A social and economic profile describes in detail the communities, economic drivers, primary and secondary industries, and resource use within a region. It tells a 'story' about the community and provides a snapshot of sectors such as employment, agriculture and industry. A social and economic profile is a useful tool as it provides insight into a region by examining its values, priorities and new directions <sup>(13)</sup>. This insight enables us to match natural resources management actions with the goals and aspirations of our community and we can anticipate how people will react to programs, incentives and policies that are developed. It can also help us understand those sectors that may not have the capacity to engage in an important proposal, decision or change in practice.

Social and economic drivers are those aspects that influence communities, social groups and individuals, including regional employment, income, primary production, cultural life, community values, political systems, environments, and general health and wellbeing. A literature review <sup>(14)</sup> identified the most common barriers to adopting changes in the management of natural resources as:

- motivational - suasive powers
- technical - complexity of the problem and the solutions and whether innovation and best practice fits with current knowledge and practice
- financial - economic benefit and the perception of risk versus profit
- biophysical. <sup>(15)</sup>

Consideration of these social and economic drivers when planning changes to how natural resources are managed will increase the likelihood of communities accepting these changes and supporting policy decisions.

## 2.5 Principles of natural resources management

A healthy environment is the foundation for a healthy region where the environment is in good condition, the community is unified, and the economy provides jobs and a reasonable standard of living. Experience has shown that an effective way to manage our natural resources is to look at natural resource assets and problems at the landscape level, while involving communities in coordinating management efforts at the local level. A number of principles have been developed in partnership with key stakeholders to guide this philosophy:

### Principle 1: Work together for success

Partnering with the community, government and industries to reach goals and targets for our region.

### Principle 2: Build knowledge

Sound decision making in managing natural resources is supported by increased awareness and knowledge that is valued by the region.

### Principle 3: Strive for balance

Undertaking natural resources management activities that support a healthy economy that is meeting social and environmental objectives.

### Principle 4: Think innovatively

Using creativity and leadership to manage our natural resources for the future.

### Principle 5: Manage holistically

Ensuring integrated landscape management by managing landscape components and processes together rather than dealing with issues in isolation.

### Principle 6: Work within the limits to ensure the future

Working within sustainable limits to protect the capacity of our resources to provide services for the wellbeing of current and future generations.

### Principle 7: Prevent rather than cure

Preventing the degradation of natural resources by dealing with causes is preferable to rehabilitation and treating symptoms.

### Principle 8: Program improvement, adaptive management and an evidence based approach

Decisions should be made at the most appropriate level using the best available scientific and technical evidence available. Past successes should be built upon, while past mistakes and new information should be considered opportunities for learning and informing the iterative processes that support future decisions. A precautionary approach should be taken where there is insufficient scientific or technical evidence on which to base a decision.

## 2.6 Principles for stakeholder engagement

Stakeholder engagement is the practice of encouraging public participation in decision making. It seeks and facilitates the involvement of individuals, groups and organisations that are potentially affected by or interested in a decision. It is a way of empowering stakeholders as part of a democratic governance structure and fosters a collective intelligence. A number of principles have been developed to guide the participation of people in a decision making process to achieve productive and resilient change. The following principles <sup>(11)</sup> have been adopted by a wide range of organisations in South Australia.

### **Principle 1 - Early engagement:**

Engagement activities should take place as early as possible in the decision making process before any decisions have been made that cannot be reversed.

### **Principle 2 - Clear understanding of what is to be achieved and clear communication:**

As renowned self-development author Stephen Covey wrote: 'To begin with the end in mind means to start with a clear understanding of your destination'. Engagement processes should be based on an understanding of the current situation and the end goal so that the steps taken are always in the right direction.

### **Principle 3 - Understanding who needs to be engaged:**

Who should we be engaging with? Is there more than one group? Are there people who we should be engaging with who might not be obvious stakeholders? These are key questions to ask at the beginning of an engagement process as they will then help determine which methodologies will attract the right audiences (Principle 6).

### **Principle 4 - History and background:**

Engaging communities and stakeholders too often or failing to build on previous engagement activities can be as detrimental as not engaging at all. It is important for people to see how previous contributions have influenced decision making outcomes.

### **Principle 5 - Authentic engagement:**

People quickly pick up when our actions lack authenticity, they see through engagement activities which are undertaken for the sake of fulfilling a process or checking a box. As soon as they do, cynicism sets in, they disengage from the process and lasting damage can be done. Engagement which is not genuine can damage the public's goodwill and make it harder for those being done with the right intent.

### **Principle 6 - Creativity, relevance and engaging:**

Is it possible to have an engagement which isn't engaging? Absolutely! There are plenty of examples of engagement activities which fail to inspire often result in low turnout figures, poor quality responses and a lack of goodwill at future engagement activities.

## Stakeholder Analysis

A "stakeholder" is any person or organisation that is actively involved in, or whose interests may be affected positively or negatively by, implementing the Regional NRM Plan. Undertaking a stakeholder analysis is a useful technique used to determine stakeholder interests, influence, participation and expectations for the management of natural resources.

### **State, federal and local Government:**

May have a statutory role, strategic planning at various levels, specific areas of technical expertise, administer budgets and grants, issue permits, create and regulate legislation and policy

### **Funders and potential funders:**

Without their support the planned activities wouldn't be possible

### **Aboriginal family groups:**

Recognises input of Traditional Owners, may require special consideration of Aboriginal heritage and cultural issues, potential on-ground delivery

### **Academic and research institutions:**

Their work may influence the types of intervention or initiative, or they may simply be sympathetic to the goals of the effort and understand them better than most

### **Non-government organisations:**

May have a philosophical interest in the issue, may be influential with other stakeholders, source of funding or technical expertise, on-ground delivery

### **Community groups and activists:**

Organisations and individuals who have a philosophical or political interest in the issue, may organise support for the effort or defeat it, provide local knowledge, deliver on-ground works

### **Industry Groups:**

The business community usually takes an interest in any effort that will provide it with more and better workers, or make it easier and more likely to make a profit. This community may also oppose efforts that are seen as costing businesses money or imposing regulations on it

### **Broader community interests:**

Community members whose lives, jobs or routines may be affected

### **Those who can influence others:**

The media, people in positions that convey influence, community leaders



# 3 The SA Murray-Darling Basin NRM region

## 3.1 The SA MDB NRM region

The SA MDB NRM region is one of eight natural resources regions in South Australia. It also forms the south-western portion of the Murray-Darling catchment into which the River Murray flows, South Australia's most substantial and important surface water resource. The region covers more than 5.6 million hectares and extends from the Victorian and New South Wales borders to the catchment boundary along the Mount Lofty Ranges, from the Rangelands in the north to the Murray Mallee and Murray Mouth in the south, and up to 14 kilometres into the Southern Ocean (Figure 2.). The region supports a population of approximately 125,000 people and is one of South Australia's most ecologically diverse and agriculturally productive areas. The Regional NRM Plan focuses on the socio-ecological systems of four districts:

1. Ranges to River
2. Mallee-Coorong
3. Rangelands
4. Riverland.

The NRM districts are described by their ecological, social and economic characteristics. Describing and planning at the level of these NRM districts ensures actions and investment can be focused at a more relevant local scale. It also improves the management of assets that have previously been considered in isolation.

## 3.2 Goals for the SA MDB NRM region

The purpose of managing our natural resources is to ensure these resources are sustainable and resilient in the long term. Regional natural resources management operates primarily at the landscape level within state and national policy frameworks. Achieving the vision for natural resources management in the region depends on the actions of people at the community level. Managing our natural resources is a long-term ongoing practice and it is important to understand the many processes and interests involved.

Natural resources management is a systematic process for managing the biophysical, socio-political and economic aspects of water, land, plants and animals and their ecosystems. An integrated approach where individual issues are considered from a holistic perspective is pivotal to managing our natural resources. This includes integrating economic, social and environmental values as well as engaging the community and industry in planning, decision making and on-ground delivery.

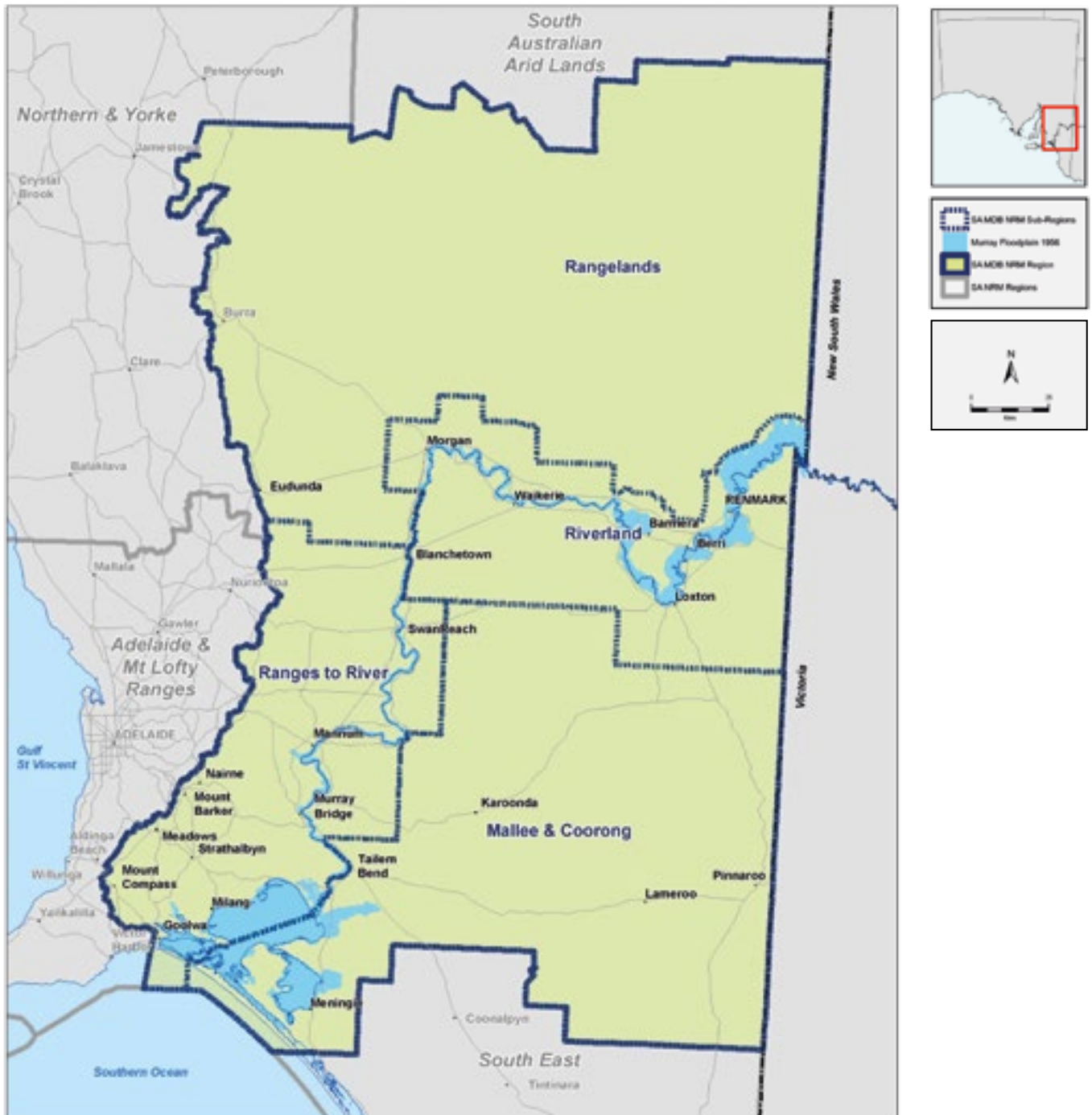
A vision for the region was created through a consultative process. The vision aims to inspire our community by clearly stating our common purpose. It reflects the unique strengths, culture, values and beliefs of the people in this region and is underpinned by three goals that mirror those of the State NRM Plan <sup>(12)</sup>. These goals recognise the link between people, production and conservation and are as follows:

1. People taking responsibility for natural resources and making informed decisions
2. Sustainable management and productive use of land, water, air and sea
3. Improved condition and resilience of natural systems.

The following information on trends within the region outlines the capacity of the community to effectively manage our natural resources and meet its NRM goals.



Figure 2 Map of the South Australian Murray-Darling Basin NRM Region



### 3.3 Lifestyles and livelihoods of the SA MDB Region

#### 3.3.1 Population demographics

The SA MDB region covers 56,703 square kilometres or 7 per cent of the area of South Australia and has a population of 125,358 or nearly 8 per cent of South Australia's population <sup>(16)</sup>. The Aboriginal population is 2 per cent of the region's population. The majority of people live in the Ranges to River district (63 per cent or 79,286 people), particularly in the major urban centres and high rainfall areas of the Eastern Hills and coastal areas. The Riverland district supports nearly a third of the region's population (27 per cent or 33,413 people), particularly in the major towns adjacent the River Murray channel and floodplains <sup>(16)</sup>.

The region's population grew by 12 per cent between 2001 and 2011 <sup>(16)</sup> largely due to growth in the Ranges to River district <sup>(17)</sup>. The Ranges to River population is expected to continue to increase significantly from now until 2026 <sup>(18)</sup>. Despite the overall growth of the regional population, the Mallee-Coorong, Rangelands and Riverland districts have had a declining population over the same period (less 7 , 1 and 5 per cent respectively) <sup>(16)</sup>. The population of these districts is expected to remain steady or experience minor decline <sup>(18)</sup>. Twenty-eight per cent of households in the region do not have an internet connection. This figure is more pronounced in the Rangelands, Mallee-Coorong and Riverland districts (32, 31 and 33 per cent respectively) <sup>(19)</sup>.

#### 3.3.2 Local government

Local government plays a significant role in managing our natural resources and provides a key link to the broader community. Fifteen local councils are located within the region and have been characterised as either a primary council, where the majority of the NRM issues are located within the region, or as a cross-regional council, where a small part of the Council's area falls within the region.

The primary councils in the region are:

- Alexandrina Council
- Berri Barmera Council
- Coorong District Council
- Regional Council of Goyder
- District Council of Karoonda East Murray
- District Council of Loxton Waikerie
- Mid Murray Council
- District Council of Mount Barker
- Rural City of Murray Bridge
- Renmark Paringa Council
- Southern Mallee District Council

The cross-regional councils in the region are:

- Adelaide Hills Council
- The Barossa Council
- City of Onkaparinga
- City of Victor Harbor

#### 3.3.3 Community groups and volunteering

According to the 2011 Australian Bureau of Statistics (ABS) Census, 20 per cent of South Australians spent time in the preceding 12 months doing some kind of voluntary work through an organisation or group. In the SA MBD region this figure was slightly higher at 26 per cent <sup>(19)</sup>. Other data collected through the 2011 to 2012 ABS Environmental Views and Behaviours Survey showed that approximately 8 per cent of the South Australian population had volunteered or become involved in environmentally related programs <sup>(23)</sup>.

The Natural Resources SA MDB volunteer database indicates that there are 95 volunteer groups involved in managing the regions natural resources, with around 1900 registered volunteers having undertaken more than 70,000 hours of NRM related work from 2011 to 2012 <sup>(27)</sup>. Local Action Planning (LAP) Groups play an important role in identifying and addressing priority issues and translating national, state and regional targets and initiatives into on-ground action. LAP Groups are supported by Natural Resources SA MDB staff and manage relatively large budgets. Other volunteer community groups that undertake significant activities at specific locations within the region include:

- Coastcare and Landcare groups
- Land management groups
- Friends of Parks groups
- Sustainable production groups
- Wetland groups
- Natural Resources Centres
- Catchment groups



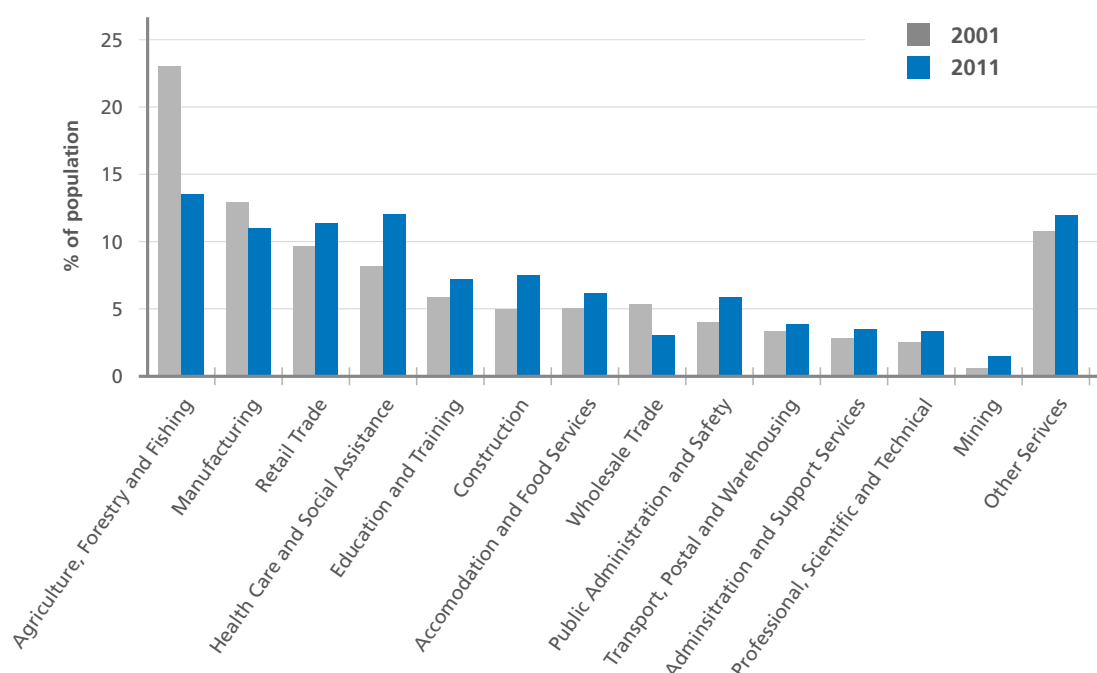
### 3.3.4 Recreation and tourism

The SA MDB region is a popular area with tourists and visitors, with peak visitation occurring from March to April and September to November. The region offers a range of recreational opportunities focussed on the River Murray, Coorong and Lower Lakes, and conservation areas such as Ngarkat Conservation Park and Murray River National Park. The Murraylands and Riverland regions cover a large portion of the region and are two of the twelve recognised tourism regions of South Australia <sup>(28)</sup>. Collectively these regions attracted more than 1.3 million visitors and close to 1.3 million overnight stays from 2010 to 2011 <sup>(27)</sup>. Annual surveys have found that more than 10 per cent of visitors to the Riverland and Murraylands tourist regions participated in water related or nature based activity such as water sports, fishing, bushwalking, picnics or barbecues <sup>(29)</sup>. These types of activities can place pressure on the natural resources they rely on, such through bank erosion from boat wash, loss of timber used for firewood and trampling of vegetation.

### 3.3.5 Industry and employment

Agriculture is the dominant employment industry across the region (14 per cent), followed by health care and social services (12 per cent), retail trade (11 per cent) and manufacturing (11 per cent). Higher proportions of the population are employed in agriculture in three of the four districts: Mallee-Coorong, 41 per cent; Rangelands, 31 per cent; and Riverland, 19 per cent. The Ranges to River district has a more diverse employment base with agriculture employing just 8 per cent by comparison. Employment in most industries has remained relatively stable over the period 2001 to 2011, with the exceptions of agriculture, forestry and fishing (declined from 23 per cent of the population to 14 per cent), and health care and social services (increased from 8 per cent to 12 per cent) <sup>(16)</sup>. These statistics are outlined in Graph 1.

**Graph 1. Trends of main industries employing people from 2001 to 2011 <sup>(16)</sup>**



### 3.3.6 Land use

In 2008, the major land uses in the region were grazing of modified pastures (25 per cent), grazing of natural vegetation (21 per cent), nature conservation (20 per cent) and cropping (19 per cent) <sup>(20)</sup>. Grazing modified pastures and cropping occurred largely in the Eastern Hills and Western Mallee of the Ranges to River and Rangelands districts, and the Southern and Northern Mallee of the Mallee-Coorong and Riverland districts.

Grazing natural vegetation and nature conservation occurred mainly in the Rangelands district, although there are also large protected areas in the Mallee-Coorong district. Irrigated production comprised 2 per cent of the region's land use and mainly occurred adjacent the Murray River and Angas Bremer catchments (mainly using surface water resources), and in the eastern part of the southern mallee (using groundwater resources).

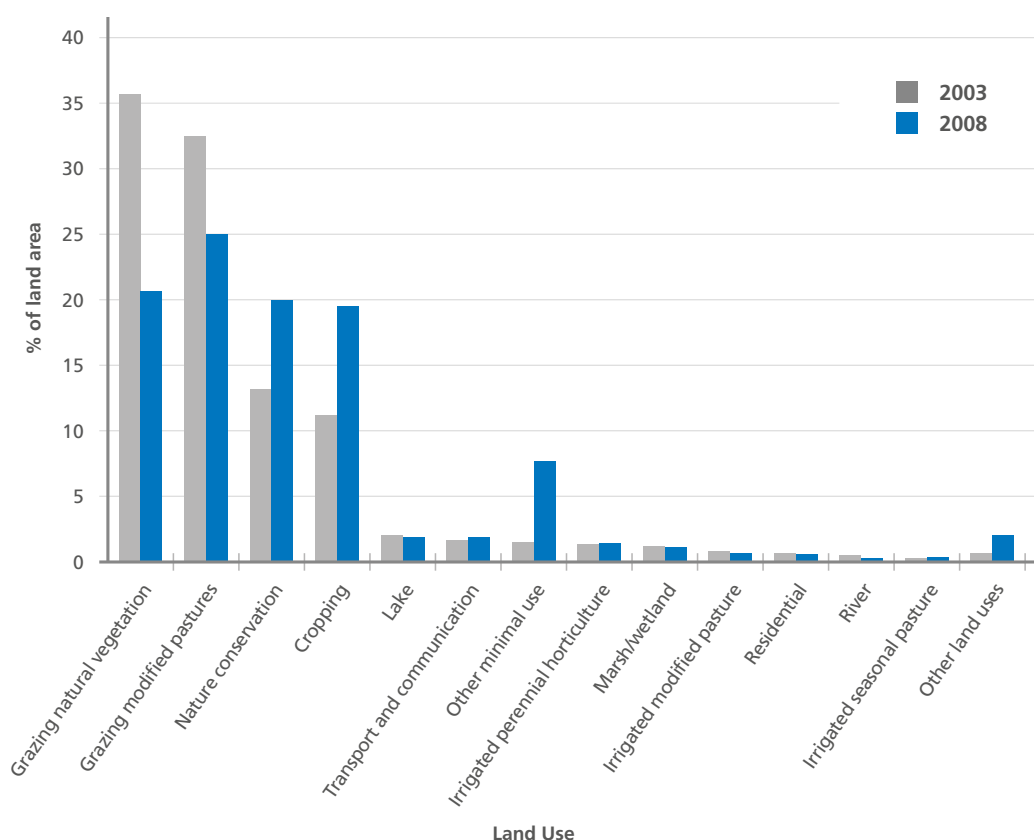
Between 2003 and 2008 large areas of grazed natural vegetation were destocked to become nature conservation areas, largely due to the inclusion of Gluepot Reserve, Calperum Station and Taylorville Station as protected areas under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* <sup>(21)</sup> <sup>(20)</sup>. Other major changes in the region were the reduction in land area

used for grazing modified pastures and increase in the land area used for cropping. It should be noted that both of these land use classes may include land in a rotation system. These statistics are outlined in Graph 2.

### 3.3.7 Community environmental behaviours and values

Surveys conducted by the Australian Bureau of Statistics for the period 2007 to 2008 <sup>(22)</sup> and 2011 to 2012 <sup>(23)</sup> found an overall decline in community concern about the environment in Australia. For example, in the 2007 to 2008 survey 86 per cent of the South Australian population was concerned about environmental problems, compared with 65 per cent in the 2011 to 2012 survey. Similarly, in the earlier survey 79 per cent of South Australians were concerned about climate change, compared with 58 per cent in the 2011 to 2012 survey. The number of South Australians who believe the condition of the natural environment is declining also decreased from 67 per cent in the 2007 to 2008 survey to 37 per cent in the 2011 to 2012 survey.

Graph 2. Trends in land use from 2003 (21) to 2008 <sup>(20)</sup>



### 3.3.8 Land holder environmental issues and management

In a recent survey commercial and lifestyle farmers in the region identified pest animal control, weed control and water quantity as the most important natural resource management issues for their farming enterprise. Lifestyle farmers also nominated fire management, native vegetation conservation and native animal habitat as important issues. The survey found that commercial farmers were concerned about these issues due to the associated consequences for their future health and prosperity, whereas lifestyle farmers were concerned because of the impact on the environment <sup>(24)</sup>. Another survey conducted within the region in 2010 and 2012 showed that water is valued as one of the most important natural resources in the region <sup>(25)</sup>.

- The Government of South Australia has commissioned regular telephone surveys of land managers in agricultural regions of South Australia. The first land manager survey was conducted in 2000 and was repeated in 2002, 2005, 2008 and 2011. The trend in survey results from 2000 to 2011 provide an insight into land managers and their practices within the region <sup>(26)</sup>:
  - the number of cropping farmers using a no-till practice for sowing crops increased from 21 per cent to 60 per cent. A high proportion of cropping managers considered stubble retention as important for soil health and erosion control
  - the percentage of farmers utilising confinement feeding of livestock to manage paddock cover for soil erosion protection increased from 31 per cent to 48 per cent
  - farmers had only applied one third of the lime needed to balance the estimated rate of soil acidification in areas with acid soils.
- In 2011
  - more than 50 per cent of cropping farmers were using some form of GPS guidance technology, such as auto steer, variable rate and yield mapping
  - nearly two thirds of farmers with non-wetting soils had used some practice to treat or overcome non-wetting soil
  - more than 30 per cent of land managers had a physical property plan that included one or more land management issues, while 28 per cent had a written strategic plan for their farm business and family
  - 60 per cent of farmers had undertaken regular soil testing for nutrition status
  - 68 per cent of farmers with saline soils on their farm had undertaken practices onsite to manage or treat salinity.

### 3.3.9 Aboriginal cultural values

For Aboriginal Australians the word 'country' describes the values, places, resources, stories and cultural obligations associated with an area and its features. When we acknowledge traditional country, it is not a hollow sentiment; we acknowledge Aboriginal people's connection to the land and their place within this region. Each traditional language group identifies strongly with different parts of the SA MBD region. For some, the connection is strongest with the vast ancient rangelands that sustained people over many tens of thousands of years. For others, the connection is with the inland waters and coastal areas that created the region's song lines (dreaming tracks). This connection is described in Aboriginal dreaming, in lore and in spirit. Water was and continues to be a pivotal connection and life line.

#### 3.3.10 Community capacity

The adaptive capacity, resilience and vulnerability of the community in the region is driven by the impact of climate change, availability of water (and trading), market forces and failures, population trends and social changes. Understanding these environmental, social and economic conditions and the characteristics, needs and aspirations of our community is essential when planning how to manage our natural resources. Because the environment, society, and the economy are fundamentally intertwined, our future depends on our ability to maintain healthy districts that have retained their biodiversity and productive capacity.

The adaptive capacity of the four districts has been measured using a single adaptive capacity index as the weighted sum of indices calculated for the physical capital, economic capital, human capital and social capital. This index has been based on the ABARES-BRS (2010) analysis <sup>(10)</sup>. A summary of this analysis is presented in each of the relevant district descriptions. The summary analysis is discussed in terms of averages in comparison to state-wide averages. The profile for each of the districts provides a baseline against which we can compare future information. Overtime, this information can be used to illustrate social and community networks, cultural diversity, social and economic infrastructure, political and institutional environments, and social fragmentation. For example, by establishing trends in population and migration and linking these with employment trends, we can gain an insight into a region's future natural resource needs, such as residential land or water. A snapshot comparison of the trends occurring in the region and districts is presented in Table 1.



**Table 1. Regional snapshot of social and biophysical trends**

	<b>SAMDB Region</b>	<b>Ranges to River District</b>	<b>Mallee- Coorong District</b>	<b>Rangelands District</b>	<b>Riverland District</b>
<b>Total Area (km<sup>2</sup>)</b>	56,703	8,551	16,889	23,763	7,500
<b>Total Population</b> <sup>(16)</sup>	125,358	79,286	8,475	4,184	33,413
<b>Median Age Trends (in years)</b> (2001-2011) <sup>(19)</sup>	+11% (38-42)	+14% (37-42)	+16% (38-44)	+15% (40-46)	+11% (38-42)
<b>Population Density Trends (km<sup>2</sup>)</b> (2001- 2011)	+12% 1.98-2.21	+24% (7.45-9.27)	-7% (0.54-0.5)	0% (0.18-0.18)	-5% (4.7-4.46)
<b>% Total Population Trends</b> (2001-2011) <sup>(16)</sup>	+12% (112,315-125,358)	+24% (63,752-79,286)	-7% (9,084- 8,475)	-1% (4,239-4,184)	-5% (35,240-33,413)
<b>% Rural Population Trends</b> (2001-2011) <sup>(16) (17)</sup>	-6% (50%-44%)	-8% (41%-33%)	-2% (85%-83%)	+26%* (74%-100%)	-2% (55%-53%)
<b>% Urban Centre Population Trends</b> (2001-2011)	+6% (50%-56%)	+8% (59%-67%)	+2% (15%-17%)	-26%* (26%-0%)	+2% (45%-47%)
<b>% Trends in land area used for agriculture</b> (2003 -2008) <sup>(20) (21)</sup>	-14% (81%-67%)	-9% (82%-73%)	-5% (74%-69%)	-23% (86%-63%)	-9% (78%-69%)
<b>% Trends in land area protected for native conservation</b> (2003 - 2008) <sup>(20) (21)</sup>	+7% (13%-20%)	+1% (3%-4% )	-1% (19%-18%)	+16% (14%-30%)	+3% (8%-11%)
<b>Main hydrology and use</b>		Surface – EMLR PWRA (irrigation) Ground – Angas- Bremer PWA (irrigation) Ground – Marne Saunders PWRA (irrigation) Surface – River Murray PWC (irrigation)	Ground – Mallee PWA (irrigation) Ground – Peake, Roby and Sherlock PWA (irrigation) Surface – River Murray PWC (irrigation)	Surface – Burra Ck. Not prescribed (stock and domestic) Ground – Burra to Truro not prescribed (stock and domestic) Surface – River Murray PWC (country town water supply)	Surface – River Murray PWC (irrigation) Ground – Noora PWA (salt interception)
<b>Percentage of native vegetation cover</b> <sup>(30)</sup>	**53%	18%	25%	**91%	38%

\*The ABS define an urban centre as having a population >1,000, if <1,000 then it is considered "rural". This is particularly pertinent when observing the Land Use Population 2011 for Rangelands as the population of Burra decreased below 1,000 and is subsequently considered "rural" despite people living in a townsite <sup>(31)</sup>.

\*\*The relatively high native vegetation cover figures for the SA MDB NRM Region (53%) reflects the large area of uncleared pastoral land in the Rangelands NRM sub-region, although much of this land is under pastoral lease and has been subject to continual, high levels of grazing pressure <sup>(32)</sup>.

### 3.4 Asset Classes and Resource Condition Targets

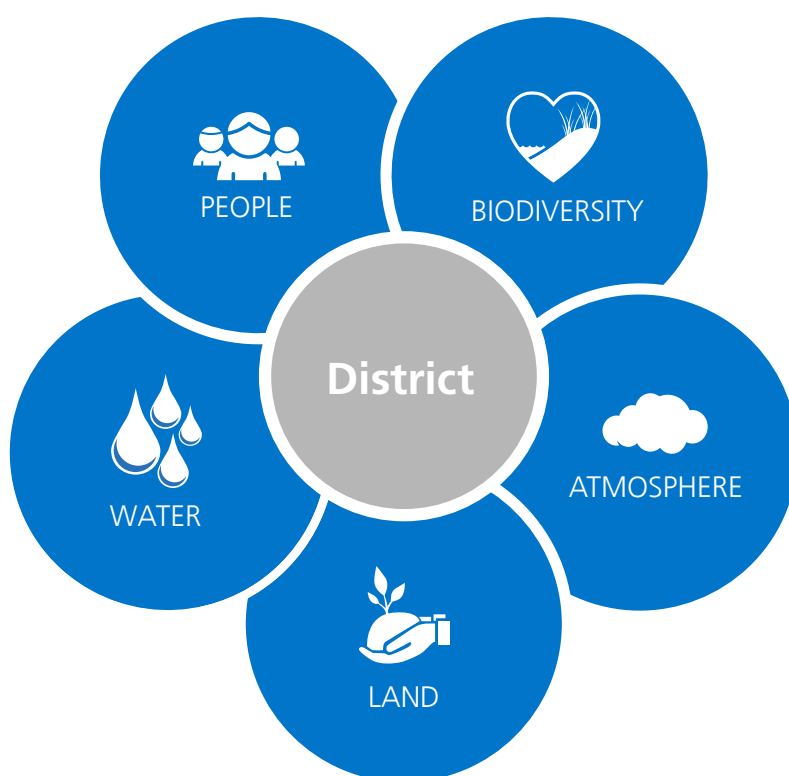
The Asset Classes and their associated Resource Condition Targets (RCTs) span the whole region in their focus. While each Asset Class exists in each district, it is how they are represented in the landscape and how they interact with each that is different. Each asset class has at least one associated RCT that has the underlying intent of sustainably managing the natural resources that are in good condition and improving those that are in a degraded condition. This is to be achieved while maintaining or improving socio-economic outcomes. The RCTs in the Regional NRM Plan are ambitious, challenging in nature and provide a broad indicator of health. They align with state-wide natural resources management targets that aim to result in healthy, functioning natural systems.

Extensive work carried out with the community in 2009 identified that the region's natural resources could be categorised into five Asset Classes: Water, Biodiversity, Land, Atmosphere and People. A vision was developed for each asset class, long-term Resource Condition Targets (RCTs) were defined, and the stepping stones to achieve the short term goals were identified in the form of


Management Action Targets (MATs). This process recorded the cause and effect relationships between each of these components and documented the assumptions and theory of change to natural resource condition. This plan adopts the five Asset Classes and their associated visions from 2009. The RCTs have been retained to describe the 20-year outcomes desired at a regional scale and to set the direction for the development of actions and investment in the Regional Action Plan.

It is difficult to quantify the exact degree of change to be achieved with the 2009 RCTs as there is often insufficient information to accurately determine baselines, trends or rates of change. For this reason, the RCTs have been refined and improved with regard to their measurability, relevance and achievability. RCTs were reviewed to apply an agreed criterion of being: Specific, Time-bound, Appropriate and Aspirational for the region. The process also reviewed RCTs for gaps, overlaps, redundancies, threats and opportunities. The RCTs will be supported by output focused Management Action Targets (MATs) which set out the degree of change to be achieved within the timeframe of the Regional Action Plan. The Regional Action Plan will describe how each of the districts contributes to the achievement of the region-wide RCTs. The amended RCTs for each asset are presented below.

**Figure 3. Asset Classes of the SA MDB NRM Region**



### 3.4.1 Water

WATER		
	<b>Vision</b>  Water resources that are healthy, valued and supporting of communities and thriving ecosystems	<b>Resource condition targets</b>  W1: All water resources are managed sustainably by 2030  W2: Improve water quality to meet regional water needs by 2030  W3: Water is available and managed to enhance and maintain the ecological function and resilience of water dependent ecosystems by 2030

#### Asset Components

Surface water; wetland and floodplain ecosystems; riverine ecosystems; estuarine, coastal and marine ecosystems; and groundwater.

#### Asset description

The River Murray is the most significant water resource in the region and the principal water resource for South Australia. Other groundwater and surface water resources within the region are important to the ecology and economies of the areas in which they occur <sup>(33)</sup>.

These include tributaries and groundwater systems in the Eastern Mount Lofty Ranges, groundwater systems in the Mallee, and ephemeral flows in the Rangelands. These water resources support significant aquatic habitats along the entire length of the River Murray, Lower Lakes, Coorong and Murray Mouth, along with habitats in other parts of the region such as the Mount Lofty Ranges and the nationally significant Fleurieu Swamps. Wetlands of international significance are described in Table 2. The interaction between surface water and groundwater resources is significant throughout the region in an otherwise dry environment.

**Table 2 Wetlands of international significance**

Wetland and Ramsar Summary Description		
Coorong, Lake Alexandrina and Lake Albert	Riverland Wetland Complex (including Chowilla Floodplain)	Banrock Station Wetland Complex
An area that includes a national park, game reserves, Crown Land and a shorebird network site. A saline to hyper saline lagoon separated from the ocean by a dune peninsula and connected to two lakes forming a wetland system at the river's mouth. The lakes contain fresh to brackish water and provide a variety of permanent and ephemeral wetlands. The site is of international significance for migratory water birds, providing habitat for more than 30 per cent of the waders summering in Australia. The site includes important nesting colonies of cormorants, herons, egrets, ibises and terns. The globally endangered Orange-bellied Parrot winters in the reserve. Human use includes camping, boating and regulated duck hunting. The area is noted for its extensive Aboriginal, historic and geological sites.	Part of the River Murray system consisting of various wetland types, including channels, anabranches, billabongs, floodplains, swamps and lakes. Home to one of the major water bird breeding areas in south eastern Australia. Many birds nest in the River Red Gum forests bordering the river. The forests support a rich flora and fauna and attract many tourists. The site is used for grazing, but tourism is the major industry. Surrounding areas support agriculture, horticulture and grazing.	A flood plain wetland that serves as a unique example of site restoration in the Murray-Darling depression to a near natural hydrological regime. Severely degraded after 67 years of permanent inundation, the water regimes were restored by reinstating wetting and drying cycles that are semi-natural. The site supports several regional or nationally threatened species including the Regent Parrot, Southern Bell Frog and River Snail. The area provides seasonal habitat for at least eight species of migratory water birds and an important pathway for fish migrating around the Lock 3 fish barrier during spring floods. The warm shallow flood waters provide fish breeding and nursery habitats. The site is adjacent to Banrock Station Wines who manage this wetland complex.



The River Murray provides the required water resources to support the domestic, industrial, livestock and irrigation demands of the region and other areas of the state. Water exported from the region supports the needs of country towns, farming and industry in areas as far away as the mid-north, Clare Valley, Barossa Valley, Yorke Peninsula, Port Pirie, Whyalla, Port Augusta, upper Eyre Peninsula and Keith. River Murray water also provides approximately 40 per cent of Adelaide's annual mains water needs, increasing to 90 per cent if required during drought. <sup>(34)</sup> Away from the River Murray corridor water is captured and diverted from tributary streams including the Marne, Angas, Bremer and Finnis Rivers and Saunders, Tookayerta and Currency Creeks. In these areas an increasing number of farm dams have reduced the volume of water available for downstream users, including the environment.

Groundwater is extracted from selected aquifers and is important to agriculture in the Angas–Bremer Catchment and irrigation, stock and domestic uses in the Mallee regions. In the Eastern Mount Lofty Ranges, use of groundwater and surface water resources for irrigation, stock and domestic use presents a significant management issue as water capture from some catchments and aquifers has exceeded sustainable levels. This has contributed to the degradation of these water resources including salinisation and ecosystem decline <sup>(33)</sup>.

In 2012, flooding in Queensland and upper catchment areas resulted in higher than normal flows in to South Australia, bringing an end to an extended period of drought for the region. Wetlands and ephemeral systems are now showing signs of recovery and groundwater levels throughout the region have mostly returned to historical levels. High salinity levels remain a key problem along the lower section of the River Murray, especially in Lake Albert. The impact of acid sulphate soils remains a problem in the Lower Murray Reclaimed Irrigation Areas and in parts of the lower lakes.

This plan recognises that water is important to all Aboriginal people in the region. Beliefs relating to water and the way they are expressed by Traditional Owner groups and other Aboriginal peoples in the region may vary. For example, the Ngarrindjeri state the following in relation to the relevance of water:


*The Meeting of the Waters is a fundamental aspect of the Ngarrindjeri world where all things are connected, whether they are living, from the past and/or for future generations. The Meeting of the Waters makes manifest core concepts of Ngarrindjeri culture that bind land, body, spirit, and story in an integrated, interfunctional world. The principles that flow from this cultural system are based upon respect for story, country, the old people, elders and family. The pursuit of these principles is contingent upon maintaining a relationship with country.* <sup>(35)</sup>

#### Major threats to the Water Asset Class:

- the taking of surface and groundwater resources for consumptive use leading to water sharing issues between consumptive users and insufficient water for aquatic ecosystem health
- declining water quality due to increasing nutrient loads, turbidity, erosion, sedimentation, and chemical and biological contamination associated with poor land management practices
- pollution from stormwater and wastewater discharges
- sulfuric acid and high concentrations of trace metals in surface water caused by the re-wetting of acid sulphate soils that have dried and oxidized as a result of lowered water levels
- increasing settlement and development pressures
- salinisation of fresh water caused by saline discharges from local and regional groundwater
- changes to hydrological flow regimes in rivers through locks, weirs and other diversions
- inability or reduced capability of natural systems to adapt to a changing climate regime
- loss of natural aquatic and riparian ecosystems and irrigated horticulture plantings due to severe and prolonged drought
- infestations of aquatic pest plant and animals.



### 3.4.2 Biodiversity

BIODIVERSITY		
	<b>Vision</b>	<b>Resource condition targets</b>
	<p>A healthy and ecologically productive environment that sustains biodiversity and is valued by the community</p>	<p>B1: Increase the ecological function and resilience of native ecosystems by 2030</p> <p>B2: Native species and ecological communities at lower or no greater risk of extinction by 2030</p>

#### Asset Components

Vegetation communities, water-dependant ecosystems, native flora, native fauna, fungi and micro-organisms, ecosystem functions, ecosystems services, and threatened species and communities.

#### Asset description

Biodiversity refers to the variety of natural organisms, including plants, animals and micro-organisms, and the ecosystems of which they are a part. Healthy, functioning ecosystems are needed to conserve the region's unique biodiversity that supports economic activities and social needs. The region has a diverse range of biodiversity assets, including:

- a wide range of vegetation communities consisting of more than 2000 different plant species, such as Mallee, chenopod shrublands, woodlands, saline and freshwater wetlands, herblands and grasslands <sup>(33)</sup>
- more than 550 native fauna species, including 95 mammal, 112 reptile, 13 frog, 31 freshwater fish and more than 320 bird species <sup>(33)</sup>

- unique landscape features such as the Fleurieu Peninsula Swamps, the Coorong and Lower Lakes, large tracts of intact remnant vegetation of the Billiatt, Ngarkat and Dangalli complexes, swathes of temperate grasslands and the rocky outcrops and woodlands along the Mount Lofty and Olary ranges.

The extent, condition and connectivity of ecological communities play an important role in determining the ability of a species or ecosystem to be resilient to change or impacts. It should be noted that the number of threatened species and ecological communities in the region is large and growing.


South Australia is a fire-prone and fire-adapted landscape and fire will always be a part of the state's future. Fire plays an important role in shaping the biodiversity and ecosystem processes in native vegetation, but can have significant economic and social consequences. The challenge for land managers and communities is to balance the ecological need for particular fire regimes with the negative economic and social impacts that may occur.

#### Major threats to the Biodiversity Asset Class:

- historical native vegetation fragmentation and declining ecosystem health of remnant populations such as extinction debt
- current and continued native vegetation clearance
- fragmentation of ecosystems
- river and dryland salinity
- grazing impacts
- pest plants and animals and disease impacts
- inappropriate fire regimes
- unnatural water regimes
- water pollution
- mining impacts
- tourism and recreational use of natural resources
- inability or reduced capability of natural systems to adapt to a changing climate regime
- urban growth.



### 3.4.3 Land

LAND		
	Vision	Resource condition targets
	Sustainable, productive landscapes	L1: Protect and improve soil and land to support the productive capacity and natural resources of the region by 2030

#### Asset Components

Soils, rural landscapes, agricultural systems, pest plants and animals, land-use (e.g. peri-urban development), geological features and mineral deposits.

#### Asset description

The region's land assets support productive dryland agriculture and grazing enterprises that underpin a large part of the regional economy <sup>(33)</sup>. Annual cropping activities (including rotational grazing production) account for around 19 per cent of land use in the region and occur primarily in the Murray Mallee, Murray Plains and parts of the Eastern Mount Lofty Ranges. Grazing enterprises account for around 46 per cent of land use in the region and occur primarily on the South Olary Plains (a pastoral area north of the River Murray), the Murray Mallee, Murray Plains and the higher rainfall areas of the Eastern Mount Lofty Ranges <sup>(20)</sup>. Other land assets of the region include conservation parks, irrigated land, and urban land and infrastructure.

While all land use requires access to soil, agriculture causes soil properties to change from their natural state. Agricultural practice aims to reduce water repellence and increase fertility, which can dramatically reduce soil health, including its structure, biota, pH, cation and anion concentrations and stability.

The soils of the region vary significantly by location. Common soils types include calcareous soils in the Murray Mallee and Murray Plains, and deep sands and shallow soils on calcrete in the Murray Mallee, Murray Plains and Coorong and Lower Lakes areas. Approximately 76 per cent of the region's soils are of moderately low to very low inherent fertility (25 per cent have low to very low inherent fertility) and require judicious management to maintain good plant nutrition. Many soils are susceptible to erosion, particularly when left unprotected without adequate surface cover. Many of the lighter duplex soils of the Eastern Mount Lofty Ranges are highly vulnerable to soil acidity. Approximately 16 per cent of soils, predominantly in the Eastern Mount Lofty Ranges and near Lameroo, are at high risk of breakdown in soil structure that leads to hard pan surface crusts and reduced infiltration <sup>(33)</sup>.


Considerable progress has been made in improving farming practices throughout the region to reduce or manage risks to soils. One key indicator of success in managing soil conditions is a measure of the amount of rainfall used by crops, commonly referred to as "Water Use Efficiency" (WUE). While levels of WUE are generally good across the region, there is still scope for improvement which suggests that there are some ongoing limitations in soil conditions. Dryland salinity is a concern in parts of the region, particularly around the Lower Lakes. The areas affected by dryland salinity are expected to increase over time as the total effects of land clearance on rates of groundwater renewal have yet to be established. Pest plants and animals threaten natural biodiversity and present a major risk to the productive and sustainable use of the region's landscapes. Many pests have adapted to the area and reproduce successfully alongside native species making widespread management impractical. For this reason an "asset-based" approach is used to minimise their impacts on high value assets only.

#### Major threats to the Land Asset Class:

- wind erosion
- water erosion, including foreshore erosion and river bank slumping
- pest plants and animals
- inappropriate land management
- over grazing
- dryland salinity
- soil acidity
- acid sulphate soils
- declining soil physical condition
- water repellence
- inability or reduced capability of natural systems to adapt to a changing climate regime
- other nutrient deficiencies and toxicities.



3.4.4 Atmosphere

ATMOSPHERE		
	<b>Vision</b>  A clean and healthy atmosphere with effective adaptation to climate change	<b>Resource condition targets</b>  A1: Reduce net greenhouse gas emissions in the SA Murray-Darling Basin in line with state targets by 2030  A2: All natural resource managers have the capacity to adapt to climate change impacts by 2030

Asset Components

Traditional weather patterns such as temperature, precipitation, humidity wind speed and direction and evaporation rates.

Asset description

The Earth’s atmosphere protects plants, animals and humans from the Sun’s harmful rays, regulates the Earth’s surface temperature and influences global weather conditions. The state of the climate is fundamental to the management of natural resources in the region. It is a key factor influencing the quality and distribution of the region’s native flora and fauna, water regimes, farming systems and even settlement patterns.



While greenhouse gases are produced from both human activities and natural systems, it is since the industrial revolution, the burning of fossil fuels and extensive clearing of native forests has contributed to a 40% increase in the atmospheric concentration of carbon dioxide. Human activities have impacted on the atmosphere and caused significant climate change <sup>(36)</sup>.


Land clearing and pollution generated by human activities has impacted on the atmosphere; with local and global effects <sup>(36)</sup>. Global warming over the 20th century has produced the hottest global average temperatures in history, with scientists concluding that the period from 1971 to 2000 was warmer than any other time in nearly 1400 years <sup>(37)</sup>. The average yearly temperature in South Australia has risen by almost one degree in the past century, and the last decade was South Australia’s warmest on record <sup>(38)</sup>. Projections for the South Australian Murray-Darling Basin indicate a trend of increasing temperatures (between 0.8 and 2 degrees annually by 2030) and decreasing rainfall (an annual reduction of 3.5 per cent by 2030 and a further 10 per cent by 2070) <sup>(39)</sup>.

Protecting the atmosphere may seem a daunting task given its global scale, but effective action can and must be taken at a local level. Climate change poses a real and long-lasting threat to the region, with major implications for the way natural resources are managed at the local level. Irrespective of current mitigation actions, adaptation to climate change will be an ongoing challenge.

Major threats to the Atmosphere Asset Class:

- expected ongoing warming of the region
- expected ongoing drying of the region
- expected increase in climate variability.

### 3.4.5 People

PEOPLE		
	<b>Vision</b>	Resource condition targets
	Communities contributing to the management of natural resources	P1: People have the capacity to manage natural resources sustainably by 2030 P2: Increase protection and preservation of Aboriginal culture through participation of Aboriginal people by 2030 P3: All planning, policy and investment decisions consider natural resources management (ecological, social and economic) by 2030

#### Asset Components

Private landholders, volunteer groups, Traditional Owners, school children, local government, non-government organisations, industry groups and members of the community interested in or impacted by natural resources management in the region.

#### Asset description

The People Asset includes everyone who lives and works in the region, those who regularly visit the region, and those who live outside the region but depend on its natural resources<sup>(33)</sup>. The health and robustness of these communities is closely linked to the health and robustness of the region's natural resources. Good NRM requires balance—an understanding of the pressures people place on natural resources, as well as an understanding of the pressures people themselves face. With this in mind, effective engagement, education, training and planning can be customised to equip people to work in partnership to implement NRM working towards long-term regional outcomes. The key focus for the People asset is to increase community capacity to better manage natural resources. With the right knowledge and skills, farmers, other land managers, industry groups, schools, community groups and individuals can make a significant contribution in this area.

Better engagement of Aboriginal communities is essential to achieving the vision for the People asset. Aboriginal people have lived in the region for tens of thousands of years. Community volunteers are also critical to achieving natural resources management outcomes, as they bring life to the region's activities by offering their precious time and resources.

While people are essential to the future of the region's natural resources, they also place immense pressure on them. These pressures include population growth and recreation and tourism. Strong population growth is expected in parts of the region closest to Adelaide and along the transport corridor to Murray Bridge, consistent with South Australia's Strategic Plan Target to increase the state's population to 2 million by 2027<sup>(40)</sup>.

Rural communities in the region are under considerable pressure from a range of immediate and long-term drivers. These include market forces and failures, the amalgamation of farms, lack of farm succession, and continuing fluctuations in weather conditions.

Research suggests that three key areas need to be addressed when trying to foster greater community involvement in managing natural resources:

1. *Volunteer exhaustion:* Communities play an increasing role in implementing natural resources management and this places a significant demand on a community's resources and time. Burnout often occurs when volunteers feel that their involvement didn't result in any biophysical change, or that funding was insufficient to achieve change<sup>(41)</sup>. Supporting volunteer groups with resources and certainty of funding is an important step in mitigating this problem<sup>(42)</sup><sup>(43)</sup>.
2. *Lack of consultation and ownership of problems:* Communities are more likely to accept policy changes that affect them when they are involved in the decision making process<sup>(44)</sup>. Clarifying facts and community values is an important step when making decisions about how to manage natural resources.
3. *Local and scientific knowledge:* It is essential to provide land managers with reliable, professional information to encourage change in practice. However, evidence suggests that landholders can be suspicious of scientific knowledge provided by government agencies. They can also be reluctant to allow agency staff on their property if the staff person also has a regulatory role<sup>(45)</sup><sup>(46)</sup><sup>(44)</sup>. The provision of reliable information, training days, demonstrations and field days can assist in rebuilding confidence within this sector of the community.

#### Major threats to the People Asset Class:

- burn out within the community, including volunteers
- economic drivers, including market forces and failures
- differing values on natural resources management
- lack of skills, knowledge and information to adequately manage natural resources
- loss of Aboriginal traditional knowledge
- socio-economic pressures resulting from climate changes and variability
- limited community understanding of climate change and its environmental, economic and social impact
- challenges associated with adapting to changes in climate.

### 3.5 Ranges to River district

Figure 4. Ranges to River district





- 1 The shallow soils over calcrete and low rainfall of the Rangelands (pastoral country) makes this area suited to grazing of native and modified pastures.
- 2 Though the remaining native vegetation in the Eastern Hills is fragmented, grassy ecosystems are national priority for management. They include Peppermint Box Grassy Woodlands and Iron-grass temperate grasslands.
- 3 Although grazing is the dominant land use of the Rangelands (pastoral country), there significant areas of protected native vegetation that provides habitat for a range of notable species such as the Southern hairy-nosed wombat..
- 4 The Lower River Murray is an important recreation and tourism area and supports a range of flora and fauna such as Murray cod, Yabby and Australasian darter.
- 5 The calcareous loams and loams over calcrete of the Western Murray Mallee are primarily used for dryland cereal cropping and grazing.
- 6 The elevated hills and valleys of the Eastern Hills have shallow soils over rock that supports grazing over improved pastures.
- 7 The Lower Murray Swamps have supported a significant dairy industry, although the industry has recently been in decline due to drought and commodity prices.
- 8 Higher rainfall areas of the Eastern Hills are used for more intensive activities such as grazing improved pastures and vineyards.
- 9 Surface water and groundwater resources of the Eastern Hills not only support a range of productive land uses but are also important for a range of biodiversity assets such as the nationally important Fleurieu Swamps.
- 10 The Murray Lakes and Coorong wetland complex is important to a range of national and international migratory waterbirds. Freshwater wetlands and associated emergent vegetation are particularly important for a range of threatened flora and fauna.
- 11 The freshwater of the Murray Lakes and Coorong supports a dairy industry and multi-species commercial fishing industry.
- 12 The calcareous soils of the Southern Mallee, with rainfall between 300mm and 500mm, are used for cereal cropping (primarily in the east) and grazing (primarily in the west). The remaining native vegetation in the western parts provides important habitat for many threatened species.
- 13 The sandier soils of the Northern Mallee, with rainfall between 240mm and 300mm, are primarily used for rotational cereal cropping and stock grazing. Native vegetation is fragmented but largely protected as public reserves or Heritage Agreements. Mallee shrublands on sandier soils are particularly important for birds at risk of local extinction.

#### Aboriginal values

Aboriginal values: This region supported large populations of Aboriginal people, who flourished with fertile hunting grounds. The lakes, rivers, wetlands were highly valued as a food source and life line for Aboriginal people. Along these areas are traditional hunting and camping grounds, the abundance of good food and water allowed for rich cultural practices to develop, the animals in this region are significant to traditional owners through a totem connection, there are many middens, burial sites, scar trees and gathering sites throughout the region. Many of these cultural practices continue to this day.

## Ranges to River community values

1. Science and experience: we use knowledge, passion, inclusiveness, inspiration and education to connect people and the environment.
2. Maintaining the environment: we recognise that the environment is made up of complex interconnected systems.
3. Healthy country means healthy people: the environment provides cultural, spiritual and physical nurturing to meet the needs of people and provides the "everything" to our existence.
4. Intrinsic value of nature: Every form of life is unique, warranting respect regardless of its worth to man.



## 3.5.1 Landscapes, Lifestyles and Livelihoods

### 3.5.1.1 Landscapes

The Ranges to River district has seven distinct biophysical landscapes, some of which cross over into other districts. Each biophysical landscape requires a different management approach as per the following:

#### The Eastern Hills

Dominated by elevated hills and valleys formed from pre-Cambrian sedimentary rocks <sup>(47)</sup>, the Eastern Hills landscape is a naturally eroded environment. The soils tend to be shallow over rock with high relief and are susceptible to water erosion <sup>(48)</sup>. These soils are often associated with acidic sandy loams over clay on rock which can readily acidify <sup>(48)</sup>. These soil types and the topography limit broad-acre cropping in the Eastern Hills in comparison to the flat landscapes across the rest of the agricultural SA MDB NRM region <sup>(49)</sup>.

The major land use of this landscape is grazing of modified pastures, although more intensive activities like grazing improved pastures, horticulture and viticulture are important economic activities in the areas of higher rainfall. These historic patterns of land use have resulted in extensive levels of native vegetation removal, with 15 per cent of the landscape retaining native vegetation <sup>(30)</sup>. Much of this remaining native vegetation is likely to have a highly modified understorey through a combination of historical stock grazing, physical soil modification (nutrient addition) and introduced plants (particularly annual grasses) <sup>(50)</sup>.

The restoration of grassy ecosystems is a priority for nature conservation in this landscape and the broader Mt Lofty Ranges <sup>(51)</sup>. The grassy ecosystems include Peppermint Box grassy woodlands and Iron Grass natural temperate grasslands, both of which are listed as threatened ecological communities under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) <sup>(52)</sup>. Due to the proximity to Adelaide, an emerging land use issue in the southern parts of the landscape is the transition of many properties from primary production to residential and lifestyle use. This change in land use may have significant implications for how natural resources management outcomes are to be achieved in this landscape.

The Mt Lofty Ranges forms a significant rain shadow and rainfall varies over short distances in this landscape. Mean annual rainfall ranges from less than 300 millimetres to nearly 1000 millimetres depending on the location. The water resources of the Eastern Hills landscape include parts of the Eastern Mount Lofty Ranges Prescribed Water Resources Area, parts of the Marne River and

Saunders Creek Prescribed Water Resource Area, and unprescribed areas to the north. These water resources are comprised of surface water catchments (that form part of the Eastern Hills, Western Murray Mallee and River Murray Landscapes), and a number of different aquifers that contain underground water, including fractured rock and sedimentary aquifers <sup>(53)</sup>. These water resources support a number of significant biodiversity assets, including:

- the EPBC listed critically endangered Fleurieu Peninsula Swamps <sup>(52)</sup> and dependent threatened species such as the southern emu-wren *Stipiturus malachurus intermedius* and southern brown bandicoot *Isodon obesulus obesulus* <sup>(52)</sup>
- a number of threatened fish species including river blackfish *Gadopsis marmoratus*, southern pygmy perch *Nannoperca australis* and purple-spotted gudgeon *Mogurnda adspersa* <sup>(54)</sup>.
- Red gum terminal swamps located on the western Murray Plains <sup>(47)</sup>.

Recovery Plans have been developed at a national or regional level for some threatened species and ecological communities, including Iron Grass Natural Temperate Grasslands and the Southern Emu-wren.

The main human uses of the water resources in this system include irrigated horticulture in the Langhorne Creek wine region, intensive animal production, farm forestry, and stock and domestic consumption. Water consumption is likely to increase due to the potential expansion of farm forestry (including carbon farming), irrigated horticulture and intensive animal production, and increasing domestic demand as regional population's increase <sup>(53)</sup>. Managing potential conflicts among these uses, as well as the demands of water-dependent ecosystems, requires ongoing assessment and management.

#### The Western Murray-Mallee

Soils of the Western Murray Mallee biophysical landscape are variable and include calcareous loams, moderately fertile loams over calcrete, sand over poorly structured clay and gradational sandy loams <sup>(47)</sup> <sup>(48)</sup>. Annual rainfall in the area makes the land suitable for dryland cereal cropping and grazing <sup>(49)</sup> which has led to the extensive removal of native vegetation. This type of cropping and grazing has occurred most heavily where there are calcareous loam soils leading to the extensive modification of the ecosystems dependent on these soil types. While much of the mallee on these plains has been extensively cleared some significant remnants remain, including Ferries-McDonald Conservation Park <sup>(55)</sup>.



These remnants contain nationally threatened species that require ongoing protection such as the malleefowl (*Leipoa ocellata*)<sup>(52) (47)</sup>. Recovery Plans have been developed at a national or regional scale for some threatened species and ecological communities, including the malleefowl.

A number of drainage lines and terminal swamps occur within the loamy plains. These lines and swamps are rarely inundated with water, but tend to have higher clay content than the surrounding landscape. While still highly modified, these wetter systems retain a higher proportion of their dependent native biota, including declining woodland birds such as the diamond firetail *Stagonopleura guttata* and brown tree creeper *Climacteris picumnus*. However, as these systems appear to be declining, the restoration of these drainage lines and seasonally inundated terminal swamps is a conservation priority<sup>(47) (56) (57)</sup>.

### The Rangelands (pastoral country)

North of the Marne River, the Rangelands pastoral country biophysical landscape is dominated by shallow soils over calcrete<sup>(48) (49)</sup>. Agricultural activity in this area is mostly restricted to grazing native and modified pastures. For this reason the proportion of the landscape that contains remnant native vegetation is much higher than the Western Murray Mallee<sup>(49)</sup>. The ecosystems associated with these calcrete plains are mallee woodlands on slightly deeper soils, and open woodlands-shrublands on very shallow soils<sup>(57)</sup>. While grazing remains extensive in these systems there are a large number of significant protected areas, including Swan Reach and Brookfield Conservation Parks<sup>(55)</sup>, and privately-owned conservation reserves such as Yookamurra Sanctuary<sup>(58)</sup>. Notable species dependent on these ecosystems include the southern hairy-nosed wombat *Lasiorhinus latifrons*, splendid daisy bush *Olearia magniflora*, and threatened bird species including bush stone curlew *Burhinus grallarius* and malleefowl *Leipoa ocellata*<sup>(47)</sup>.

The systemic conservation issue in this landscape is the impact that total grazing and browsing pressure has on the ground layer and understorey, and subsequent modifications due to competition by introduced weeds such as onion weed *Asphodelus fistulosus*<sup>(56) (57)</sup>. Management of grazing and browsing and restoration of understorey structure and function in overgrazed areas are priority actions for conservation across this landscape.

### The Lower River Murray

The section of the River Murray that flows through the landscape of the Ranges to River district is part of the River Murray Prescribed Water Resource. It is comprised of the lower gorge (from Blanchetown to Mannum) and the lower Murray swamps (Mannum to Wellington) that flow into the lower lakes and Coorong. The area of floodplain and wetland in the gorge section is small compared with the River Murray section that flows through the landscape of the Riverland district. Steep limestone cliffs and highland plains constrain this section of the River Murray. Below Blanchetown the river forms a single weir pool between Lock 1 and the Coorong Barrages and flow into this section of the river is regulated by the operation of these two structures<sup>(59)</sup>.

While agriculture in the gorge is less dependent on the surface water resources of the River Murray, compared to the Riverland, some irrigated agriculture still occurs. In recent history, the lower Murray swamps supported a significant dairy industry on the modified floodplains of this section of the river. The size of this industry has been significantly reduced through a combination of commodity prices and the impacts of recent prolonged drought. The channel and associated wetlands and floodplains provide critical services to the social and economic values of the Ranges to River district and are an important recreational and tourism area in South Australia.

Ngaut Ngaut Conservation Park is located in the Lower River Murray on the east bank downstream from Nildottie Township and has great cultural significance for the descendants of the Nganguraku and Ngaiwang people (members of the Ngarrindjeri nation). Ngaut Ngaut Conservation Park was proclaimed in 1976 to conserve and protect Aboriginal heritage and a co-management agreement between the Government of South Australia and Mannum Aboriginal Community Association Incorporated was established in 2005<sup>(60)</sup>.

A range of biodiversity, particularly those species that depend on the main channel of the river such as the Murray cod *Maccullochella peelii*, yabby *Cherax destructor*, and Australasian darter *Anhinga novae-hollandiae*. Red gum woodlands associated with the lower Murray also provide important nesting habitat for the regent parrot *Polytelis anthopeplus*<sup>(47)</sup>. Recovery Plans have been developed at a national or regional level for some threatened species and ecological communities, including the Murray cod and regent parrot.

The River Murray ecosystems rely on appropriate timing, duration and volume of water delivery from upstream (Queensland, New South Wales and Victoria), and effectively managed local water delivery infrastructure.



A key emerging issue for the management of natural resources in the district will be the implementation of the Murray-Darling Basin Plan ('The Basin Plan')<sup>(85)</sup>. The plan will outline how water delivery and infrastructure will operate in the landscape and this is likely to be a stronger driver of outcomes for local systems than other emerging threats like climate change<sup>(90)</sup>. Like other landscapes across the South Australian Murray-Darling Basin, a key future challenge will be to demonstrate how water can be managed to support both social and ecological resilience in this landscape.

### The Southern Mallee

Most of the Southern Mallee biophysical landscape<sup>(47)</sup> is located within the Mallee-Coorong district, with a small portion to the east of the River Murray near Murray Bridge occurring in the Ranges to River district. The Southern Mallee contains a mixture of calcareous soils in the west and sandy and loamy soils in the east<sup>(48)</sup>. These soils, coupled with an average annual rainfall of between 300 and 500 millimetres, have resulted in much of the landscape being used for cereal cropping and grazing introduced pasture<sup>(49)</sup>.

The high suitability of the Southern Mallee for agriculture has led to the extensive removal of native vegetation, with only 5.5 per cent of the original native vegetation remaining<sup>(30)</sup>. Much of this relictual vegetation is concentrated in the west of the landscape where soils become shallow and have a calcrete cover<sup>(48)</sup><sup>(30)</sup>.

Ecosystems associated with the west of this landscape appear to be at risk of irreversible decline, with the primary driver of this decline being the ongoing impact of vegetation clearance and fragmentation<sup>(47)</sup><sup>(56)</sup><sup>(62)</sup>. Species at risk include malleefowl *Leipoa ocellata*, metallic sun orchid *Thelymitra epipactoides*, sand hill greenhood *Pterostylis arenicola*, and a number of woodland bird species, including hooded robin *Melanodryas cucullata*, brown treecreeper *Climacteris picumnus* and restless flycatcher *Myiagra inquieta*. Restoration of the open woodlands associated with these western calcareous soils is a conservation priority in this landscape.

### The Northern Mallee

The Northern Mallee biophysical landscape is found in the landscapes of the Mallee-Coorong and Riverland districts, with a small portion to the east of the River Murray around Swan Reach<sup>(47)</sup>. The Northern Mallee consists of a series of primarily longitudinal siliceous dunes embedded within a matrix of primarily calcareous loams<sup>(48)</sup><sup>(62)</sup>. Rainfall is lower in this northern landscape with a mean annual rainfall of 240 to 300 millimetres. Water availability is higher in the sandier soils<sup>(62)</sup><sup>(63)</sup> which have been preferentially targeted for dryland agriculture, particularly rotational cereal cropping and stock grazing<sup>(49)</sup>. The combination of low rainfall and sandy soil texture means that these soils have a high inherent risk of wind erosion that needs to be managed by maintaining vegetation cover, particularly through summer<sup>(48)</sup>.

Approximately 18 per cent of the area's remaining vegetation<sup>(30)</sup>

is fragmented, with much of this vegetation protected as public reserves or private Heritage Agreements<sup>(55)</sup><sup>(58)</sup>. While the open mallee ecosystems associated with the calcareous loams appear to be relatively stable, the mallee shrublands associated with sandier soils appear to be declining and at risk of losing dependent native biota. This includes a number of bird species that are at risk of local extinction in this landscape, including the southern scrub robin *Drymodes brunneopygia*, shy heathwren *Hylacola cauta*, purple-gaped honeyeater *Lichenostomus cratitius* and malleefowl. The restoration of mallee shrubland ecosystems associated with deep sands is a conservation priority in this landscape<sup>(47)</sup><sup>(56)</sup><sup>(62)</sup>.

### The Lower Lakes and Coorong

The Lower Lakes and Coorong biophysical landscape<sup>(47)</sup> crosses into the landscape of the Mallee-Coorong district and is part of the River Murray Prescribed Water Resource. It is dominated by Lake Alexandrina, Lake Albert and the northern parts of the Coorong. These systems form the estuary of the Murray-Darling Basin and are an internationally recognised wetland complex under the Ramsar Convention due to their importance for a range of national and international migratory waterbirds<sup>(64)</sup><sup>(65)</sup><sup>(66)</sup>. The lakes are separated from the Coorong by a series of barrages that maintain lake water levels and prevent the incursion of marine water<sup>(67)</sup>. The maintenance of the relatively freshwater environments of the lakes is important both ecologically and socio-economically.

The lakes in their current state continue to support a number of freshwater-dependent ecosystems and species that are found nowhere else in the Lower Lakes, Coorong and Murray Mouth Ramsar Site. In particular, the freshwater wetlands and associated emergent vegetation are critical habitat for a range of threatened species, including the southern pygmy perch *Nannoperca australis*, murray hardyhead *Craterocephalus fluviatilis*, Australasian bittern *Botaurus poiciloptilus*, and southern bell frog *Litoria raniformis*<sup>(52)</sup>. Recovery Plans have been developed at a national or regional level for some threatened species and ecological communities, including the murray hardyhead.

The availability of freshwater supports a dairy industry dependent on irrigated pasture, as well as a commercial fishery that depends on freshwater native species such as Golden Perch *Macquaria ambigua* and bony bream *Nematalosa erebi*, and the introduced fish redfin perch *Perca fluviatilis* and European carp *Cyprinus carpio*<sup>(68)</sup>.

Maintaining a hydrological connection between the fresh water lakes and saline Coorong is critical for the maintenance of the aquatic ecosystems<sup>(64)</sup><sup>(69)</sup>. The delivery of water from the River Murray to the Coorong usually maintains an open river mouth and, when delivered appropriately, supports water levels and water quality for the maintenance of native biota in the Coorong itself. The dependent bird fauna include the nationally threatened fairy tern *Sternula nereis*<sup>(52)</sup><sup>(70)</sup>, a permanent breeding colony (one of very few in Australia) of the iconic Australian pelican *Pelecanus*

*conspicillatus*, and a high diversity of local and international waders and other waterbirds <sup>(64)</sup>. A diversity of estuarine, diadromous and marine fish species also occur in the Coorong, including the commercially important yellow-eyed or Coorong mullet *Aldrichetta forsteri*, greenback flounder *Rhombosolea tapirina* and black bream *Acanthopagrus butcheri* <sup>(68)</sup>, and the ecologically important smallmouth hardyhead *Atherinosoma microstoma* <sup>(64)</sup>. Recent drought conditions necessitated a wide range of emergency activities to prevent species extinctions from the landscape, while the local dairy industry almost collapsed due to the combination of water availability and commodity prices. This highlights the consequences of inappropriate water management for the Lower Lakes and Coorong social and ecological systems. The key driver of social and ecosystem resilience in this landscape is the nature of the flow regime from the Murray-Darling Basin, which in turn is determined by how water resources are managed across the entire Basin.

### 3.5.1.2 Lifestyles

#### Population demographics

The landscape of the Ranges to River district covers 8551 square kilometres and is home to 79,286 people, which equates to approximately nine persons per square kilometre <sup>(16)</sup>. The district's population grew by 24 per cent between 2001 and 2011 <sup>(16)</sup>. The majority of the district's population reside in the urban centres of Murray Bridge (15,967), Mount Barker (14,452), Strathalbyn (5292), Nairne (4198), Mannum (2164), Mount Compass (1042), and the densely populated region around Goolwa (10,145) <sup>(17)</sup>. Significant growth has been experienced in all of these urban centres since 2001, including Mount Barker (59 per cent), Murray Bridge (23 per cent), Strathalbyn (65 per cent), and the coastal area around Goolwa (39 per cent). This increase is consistent with the 30-Year Plan for Greater Adelaide, which identifies Mount Barker, Murray Bridge, Goolwa and Hindmarsh Island as new areas for steady population growth, the construction of additional homes and the creation of jobs for South Australia <sup>(71)</sup>. Some growth was also experienced in the higher rainfall areas outside the urban centres <sup>(17)</sup>. The population has remained stable in the drier areas of the north and south-east around Murray Bridge.

An increase in the population of three of the four primary council areas of the Ranges to River NRM district is expected for the period 2006 to 2026. This includes a 33 per cent increase for the Rural City of Murray Bridge, a 62 per cent increase for the District Council of Mount Barker, and a 45 per cent increase for the Alexandrina Council. The Mid-Murray Council, which covers the majority of the northern half of the district, is expected to have very slow growth of less than 1 per cent. The median age for the district has increased from 37 to 42 years of age. The Goolwa and Mannum areas have the highest 2011 median age at 53 and 48 respectively <sup>(16)</sup>.

One quarter of households in the district do not have an internet connection, but 66 per cent have Broadband <sup>(19)</sup>.

#### Local government

Local government plays a significant role in managing natural resources and provides a key link to the broader community. Eight councils are located within the Ranges to River district. The entire council area of Alexandrina Council, District Council of Mount Barker, Rural City of Murray Bridge and Mid Murray Council is located within this district. Cross-regional councils that have small areas of land within the district are Adelaide Hills Council, the Barossa Council, City of Onkaparinga and City of Victor Harbor.

#### Community groups and volunteering

Community groups and volunteers play an important role in delivering natural resources management initiatives in the Ranges to River district. There are 55 volunteer organisations registered with Natural Resources SA MDB in the Ranges to River district, and more than 1100 registered volunteers who each undertake an average of 36 volunteer hours per year <sup>(27)</sup>.

#### Recreation and tourism

There are twelve recognised tourism regions in South Australia, five of which cover sections of the Ranges to River district. The Murraylands tourism region is the largest and includes the section of the River Murray from Blanchetown to Wellington. It also covers a large proportion of the Mallee-Coorong district and is a popular area for tourists and visitors, with peak periods in March to April and September to October. In 2010 to 2011, the region attracted 914,000 visitors with 608,000 overnight stays <sup>(28)</sup>. The region offers a range of recreational opportunities focussed on the River Murray and conservation areas such as Brookfield Conservation Park. Annual surveys indicate that from 2010 to 2012 a total of 10 per cent of visitors to the area undertook water activities or sports, 9 per cent participated in fishing, 7 per cent bushwalked, 9 per cent held picnics or barbecues, and 4 per cent undertook some other outdoor activity <sup>(29)</sup>.

Many visitor activities can place pressure on natural resources such as the River Murray and conservation areas. Examples of pressure include erosion from boat wash, loss of timber used for firewood and trampling of vegetation.



### 3.5.1.3 Livelihoods

#### Industry and employment

The Ranges to River district has a broad range of major employing industries. It is the only district where agriculture, forestry and fishing are not the highest employing industries (Graph 3.). Major contributors to employment in 2011 were health care and social services (12 per cent), manufacturing (12 per cent), retail trade (12 per cent), construction (8 per cent), and agriculture, forestry and fishing (8 per cent).

Employment in many Ranges to River industries remained relatively stable between 2001 and 2011, with the following exceptions:

- a decline in Agriculture from 15 per cent to 8 per cent
- a decline in manufacturing (from 15 per cent to 12 per cent)
- an increase in health care and social services 9 per cent to 12 per cent
- an increase in construction from 6 per cent to 8 per cent <sup>(16)</sup>.

The Murray and Mallee Region Plan identifies Murray Bridge and Monarto as locations to promote industrial growth as part of the Murray and Mallee regional vision <sup>(108)</sup>.

#### Land use trends

In 2008 <sup>(20)</sup> the major land uses in the district were grazing of modified pastures (46 per cent) and cropping (23 per cent). Other major land uses included nature conservation (4 per cent) and residential (2 per cent). Conservation areas were generally small fragmented areas formally protected by Heritage Agreements or gazetted under the *National Parks and Wildlife Act 1972*. The major change observed since 2003 <sup>(21)</sup> was the reduction in land used for irrigated modified pastures, particularly in the higher rainfall areas of the south-west. However, this land use class may include land in a rotation system that is under cropping at other times. Sheep and cattle grazing of modified pastures in the Eastern Hills has remained the major land use in this area since 2003, as the land is generally too steep or rocky for cropping.

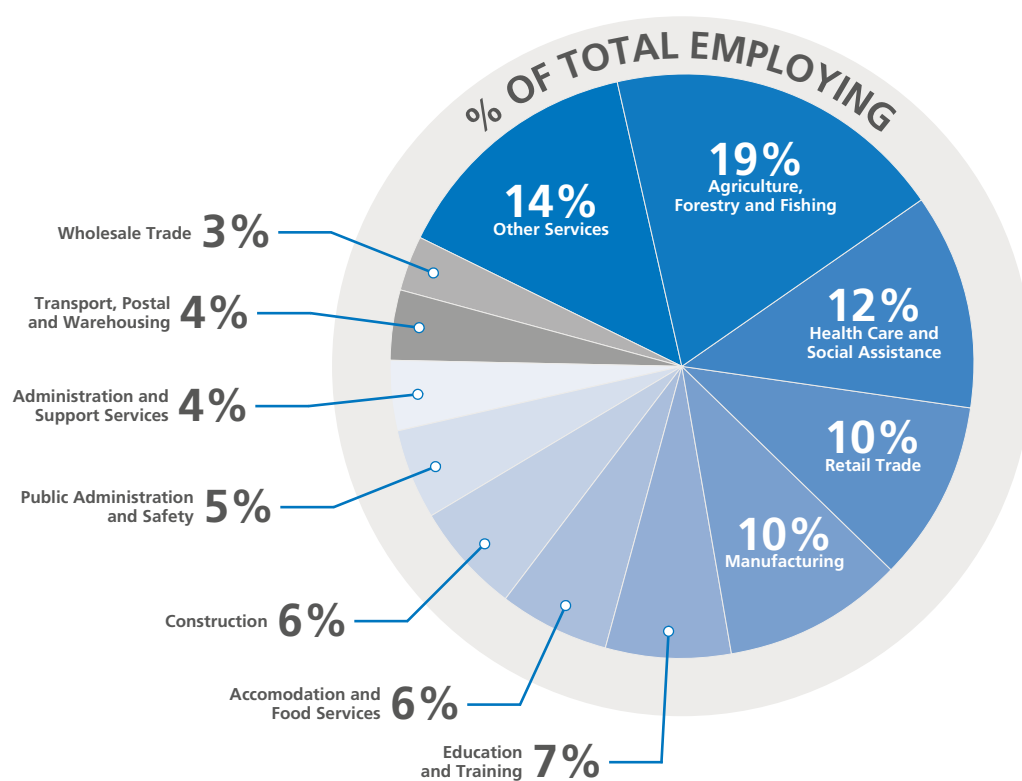
#### Landholder environmental issues

A 2010 <sup>(24)</sup> survey of commercial and lifestyle farmers in the Eastern Mount Lofty Ranges and Murray Plains identified weed control, pest animal control, water quantity and fire management as the main issues impacting on their farming enterprise. Approximately 54 per cent of these landholders had taken steps to conserve native vegetation; including planting native trees and shrubs covering around 13 per cent of their total land area, and fencing 18 per cent of native vegetation on their land to permanently prevent stock access.





Graph 3. Ranges to River main employing industries for 2011 <sup>(16)</sup>









#### 3.5.1.4 Community adaptive capacity

The Ranges to River district has an above average community adaptive capacity when compared to the state average. However, some communities within the region have significantly higher or lower capacities. A summary analysis for each of the capitals in the district is provided below.

**Physical Capital Index:** remoteness, population size, population change and internet access

The district's physical capital is slightly better than the state average. It is comparatively accessible, has above average internet access and has seen substantial population growth. This is balanced against a smaller than average population.

**Economic Capital Index:** economic diversity, median household income, income/housing cost, unemployment and mean household size. The district's economic capital is below the state average. It is a relatively expensive place to live when comparing average income to housing costs, the median household income is relatively lower than the state average, and household sizes are relatively larger. This is balanced by an economic diversity equal to that of the state and an unemployment rate that is relatively low.

**Human Capital Index:** percentage graduates, population 65 and over, percentage completed high school, one parent households, lone person households and females in non-routine occupations

The district's human capital is comparable to the state. It has a very slightly higher proportion of elderly people, a lower number of people who have completed high school and a slightly below average number of women in managerial or technical occupations. This is balanced by an equal proportion of graduates as the state average, lower than average single parent families and lower than average lone person households.

**Social Capital Index:** voluntary work. The district's social capital is slightly above the state average. The level of volunteering is above average, which is an indication of a socially cohesive community.

### 3.6 Mallee – Coorong district

Figure 5. Mallee-Coorong district





- 1 The calcareous soils of the Southern Mallee, with rainfall between 300mm and 500mm, are used for cereal cropping (primarily in the east) and grazing (primarily in the west).
- 2 The remaining native vegetation in the Northern Mallee is fragmented but largely protected as public reserves or Heritage Agreements. The mallee shrublands associated with sandier soils is particularly important for birds at risk of local extinction.
- 3 The sandier soils of the Northern Mallee, with rainfall between 240mm and 300mm) are primarily used for rotational cereal cropping and stock grazing.
- 4 The sandy and loamy soils of the eastern portion of the Southern Mallee, and availability of groundwater from the Murray Group Limestone Aquifer, supports irrigated cropping (particularly potatoes).
- 5 Native vegetation of the Lowan Mallee provides habitat for many threatened flora and fauna, and is popular for bird watching and four wheel driving. The Ngarkat shrublands are also used by the apiary industry in the production of honey.
- 6 Though fragmented, the remaining native vegetation of the western parts of the Southern Mallee provides important habitat for many threatened species.
- 7 The freshwater of the Murray Lakes and Coorong supports a dairy industry and multi-species commercial fishing industry.
- 8 The Murray Lakes and Coorong wetland complex is important to a range of national and international migratory waterbirds. Freshwater wetlands and associated emergent vegetation are particularly important for a range of threatened flora and fauna.

### Aboriginal values

Aboriginal values: This region supported large populations of Aboriginal people, who flourished with fertile hunting grounds. The lakes, rivers, wetlands were highly valued as a food source and life line for Aboriginal people. Along these areas are traditional hunting and camping grounds, the abundance of good food and water allowed for rich cultural practices to develop, the animals in this region are significant to traditional owners through a totem connection, there are many middens, burial sites, scar trees and gathering sites throughout the region. Many of these cultural practices continue to this day.

## Mallee – Coorong community values

1. Family history and future generations: We are deeply connected to the past, present and future of this land. Our experience is steeped in tradition and through the passing of time. We plan and maintain hope for future generations to ensure these traditions continue.
2. Understanding different perspectives: We acknowledge different cultures and incorporate different points of view into our decision making. We work together to achieve common goals and learn from our experiences.
3. Agricultural viability: Food production is important for the future of our community. We embrace new technology, research and development to improve our practices in the stewardship of our natural resources.
4. Ecosystem services: We rely on the natural resources and processes provided by this landscape. We value the services that regulate our climate, support the cycles of life and provide cultural, spiritual and recreational benefit that connect our families and community.



## 3.6.1 Landscapes, Lifestyles and Livelihoods

### 3.6.1.1 Landscapes

The Mallee-Coorong district encompasses a number of distinct biophysical landscapes that also overlap with other districts. The biophysical variation within the landscape determines the natural resources issues that impact on the social, economic and ecological values of the area.

#### The Lowan Mallee

The Lowan Mallee biophysical landscape <sup>(47)</sup> is dominated by deep, bleached siliceous sands that are among the least suitable soils for dryland agriculture in South Australia <sup>(48)</sup>. These soils are inherently sensitive to wind erosion <sup>(48)</sup> and soil mobilisation can occur through the removal of vegetation either mechanically or through processes such as large scale fire. The inherent infertility of these soils has led to gradients and buffers of modified native habitat, with other areas being used for grazing of introduced pasture <sup>(49)</sup>.

The Lowan Mallee is considered a variegated <sup>(61)</sup> landscape, with large areas of remnant native vegetation covering more than 60 per cent of the land <sup>(30)</sup>. Most of the native vegetation is protected within public reserves, particularly Ngarkat and Billiatt Conservation Parks <sup>(55)</sup>, and provides habitat for a range of threatened flora and fauna. This includes a number of threatened birds such as the mallee emu-wren *Stipiturus mallee*, striated grasswren *Amytornis striatus*, red-lored whistler *Pachycephala rufogularis* and western whipbird *Psophodes nigrogularis* <sup>(72)</sup>. Recovery Plans have been developed at a national or regional scale for some threatened species that occur in this landscape, including the malleefowl (*Leipoa ocellata*). In addition to their value for nature conservation, these reserves are managed for their natural values and recreational opportunities. Ngarkat in particular is an important location for bird watching and 4WD tourism <sup>(73)</sup>. The shrublands of Ngarkat, dominated by *Banksia ornata*, are also used seasonally by the apiary industry in the production of honey <sup>(73)</sup>.

Given the dominance of native vegetation in this landscape, fire regimes and how they impact on the natural resources of the large remnant reserves is a key issue <sup>(73)</sup>. Large scale, uncontrolled bushfires are a primary threat to the biodiversity of these large remnants, especially to the threatened bird species <sup>(47)</sup>. Recent evidence suggests that extended dry periods can interact with fire to the detriment of native biota in this landscape <sup>(74)</sup>.

Other issues in this landscape include the impact of goats and other introduced herbivores, as well as foxes and other introduced carnivores <sup>(47) (73)</sup>. The combined impact of these issues has led to noticeable declines in species associated with these systems <sup>(74)</sup>. As this landscape crosses into the South East NRM Region, these issues need to be addressed in collaboration.

#### The Southern Mallee

The Southern Mallee biophysical landscape <sup>(47)</sup> contains a mixture of calcareous soils in the west, to sandy and loamy soils in the east <sup>(48)</sup>. These soils, coupled with an average annual rainfall of between 300 and 500 millimetres, have resulted in much of the landscape being used for cereal cropping and grazing introduced pasture <sup>(49)</sup>. Suitable soils to the east have also been developed for irrigated cropping such as potatoes. These enterprises utilise groundwater from the Murray Group Limestone Aquifer within the Mallee Prescribed Wells Area <sup>(53)</sup>. There is a risk that in 100 to 150 years this water resource may be depleted if the current usage continues along with the clearance of native vegetation <sup>(53)</sup>. These relatively intensive agricultural activities support a number of townships, including Pinnaroo and Lamerloo in the east, and Tailem Bend in the west.

The high suitability of the Southern Mallee for agriculture has led to the extensive removal of native vegetation, with only 5.5 per cent of the original native vegetation remaining <sup>(30)</sup>. Much of this relictual vegetation is concentrated in the west of the landscape where soils become shallow and have a calcrete cover <sup>(48) (30)</sup>. Ecosystems associated with the west of this landscape appear to be at risk of irreversible decline, with the primary driver of this decline being the ongoing impact of vegetation clearance and fragmentation <sup>(47) (56) (62)</sup>. Species at risk include malleefowl *Leipoa ocellata*, metallic sun orchid *Thelymitra epipactoides* (a recovery plan exists for both), sand hill greenhood *Pterostylis arenicola*, and a number of woodland bird species, including hooded robin *Melanodryas cucullata*, brown tree creeper *Climacteris picumnus* and restless flycatcher *Myiagra inquieta*. Restoration of the open woodlands associated with these western calcareous soils is a conservation priority in this landscape.

#### The Northern Mallee

The Northern Mallee biophysical landscape <sup>(47)</sup>, which crosses into the landscape of the Riverland district, consists of a series of primarily longitudinal siliceous dunes embedded within a matrix of primarily calcareous loams <sup>(48) (62)</sup>. Rainfall is lower in this northern landscape with a mean annual rainfall of 240 to 300 millimetres. Water availability is higher in the sandier soils <sup>(62) (63)</sup> and these soils have been preferentially targeted for dryland agriculture, particularly rotational cereal cropping and stock grazing <sup>(49)</sup>. The combination of low rainfall and sandy soil texture means that these soils have a high inherent risk of wind erosion <sup>(48)</sup> that needs to be managed by maintaining vegetation cover, particularly through summer.

The Mallee Prescribed Wells Area comprises the groundwater resource of the landscape <sup>(53) (75)</sup>. The demand on groundwater resources in this landscape is small and limited to domestic and stock use <sup>(53) (75)</sup>.



Approximately 18 per cent of the area's remnant vegetation <sup>(30)</sup> is highly fragmented, but much of it is protected as public reserves or private Heritage Agreements <sup>(55) (58)</sup>. While the open mallee ecosystems associated with the calcareous loams appear to be relatively stable, the mallee shrublands associated with sandier soils appear to be declining and at risk of losing dependent native biota. This includes a number of bird species that are at risk of local extinction in this landscape, including the southern scrub robin *Drymodes brunneopygia*, shy heathwren *Hylacola cauta*, purple-gaped honeyeater *Lichenostomus cratitius* and malleefowl. The restoration of mallee shrubland ecosystems associated with deep sands is a conservation priority in this landscape <sup>(47) (56) (62)</sup>.

### The Lower Lakes and Coorong

The Lower Lakes and Coorong biophysical landscape <sup>(47)</sup>, which crosses into the Ranges to River NRM district, is part of the River Murray Prescribed Watercourse. It is dominated by Lake Alexandrina, Lake Albert and the northern parts of the Coorong. These systems form the estuary of the Murray-Darling Basin and are an internationally recognised wetland complex under the Ramsar Convention due to their importance for a range of national and international migratory waterbirds <sup>(64) (65) (66)</sup>. The lakes are separated from the Coorong by a series of barrages that maintain lake water levels and prevent the incursion of marine water <sup>(67)</sup>. The maintenance of the relatively freshwater environments of the lakes is important both ecologically and socio-economically.

The lakes in their current state continue to support a number of freshwater-dependent ecosystems and species that are found nowhere else in the Lower Lakes, Coorong and Murray Mouth Ramsar Site. In particular, the freshwater wetlands and associated emergent vegetation are critical habitat for a range of threatened species, including the southern pygmy perch *Nannoperca australis*, Murray hardyhead *Craterocephalus fluviatilis*, Australasian bittern *Botaurus poiciloptilus*, and southern bell frog *Litoria raniformis* <sup>(52)</sup>. Recovery Plans have been developed at a national or regional level for some threatened species and ecological communities, including the Murray hardyhead.

The availability of freshwater supports a dairy industry dependent on irrigated pasture, as well as a commercial fishery that depends on freshwater native species such as golden perch *Macquaria ambigua* and bony bream *Nematalosa erebi*, and the introduced fish redfin perch *Perca fluviatilis* and European carp *Cyprinus carpio* <sup>(68)</sup>.

Maintaining a hydrological connection between the fresh water lakes and saline Coorong is critical for the maintenance of the aquatic ecosystems <sup>(64) (69)</sup>. The delivery of water from the River Murray to the Coorong usually maintains an open river mouth and, when delivered appropriately, supports water levels and water quality for the maintenance of native biota in the Coorong itself. The dependent bird fauna include the nationally threatened fairy tern *Sternula nereis* <sup>(52) (70)</sup>, a permanent breeding colony (one of very few in Australia) of the iconic Australian pelican *Pelecanus conspicillatus*, and a high diversity of local and international waders and other waterbirds <sup>(64)</sup>. A diversity of estuarine, diadromous and marine fish species also occur in the Coorong, including the commercially important yellow-eyed or Coorong mullet *Aldrichetta forsteri*, greenback flounder *Rhombosolea tapirina* and black bream *Acanthopagrus butcheri* <sup>(68)</sup>, and the ecologically important smallmouth hardyhead *Atherinosoma microstoma* <sup>(64)</sup>.

Recent drought conditions necessitated a wide range of emergency activities to prevent species extinctions from the landscape, while the local dairy industry almost collapsed due to the combination of water availability and commodity prices. This highlights the consequences of inappropriate water management for the Lower Lakes and Coorong social and ecological systems. The key driver of social and ecosystem resilience in this landscape is the nature of the flow regime from the Murray-Darling Basin, which in turn is determined by how water resources are managed across the entire Basin.

### 3.6.1.2 Lifestyles

#### Population demographics

The landscape of the Mallee-Coorong district covers 16,889 square kilometres and is home to 8475 people <sup>(16)</sup>, which equates to approximately 0.5 people per square kilometre. Approximately 4.5 per cent of the population identify themselves as Aboriginal, which is higher than the state and regional average of 2 per cent. The urban centre of Tailem Bend has a population of 1405, or 17 per cent of the district's population. The remaining 83 per cent of the population is classed as rural and can be found in the township localities of Karoonda (330), Lameroo (537), Meningie (921) and Pinnaroo (558) <sup>(17)</sup>.

The districts total population declined by 7 per cent between 2001 and 2011. This decline is expected to continue in all local government areas within the district, particularly the Southern Mallee District Council where a 10 per cent decline is expected between 2006 and 2026 <sup>(18)</sup>. The median age for the district has increased from 38 to 44 years over this period <sup>(16)</sup>. Thirty two per cent of households in the district do not have an internet connection, but 59 per cent have Broadband <sup>(19)</sup>.

#### Local government

Local government plays a significant role in managing natural resources and provides a key link to the broader community. Four local councils are located within the Mallee-Coorong district. The total area of the District Councils of Southern Mallee and Karoonda East Murray are within the district. The Coorong District Council extends into the South East NRM Region, while the northern half of the District Council of Loxton Waikerie is within the Riverland district.

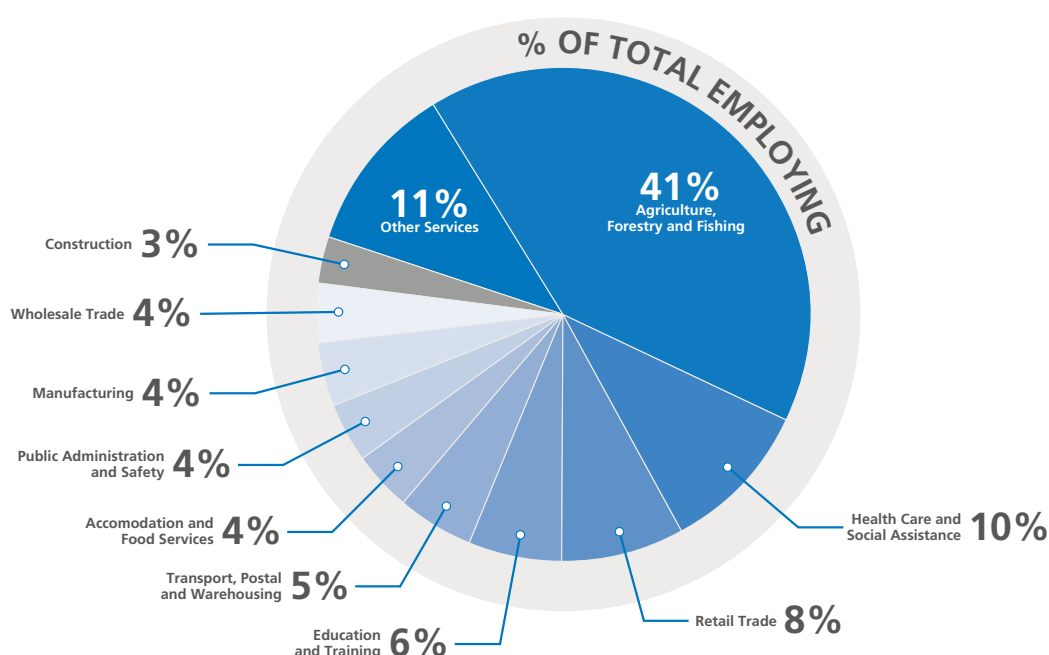
#### Community groups and volunteering

Community groups and volunteers play an important role in delivering natural resources management initiatives in the Mallee-Coorong district. There are ten volunteer organisations registered with Natural Resources SA MDB in the Mallee-Coorong district, and a total of 50 registered volunteers who each undertake an average of 22 volunteer hours per year <sup>(27)</sup>.

#### Recreation and tourism

The Murraylands tourism region covers a large proportion of the Mallee-Coorong district and includes Ngarkat Conservation Park. It is a popular area for tourists and visitors with peak periods in March to April and September to October. In 2010 to 2011, the region attracted 914,000 visitors with a total of 608,000 overnight stays <sup>(28)</sup>. The region offers a range of recreational opportunities focussed on the River Murray and conservation areas like Ngarkat. Annual surveys indicate that from 2010 to 2012 a total of 10 per cent of visitors to the area undertook water activities or sports, 9 per cent participated in fishing, 7 per cent bushwalked, 9 per cent held picnics or barbecues, and 4 per cent undertook some other outdoor activity <sup>(29)</sup>. Many visitor activities can place pressure on natural resources such as the River Murray and conservation areas. Examples of pressure include erosion from boat wash, loss of timber used for firewood and trampling of vegetation.

Graph 4. Mallee-Coorong main employing industries 2011 <sup>(16)</sup>











### 3.6.1.3 Livelihoods

#### Industry and employment

Agriculture is the dominant employing industry of people over 15 years of age in the Mallee-Coorong district (Graph 4). In 2011, 41 per cent of the population were employed in the agriculture industry, particularly dryland farming. Other major contributors were health care and social services (10 per cent), retail trade (8 per cent), education and training (6 per cent), and transport, postal and warehousing (5 per cent) <sup>(16)</sup>.

Employment in most industries remained relatively stable between 2001 and 2011, with the following exceptions:

- a decline in agriculture from 47 per cent to 41 per cent
- an increase in health care and social services from 6 per cent to 10 <sup>(16)</sup>.

The Murray and Mallee Region Plan <sup>(108)</sup> identifies Taillem Bend as a location to promote industrial growth as part of the Murray and Mallee regional vision.

#### Land use trends

In 2008 <sup>(20)</sup> the major land uses in the region were cropping (34 per cent) and grazing of modified pastures (35 per cent), occurring mainly in the Southern and Northern Mallee bio-physical landscapes. These areas have mainly been used for dryland farming since 2003 <sup>(21)</sup>, however mapping has shown a significant increase in the area of land used for cropping (from 19 per cent to 34 per cent), and a reduction in grazing of modified pastures (from 47 per cent to 35 per cent). It should be noted that both of these land use classes may include land in a rotation system.

The land area used for nature conservation remained relatively steady at 19 per cent between 2003 and 2008. This area is mainly comprised of Ngarkat Conservation Park and the Billiatt Wilderness Area in the Lowan Mallee.

The area of land irrigated for cropping, modified pasture, perennial horticulture and seasonal horticulture, represents 1 per cent of the total land area. This area increased from 6,856 hectares in 2003 <sup>(21)</sup> to 13,281 hectares in 2008 <sup>(20)</sup>. Irrigation water is sourced from the Mallee Prescribed Wells Area, the eastern portion of the Southern Mallee bio-physical landscape between Pinnaroo and Lameroo, and the northern section of the Lowan Mallee. It should be noted that some irrigated land use classes may include land in a rotation system.

#### Landholder environmental issues

A 2010 <sup>(24)</sup> survey of commercial and lifestyle farmers in the Murray Mallee identified weed control, pest animal control, water quantity and fire management as the main issues impacting on their farming enterprise. Approximately 50 per cent of these landholders had taken steps to conserve native vegetation, including planting native trees and shrubs covering around 12 per cent of their total land area, and fencing 21 per cent of native vegetation on their land to permanently prevent stock access.



#### 3.6.1.4 Community adaptive capacity

The Mallee-Coorong district has a below average community adaptive capacity when compared to the state average. This is due to a concentration of employment in one industry sector, an ageing population, a declining population and a workforce with relatively low levels of formal qualification. The district's strengths lie in its community cohesion. A summary analysis for each of the capitals in the district is provided below.

**Physical Capital Index:** remoteness, population size, population change and internet access

The district's physical capital is lower than the state average. It is comparatively remote, has below average internet access, a smaller than average population and has seen substantial population decline.

**Economic Capital Index:** economic diversity, median household income, income/housing cost, unemployment and mean household size

The district's economic capital is slightly below the state average. Its economic diversity is low due to employment being concentrated in the agriculture sector. Agriculture has experienced declining terms of trade and this is reflected to some degree in the substantially below average median household income. This is balanced by a comparatively high income to housing cost, relatively small median household sizes and relatively low levels of unemployment.

**Human Capital Index:** percentage graduates, population 65 and over, percentage completed high school, one parent households, lone person households and females in non-routine occupations

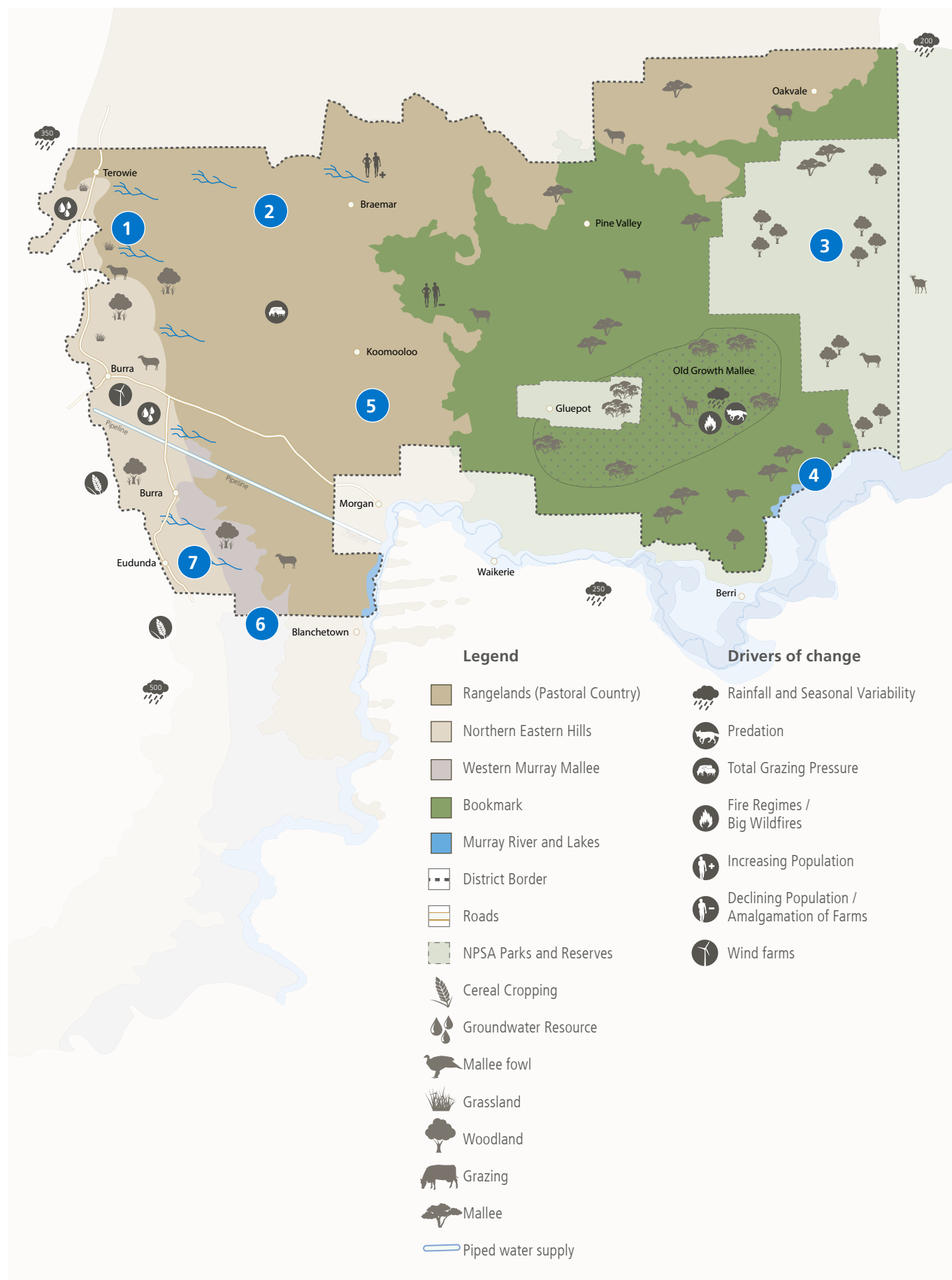
The district's human capital is below the state average. It has a high proportion of elderly people and lone person households. It also has a substantially lower number of graduates and number of people who have completed high school. This is balanced by a below average proportion of single parent families and an above average number of women in managerial or technical occupations.

**Social Capital Index:** voluntary work

The district's social capital is substantially above the state average. The level of volunteering is well above average, which is an indication of a socially cohesive community.

### 3.7 Rangelands district

Figure 6. Rangelands district





- 1 The lower rainfall areas of the Mount Lofty Ranges support extensive areas of the Nationally important natural grasslands, open grassy woodlands and threatened species such as Pygmy blue tongue lizard and Spalding blown-grass.
- 2 The gently undulating plains and calcareous soils of the Rangelands (pastoral country) support extensive areas of native vegetation grazed by sheep and cattle.
- 3 The Bookmark area is predominantly used for nature conservation and over 60% is under formal conservation protection. These areas also provide wilderness recreation and tourism experiences.
- 4 The Bookmark area provides important habitat for threatened species that depend on Woodland ecosystems, including Malleefowl, Black-eared miner, Red-lored whistler and Striated grass-wren.
- 5 Shrublands of the Rangelands (pastoral country) provide significant habitat for flora and fauna, including the nationally threatened Plains wanderer and chenopod dependant reptile fauna.
- 6 The calcareous loams and loams over calcrete of the Western Murray Mallee are primarily used for dryland cereal cropping and grazing.
- 7 The rocky slopes of the northern Eastern Hills are largely used for grazing of domestic stock. There are also large areas of cereal crops in the gentler slopes between hills.

### Aboriginal values

Aboriginal values: This region supported large populations of Aboriginal people, who flourished with fertile hunting grounds. The lakes, rivers, wetlands were highly valued as a food source and life line for Aboriginal people. Along these areas are traditional hunting and camping grounds, the abundance of good food and water allowed for rich cultural practices to develop, the animals in this region are significant to traditional owners through a totem connection, there are many middens, burial sites, scar trees and gathering sites throughout the region. Many of these cultural practices continue to this day.

## Rangelands community values

1. The uniqueness of the rangelands: We acknowledge the enormity of the rangelands and its distinctiveness is appreciated both within and outside the district.
2. People working together: We encourage participation and inclusiveness and show tolerance of all people.
3. Sustainable Production and Healthy Ecosystems: We care for and protect our environment while using it to produce wholesome food.
4. Best available science: We use knowledge, innovation, monitoring, evaluation and adaptation to take stock of where we are and where we are heading.



## 3.7.1 Landscapes, Lifestyles and Livelihoods

### 3.7.1.1 Landscapes

The Rangelands district lies outside the South Australian agricultural zone due to the landscape's low and variable rainfall. Mean annual rainfall in the landscape can be greater than 500 millimetres in the north-eastern Mt Lofty Ranges, but annual rainfall is typically less than 250 millimetres. The bulk of the Rangelands district can be split into the two distinct biophysical landscapes of the Rangelands Pastoral Country and Bookmark. The northern parts of the Eastern Hills and Western Murray Mallee biophysical landscapes are also described here.

#### The northern Eastern Hills

The northern Eastern Hills are located in the west of the district and are mainly comprised of hills and slopes with shallow soils formed on basement rock grading to plains and gentle slopes with soils formed of outwash sediments derived from basement rock highs <sup>(48)</sup>.

These lower rainfall ranges support extensive natural grasslands and open grassy woodlands, with mallee and riparian woodlands dominating drainages and plains between the rises. The northern Eastern Hills retain a range of significant biodiversity assets that are threatened, including the EPBC listed pygmy blue tongue lizard, Spalding blown-grass, Iron-grass Natural Temperate Grassland, and Peppermint Box (*Eucalyptus odorata*) Grassy Woodland <sup>(47)</sup> <sup>(52)</sup>. Recovery Plans have been developed at a national or regional level for some threatened species and ecological communities, including the pygmy blue tongue lizard, Spalding blown-grass and Iron-grass Natural Temperate Grassland.

While the northern Eastern Hills are largely used for grazing domestic stock, significant areas of cereal crops also occur in the southern parts of this landscape <sup>(49)</sup>.

Water erosion is an important issue across the landscape, but particularly in the north-eastern Mt Lofty Ranges. The risk of water erosion is increased where inappropriate grazing and vegetation management occurs <sup>(48)</sup>.

A significant and emerging land use issue in the northern ranges relates to the development of wind farms.

#### The Rangelands (pastoral country)

The Rangelands pastoral country biophysical landscape <sup>(47)</sup> consists of gently undulating plains comprised of calcareous soils interspersed with aeolian dunefields. Mallee woodlands are found in the northern Mt Lofty Ranges and spread to a limited extent onto the eastern plains of this landscape. These woodlands gradually transition into black oak Casuarina pauper woodlands and chenopod shrublands dominated by *Maireana sedifolia* and *M. pyramidata*.

Grazing of domestic stock is the dominant land use of the Rangelands pastoral country and relies exclusively on native vegetation. The native vegetation in this landscape is extensive and

is almost completely utilised by grazing activity <sup>(49)</sup>. While uncleared native vegetation cover is considered greater than 90 per cent, much of this land is under pastoral lease and has historically and currently been subjected to high levels of grazing pressure <sup>(61)</sup> <sup>(30)</sup>.

A number of areas in the far west of the landscape are protected for nature conservation, including Carroona Creek Conservation Park, Pandappa Conservation Park and parts of Red Banks Conservation Park. The shrublands on the plains support significant ecosystem assets, including the EPBC listed plains wanderer *Pedionomus torquatus* <sup>(52)</sup> and a range of chenopod dependent reptile fauna <sup>(76)</sup>. A range of significant fauna depend on the semi-arid woodlands in this landscape, including white-browed tree creeper *Climacteris affinis* and marbled velvet gecko *Oedura marmorata* <sup>(76)</sup>. Recovery Plans have been developed at a national or regional level for some threatened species and ecological communities that occur in this landscape, including the malleefowl (*Leipoa ocellata*).

The systemic driver that places these biota at risk is total grazing pressure, particularly around drainage lines <sup>(77)</sup>. Historical grazing and browsing pressure has simplified the age structure of semi-arid woodland tree species. This may have implications for both the long-term maintenance of these woodlands and their value as fauna habitat <sup>(77)</sup>.

As the distribution of domestic and wild herbivores is limited by access to water, managing the distribution of water may assist in protecting certain areas from overgrazing <sup>(77)</sup>. Future management of this landscape needs to include an assessment of the impact that total grazing pressure (including domestic stock and native and introduced herbivores) has on native biota and sustainable grazing. A key future challenge will be to identify the relationship between pastoral activity and nature conservation, in order to address the long-term requirements of the social and ecological systems of this landscape.

#### Bookmark

The eastern half of the Rangelands district consists of the Bookmark biophysical landscape and is dominated by extensive semi-arid woodlands <sup>(47)</sup> <sup>(30)</sup>. The shift from shrublands to mallee across the landscape of the Rangelands district appears to be driven by changes in the nature of the soil, with the shrublands of the Rangelands landscape being found on soils with the more continuous clay soils, than the woodlands associated with a sandier matrix of the Bookmark landscape. The sandier soils of this landscape are inherently sensitive to wind and water erosion <sup>(48)</sup>.

The dominant land use is nature conservation, with more than 60 per cent <sup>(49)</sup> of the landscape under some form of conservation protection compared with 14% in the Rangelands biophysical landscape <sup>(49)</sup>. This includes public reserves such as Danggali Conservation Park and Wilderness Protection Area and Chowilla Regional Reserve, as well as reserves held by non-government organisations such as Gluepot, Calperum and Taylorville. In addition to their conservation value, these conservation areas provide significant recreational and tourism opportunities <sup>(78)</sup>.

Threatened species that depend on the suitable management of the woodland ecosystems include the black-eared miner *Manorina melanotis*, malleefowl *Leipoa ocellata*, red-lored whistler *Pachycephala rufogularis*, striated grasswren *Amytornis striatus*, southern ninguai *Ningau i yvonneae*, and club spear grass *Austrostipa nullanulla*. Recovery Plans have been developed at a national or regional level for some threatened species and ecological communities, including the malleefowl and black-eared miner.

The key natural resources management issues in Bookmark relate to total grazing pressure from domestic stock and native and introduced herbivores, as well as inappropriate fire regimes. The management of these systems requires an integrated approach to fire and total grazing pressure. Native Pine woodlands continue to be impacted by historic grazing and may require active restoration to retain their functions in the landscape.

### The Western Murray-Mallee

The Western Murray Mallee biophysical landscape occurs mainly in the Ranges to River district, with a small portion in the south-west corner of the Rangelands district between the Mount Lofty Ranges and Rangelands Pastoral Country. The soils are variable and include calcareous loams, moderately fertile loams over calcrete, sand over poorly structured clay and gradational sandy loams<sup>(48)</sup>. Annual rainfall in the area makes the land suitable for dryland cereal cropping and grazing<sup>(49)</sup>. This land use has led to extensive removal of native vegetation with approximately 12.5% remaining<sup>(30)</sup>. This type of cropping and grazing has occurred most heavily where there are calcareous loam soils, leading to the extensive modification of the ecosystems dependent on these soil types.

While much of the mallee on these plains has been extensively cleared, important remnants still remain<sup>(55)</sup>. These remnants contain nationally threatened species that require ongoing protection such as the malleefowl (*Leipoa ocellata*)<sup>(52)</sup><sup>(47)</sup>. Recovery Plans have been developed at a national or regional scale for some threatened species and ecological communities, including the malleefowl.

A number of drainage lines and terminal swamps occur within the loamy plains. These lines and swamps are rarely inundated with water, but tend to have higher clay content than the surrounding landscape. While still highly modified, these wetter systems retain a higher proportion of their dependent native biota, including declining woodland birds such as the diamond firetail *Stagonopleura guttata* and brown tree creeper *Climacteris picumnus*, although these appear to be declining in this landscape. The restoration of these drainage lines and seasonally inundated terminal swamps is a priority for nature conservation in this highly fragmented landscape<sup>(47)</sup><sup>(57)</sup><sup>(56)</sup>.

## 3.7.1.2 Lifestyles

### Population demographics

The landscape of the Rangelands district covers 23,763 square kilometres and has a population of 4,184 people<sup>(16)</sup> which equates to approximately 0.2 people per square kilometre. The majority of the population live in the northern Eastern Hills biophysical landscape and the whole district is classed as having a rural population. Thirty two percent (32%) of people in the district live in the township localities of Burra (893) and Eudunda (632)<sup>(17)</sup>.

The Rangelands district has a slightly declining population (approximately -1% between 2001 and 2011) and the median age has risen from approximately 40 to 46 years during that same period<sup>(16)</sup>. Eudunda has experienced slow population growth in line with forecasts, and Burra has experienced a decline of 19% over the period from 2001 to 2011<sup>(16)</sup>. The northern Eastern Hills is expected to experience slow levels of population growth over the period from 2006 to 2026 (3% for the Goyder Regional Council area<sup>(18)</sup>). Thirty one percent (31%) of households in the Rangelands district do not have an internet connection; however, 59% have Broadband connection<sup>(19)</sup>.

### Local government

Local government plays a significant role in natural resources management and provides a key link to the broader community. Two local governments are located within the Rangelands district. Goyder Regional Council covers the northern Eastern Hills and extends into the Northern and Yorke NRM Region. Mid-Murray Council is in the Ranges to River district but extends into the Rangelands in the area between Robertstown and Morgan. The remainder of the Rangelands district (the Rangelands Pastoral Country and Bookmark Mallee biophysical landscape portion) is under the Outback Communities Authority.

### Community groups and volunteering

Community groups and volunteers play an important role in delivering NRM initiatives in the Rangelands District. There are 7 NRM related volunteer organisations registered with Natural Resources SA MDB, and a total of 12 registered volunteers, each undertaking an average of 2 volunteer hours each year<sup>(27)</sup>.

### 3.7.1.3 Livelihoods

#### Industry and employment

Agriculture is the dominant employing industry of people over 15 years of age in the Rangelands district (Graph 5). In 2011, 31 per cent of the population were employed in the agriculture, forestry and fishing industry. Other major contributors were manufacturing (11 per cent), health care and social services (10 per cent), retail trade (9 per cent), and accommodation and food services (6 per cent) <sup>(16)</sup>.

Employment in most industries remained relatively stable between 2001 and 2011, with the following exceptions:

- a decline in agriculture from 40 per cent to 31 per cent
- an increase in health care and social services from 7 per cent to 10 per cent <sup>(16)</sup>.

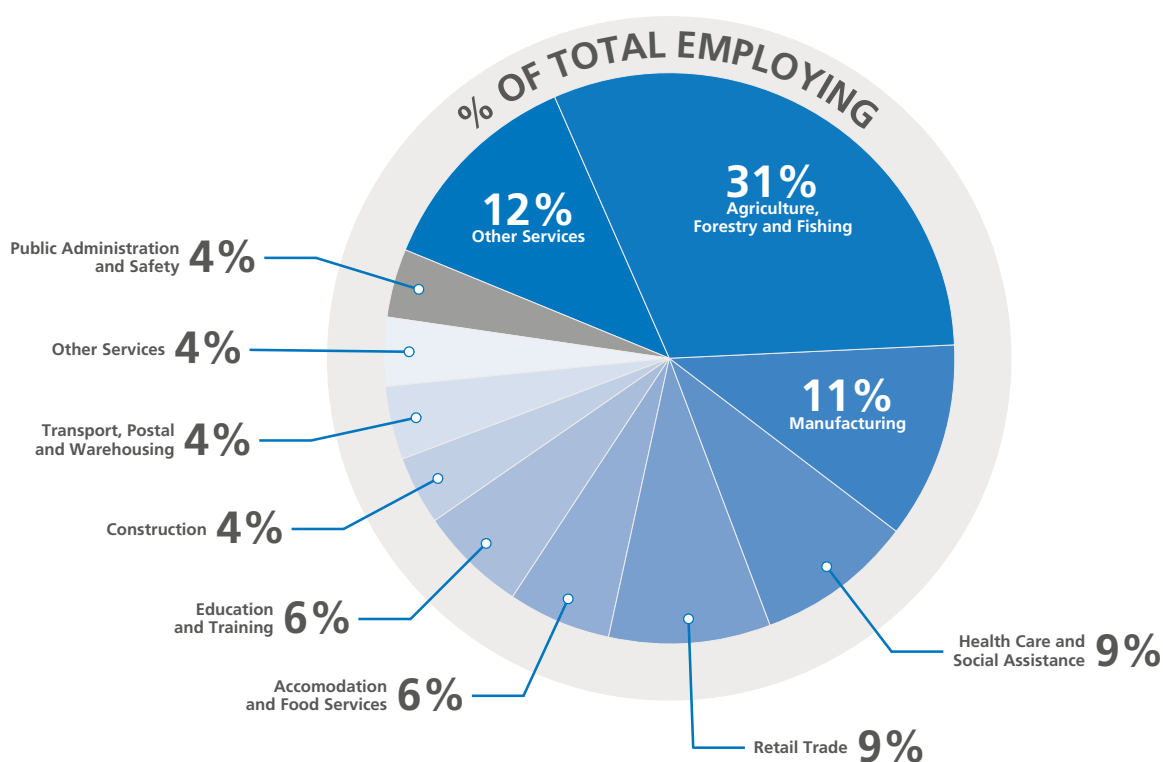
#### Land use trends

In 2008 <sup>(20)</sup>, the major land uses in the district were grazing of natural vegetation (48%) in the Rangelands Pastoral Country biophysical landscape, and nature conservation (30%) in the Bookmark Mallee biophysical landscape. In the “Rangelands” landscape, most land is held as pastoral leases, and chenopod shrublands provide the basic feed supply for grazing sheep and beef cattle. In 2003, the land-use for grazing natural vegetation was much higher (71%) and nature conservation was much lower (14%) <sup>(21)</sup>. This change is due to three large properties in the Bookmark Mallee (Calperum Station, Gluepot Reserve and Taylorville) becoming protected areas under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*. Other significant land uses are grazing of modified pastures (11%) and cropping (4%), which occur in the Eastern Hills biophysical landscape and have remained relatively stable in area since 2003 <sup>(20) (21)</sup>.

#### Landholder environmental issues

A 2010 survey of commercial and lifestyle farmers of the Rangelands identified pest animal control, weed control and water quantity as the main issues impacting on their farming enterprise <sup>(24)</sup>.

Graph 5. Rangelands main employing industries for 2011 <sup>(16)</sup>





#### 3.7.1.4 Community Adaptive Capacity Index

The Rangelands district has a below average community adaptive capacity when compared to the state average. This is due to a concentration of employment in one industry sector, an ageing population, a declining population and a workforce with relatively low levels of formal qualification. The district's strengths lie in its community cohesion. A summary analysis for each of the capitals in the district is provided below.

**Physical Capital Index:** remoteness, population size, population change and internet access

The district's physical capital is lower than the state average. It is comparatively remote, has below average internet access, a smaller than average population and has seen a decline in its population.

**Economic Capital Index:** economic diversity, median household income, income/housing cost, unemployment and mean household size

The district's economic capital is below the state average. It has a substantially low economic diversity due to employment being concentrated in the agriculture sector. Agriculture has experienced declining terms of trade and this is reflected to some degree in the substantially below average median household income. This is balanced by a comparatively high income to housing cost, relatively small median household sizes and relatively low levels of unemployment.

**Human Capital Index:** percentage graduates, population 65 and over, percentage completed high school, one parent households, lone person households and females in non-routine occupations

The district's human capital is below the state average. It has a comparatively high proportion of elderly people and lone person households, a below average number of women in managerial or technical occupations, and a substantially lower number of graduates and number of people who have completed high school. This is balanced by a below average proportion of single parent families.

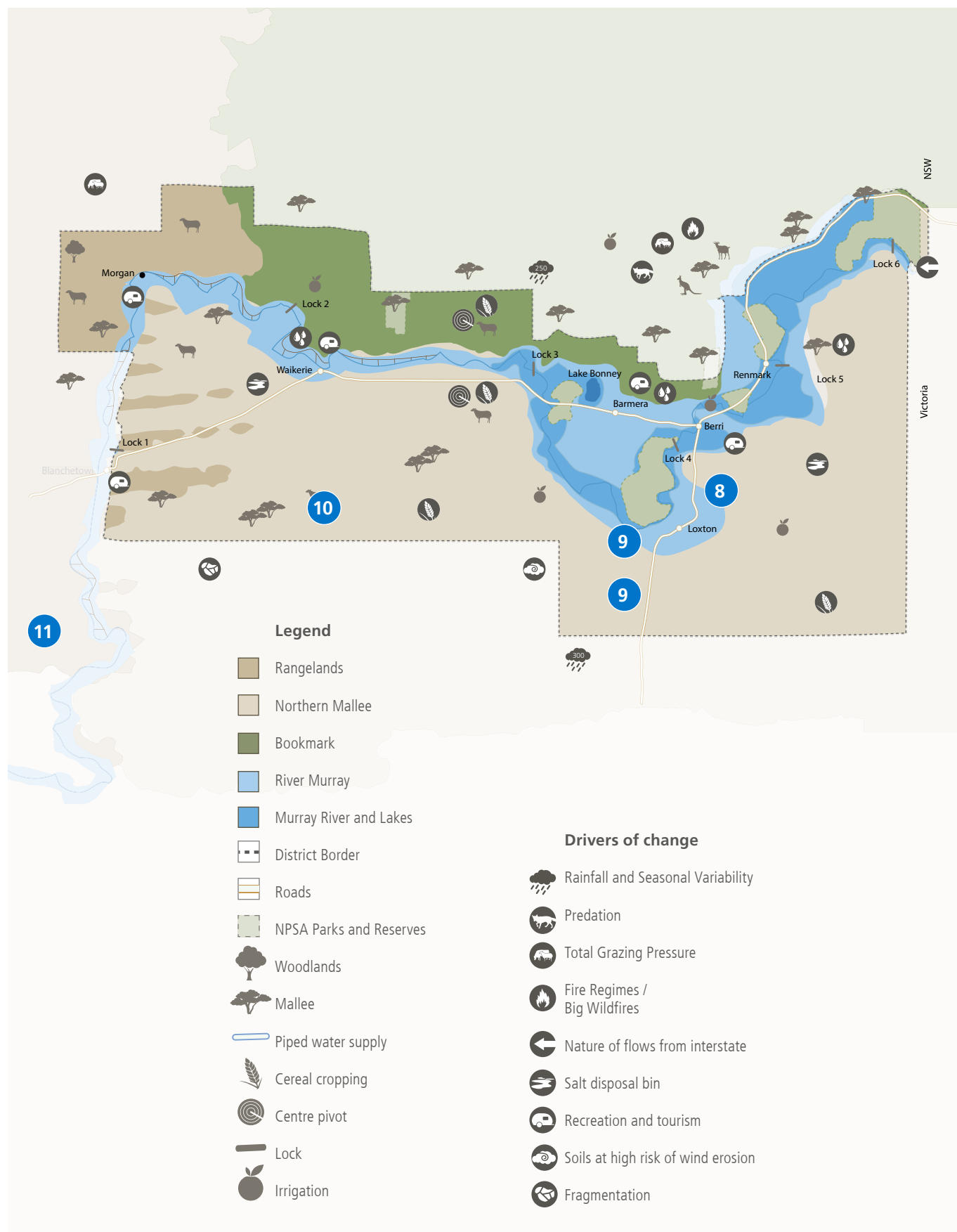
**Social Capital Index:** voluntary work

The district's social capital is substantially above the state average. The level of volunteering is well above average, which is an indication of a socially cohesive community.



### 3.8 Riverland district

Figure 7. Riverland district



- 1 The gently undulating plains and calcareous soils of the Rangelands (pastoral country) support extensive areas of native vegetation grazed by sheep and cattle.
- 2 Wetlands and Floodplains act as a critical drought refuge for a range of woodland bird species of the surrounding semi-arid landscape.
- 3 The Bookmark area provides important habitat for threatened species that depend on Woodland ecosystems, including Malleefowl, Black-eared miner, Red-lored whistler and Striated grass-wren.
- 4 The floodplain of the Upper River Murray supports, in places, pastoral enterprises.
- 5 The Bookmark area is predominantly used for nature conservation and over 60% is under formal conservation protection. These areas also provide wilderness recreation and tourism experiences.
- 6 The Upper River Murray contains two Ramsar wetlands of international importance (Riverland Ramsar Site and Banrock Station Ramsar Wetland Complex).
- 7 The sandier soils of the Northern Mallee, with rainfall between 240mm and 300mm) are primarily used for rotational cereal cropping and stock grazing.
- 8 Irrigated agriculture relies heavily on the surface waters of the River Murray, which in turn indirectly supports the local economies of a number of Riverland towns.
- 9 The River Murray provides significant tourism and recreation opportunities that contribute to the local economy.
- 10 The remaining native vegetation in the Northern mallee is fragmented but largely protected as public reserves or Heritage Agreements. The mallee shrublands associated with sandier soils is particularly important for birds at risk of local extinction.
- 11 Shrublands of the Rangelands (pastoral country) provide significant habitat for flora and fauna, including the nationally threatened Plains wanderer and chenopod dependant reptile fauna.

### Aboriginal values

Aboriginal values: This region supported large populations of Aboriginal people, who flourished with fertile hunting grounds. The lakes, rivers, wetlands were highly valued as a food source and life line for Aboriginal people. Along these areas are traditional hunting and camping grounds, the abundance of good food and water allowed for rich cultural practices to develop, the animals in this region are significant to traditional owners through a totem connection, there are many middens, burial sites, scar trees and gathering sites throughout the region. Many of these cultural practices continue to this day.

## Riverland community values

1. Whole sustainable landscapes: We embrace new ideas and technology to enhance the production value and protection of our natural resources.
2. People Connecting to Country: The spiritual connection and well-being of people and the community is intrinsically linked to a healthy environment.
3. Growth and knowledge over time: The effectiveness of our actions are used to educate others. We share stories based on experience and science and we listen to the stories of others.
4. Intrinsic value of nature: We recognise different parts of our landscape and manage them for environmental outcomes.

## 3.8.1 Landscapes, Lifestyles and Livelihoods

### 3.8.1.1 Landscapes

The main biophysical landscapes of the Riverland district are the northern parts of the Northern Mallee (that crosses into the Mallee-Coorong district), the River Murray (including the Murray Valley and parts of the Gorge), and the southernmost parts of the Rangelands and Bookmark biophysical landscapes.

#### The River Murray

The wetlands, floodplains, anabranches and main river channel of the River Murray<sup>(47)</sup> are part of the River Murray Prescribed Water Resource. They provide critical ecosystem services to the social, economic and ecological systems of the Riverland district. The section of the Murray within the Riverland district contains the internationally significant Riverland Ramsar site and Banrock Station Ramsar Wetland Complex<sup>(79)</sup>. It encompasses Chowilla Floodplain and Lindsay–Wallpolla Islands Icon Site<sup>(80)</sup>, and the River Murray Channel<sup>(81)</sup>, which are Living Murray Icon Sites. The River Murray also contains a number of protected areas that are managed for nature conservation, including the Murray River National Park, Calperum Station, Maize Island Conservation Park, Hogwash Bend, Clark’s Floodplain and Katarapoko Conservation Park<sup>(55) (58)</sup>. The River Murray ecosystems rely on appropriate timing, duration and volume of water delivery from upstream (Queensland, New South Wales and Victoria), and effectively managed local water delivery infrastructure.

Water management at local and regional scales are key drivers for a range of diverse and productive fish<sup>(86)</sup>, vegetation<sup>(80)</sup> and waterbird<sup>(87)</sup> communities on the River Murray. Species impacted include the Murray cod *Maccullochella peelii*<sup>(52)</sup> and golden bell frog *Litoria raniformis*<sup>(52)</sup>. The river’s wetlands and floodplains are important refugia from drought in the surrounding semi-arid landscape. For example, a range of woodland bird species that are typically found in the mallee, such as the brown treecreeper *Climacteris picumnus* and hooded robin *Melanodryas cucullata*, also frequent the floodplain woodlands. This is particularly the case in the higher elevation Black Box *Eucalyptus largiflorens* woodlands<sup>(88)</sup>. Management of the floodplains and wetlands of the River will have important consequences for the biodiversity of the surrounding semi-arid landscape. Recovery Plans have been developed at a national and regional level for some threatened species and ecological communities, including the Murray cod.

A proportion of the South Australian River Murray floodplain, particularly in the Riverland district, supports pastoral enterprises<sup>(49)</sup>. Floodplain country can be a valuable resource for these enterprises given its relatively moist environment compared to the surrounding semi-arid landscape.

The surface waters of the River Murray are the primary water resource for the district and are critical to the long-term social, economic and ecological outcomes for the area. For example, the most significant economic activity within the Riverland landscape is irrigated agriculture and horticulture,<sup>(49) (59)</sup> which is dependent

on River Murray surface water. The River Murray also contributes to the local economies of a number of townsites by providing significant tourism and recreational opportunities.

The central driver impacting the management of natural resources in this landscape is the volume, timing and duration of water delivery across the Murray-Darling Basin from upstream into South Australia<sup>(33) (85)</sup>. The water delivery into South Australia has significant implications in the Riverland district, and subsequently for downstream assets, including the lower River Murray, Lower Lakes and Coorong<sup>(64) (69) (85) (89)</sup>.

A key emerging issue for the management of natural resources in the district will be the implementation of the Murray-Darling Basin Plan (‘The Basin Plan’)<sup>(85)</sup>. The plan will outline how water delivery and infrastructure will operate in the landscape and this is likely to be a stronger driver of outcomes for local systems than other emerging threats like climate change<sup>(90)</sup>. Like other landscapes across the South Australian Murray-Darling Basin, a key future challenge will be to demonstrate how water can be managed to support both social and ecological resilience in this landscape.

#### The Northern Mallee

The Northern Mallee biophysical landscape is found in the landscapes of the Mallee-Coorong and Riverland districts<sup>(47)</sup>. The Northern Mallee consists of a series of longitudinal siliceous dunes embedded within a matrix of primarily calcareous loams<sup>(48)</sup><sup>(62)</sup>. Rainfall is lower in this northern landscape with a mean annual rainfall of 240 to 300 millimetres. Water availability is higher in the sandier soils<sup>(62) (63)</sup> which have been preferentially targeted for dryland agriculture, particularly rotational cereal cropping and stock grazing<sup>(49)</sup>. The combination of low rainfall and sandy soil texture means that these soils have a high inherent risk of wind erosion that needs to be managed by maintaining vegetation cover, particularly through summer<sup>(48)</sup>.

The Noora Prescribed Wells Area comprise the groundwater resources of the Riverland district. The demand on groundwater resources in this landscape is small and limited to domestic and stock use<sup>(53) (75)</sup>.

Approximately 18 per cent of the area’s remaining vegetation<sup>(30)</sup> is fragmented, with much of this vegetation protected as public reserves or private Heritage Agreements<sup>(55) (58)</sup>. While the open mallee ecosystems associated with the calcareous loams appear to be relatively stable, the mallee shrublands associated with sandier soils appear to be declining and at risk of losing dependent native biota. This includes a number of bird species that are at risk of local extinction in this landscape, including the southern scrub robin *Drymodes brunneopygia*, shy heathwren *Hylacola cauta*, purple-gaped honeyeater *Lichenostomus cratitius* and malleefowl. The restoration of mallee shrubland ecosystems associated with deep sands is a conservation priority in this landscape<sup>(47) (56) (62)</sup>.

#### The Rangelands (pastoral country)

A small portion of the Rangelands pastoral country biophysical landscape<sup>(47)</sup> occurs in the western part of the Riverland district.

The landscape<sup>(47)</sup> consists of gently undulating plains comprised of calcareous soils interspersed with aeolian dunefields. Mallee woodlands are found in the northern Mt Lofty Ranges and spread to a limited extent onto the eastern plains of this landscape. These woodlands gradually transition into black oak *Casuarina pauper* woodlands and chenopod shrublands dominated by *Maireana sedifolia* and *M. pyramidata*.

Grazing of domestic stock is the dominant land use of the Rangelands pastoral country and relies exclusively on native vegetation. The native vegetation in this landscape is extensive and is almost completely utilised by grazing activity<sup>(49)</sup>. While uncleared native vegetation cover is considered greater than 90 per cent, much of this land is under pastoral lease and has historically and currently been subjected to high levels of grazing pressure<sup>(61) (30)</sup>.

The shrublands on the plains support significant ecosystem assets, including the EPBC listed plains wanderer *Pedionomus torquatus*<sup>(52)</sup> and a range of chenopod dependent reptile fauna<sup>(76)</sup>. A range of significant fauna also depend on the semi-arid woodlands in this landscape, including the white-browed treecreeper *Climacteris affinis* and marbled velvet gecko *Oedura marmorata*<sup>(76)</sup>.

Historical grazing and browsing pressure has simplified the age structure of semi-arid woodland tree species. This may have implications for both the long-term maintenance of these woodlands and their value as fauna habitat<sup>(77)</sup>. As the distribution of domestic and wild herbivores is limited by access to water, managing the distribution of water may assist in protecting certain areas from overgrazing<sup>(77)</sup>. Future management of this landscape needs to include an assessment of the impact that total grazing pressure (including domestic stock and native and introduced herbivores) has on native biota and sustainable grazing.

Historical grazing and browsing pressure has simplified the age structure of semi-arid woodland tree species. This may have implications for both the long-term maintenance of these woodlands and their value as fauna habitat<sup>(77)</sup>. As the distribution of domestic and wild herbivores is limited by access to water, managing the distribution of water may assist in protecting certain areas from overgrazing<sup>(77)</sup>. Future management of this landscape needs to include an assessment of the impact that total grazing pressure (including domestic stock and native and introduced herbivores) has on native biota and sustainable grazing.

## Bookmark

Bookmark is located in the area to the north of the River Murray between Waikerie and Renmark and extends into the eastern half of the Rangelands district. The landscape is dominated by extensive semi-arid woodlands<sup>(47) (30)</sup> associated with the sandier environment of the Bookmark landscape. The sandier soils of this landscape are inherently sensitive to wind and water erosion<sup>(48)</sup>.

The dominant land use is nature conservation, with more than 60 per cent<sup>(49)</sup> of the landscape under some form of conservation protection<sup>(49)</sup>. This includes public reserves such as Danggali Conservation Park, Wilderness Area and Chowilla Regional

Reserve, as well as reserves held by non-government organisations such as Gluepot, Calperum and Taylorville. A number of smaller public reserves also occur within the Riverland district, including Pooginook Conservation Park and Cooltong Conservation Park. The woodland systems of Bookmark contain ongoing grazing activity, however, these conservation areas provide significant recreational and tourism opportunities<sup>(78)</sup>.

Threatened species that depend on the suitable management of the woodland ecosystems include the black-eared miner *Manorina melanotis*, malleefowl *Leipoa ocellata*, red-lored whistler *Pachycephala rufogularis*, striated grasswren *Amytornis striatus*, southern ninguai *Ningau i yvonneae*, and club spear grass *Austrostipa nullanulla*. Recovery Plans have been developed at a national or regional level for some threatened species and ecological communities, including the malleefowl and black-eared miner.

The main natural resources management issues in Bookmark relate to total grazing pressure from domestic stock and native and introduced herbivores, as well as inappropriate fire regimes. Because these semi-arid woodlands have strong interactions between fire, grazing and rainfall and are sensitive to climate variation, an integrated management approach is necessary. Another key issue is the impact of historic grazing on Native Pine woodlands, which may require active restoration in order to retain their functions in the landscape.

### 3.8.1.2 Lifestyles

#### Population demographics

The Riverland district covers 7,500 square kilometres and has a population of 33,413 people. This equates to approximately four persons per square kilometre, which is twice that of the whole SA MDB NRM Region<sup>(16)</sup>. Approximately half of the population live in the urban centres of Barmera (1914), Berri (4103), Loxton (3795), Renmark (4387) and Waikerie (1633)<sup>(17)</sup>. Approximately 3 per cent of the population identify themselves as Aboriginal, which is slightly higher than the state and regional average of 2 per cent<sup>(16)</sup>.

Between 2001 and 2011, the district's population declined by 5 per cent and the median age increased from 38 to 42 years<sup>(16)</sup>. Most urban centres have experienced minor declines in population with the exception of Loxton which increased by 13 per cent<sup>(17)</sup>. The most significant population losses were in areas outside the urban centres, including an 11 per cent decline within the Loxton dryland farming region. The 20 year growth objectives in the Riverland Regional Prospectus include increasing the region's population by approximately 7,000 people or 20 per cent<sup>(91)</sup>. However, in the period 2006 to 2026 the population in the District Council of Loxton Waikerie is expected to decline by 4 per cent, while the Council of Renmark Paringa can expect an increase of 4 per cent (18). Berri Barmera Council is expected to remain stable.

Thirty-three per cent of households in the district do not have an internet connection, however 57 per cent have Broadband<sup>(19)</sup>.



### Local government

Local government plays a significant role in managing natural resources and provides a key link to the broader community. Four local governments are located within the Riverland district. Berri Barmera Council and the Council of Renmark and Paringa are completely within the district. While the Mid-Murray Council covers most of the Ranges to River district, it extends into both the Riverland and Rangelands districts. The southern half of the District Council of Loxton Waikerie is within the Mallee-Coorong district.

### Community groups and volunteering

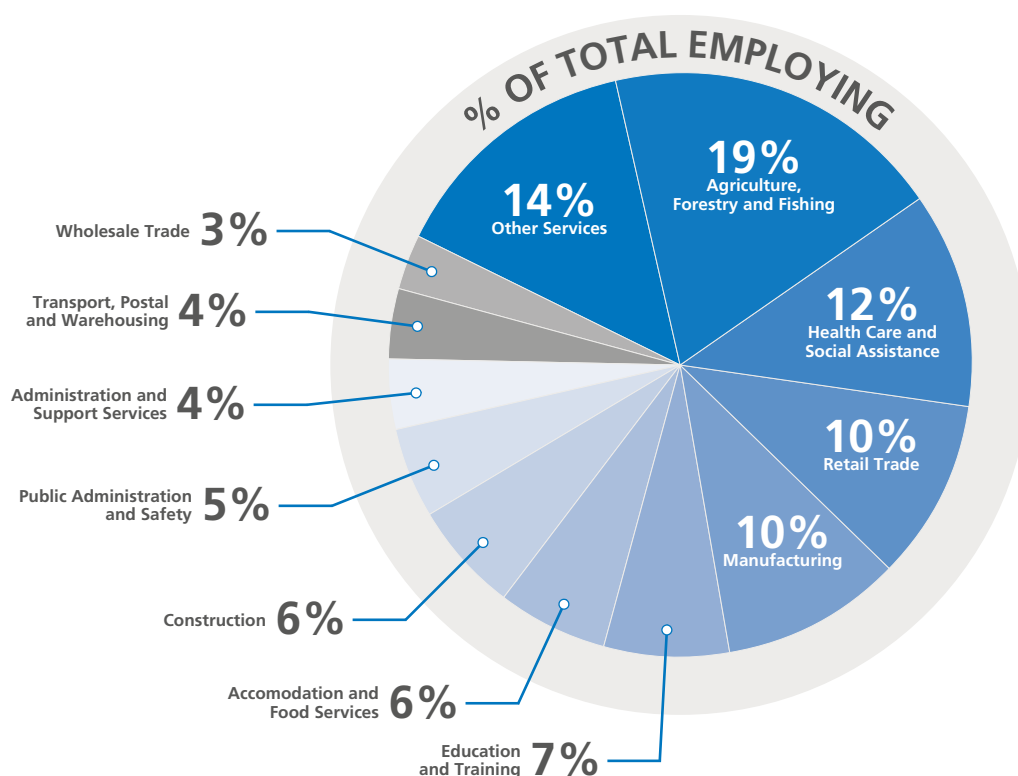
Community groups and volunteers play an important role in delivering natural resources management initiatives in the Riverland. There are 23 volunteer organisations registered with Natural Resources SA MDB for the district, and 749 registered volunteers who each undertake an average of 49 volunteer hours each year <sup>(27)</sup>.

### Recreation and tourism

The Riverland tourism region covers most of the Riverland district (as well as parts of the Rangelands and Mallee-Coorong districts). It is a popular area for tourists and visitors with peak periods in

March to April and September to November. The region offers a range of recreational opportunities focussed on the River Murray and conservation reserves such as Murray River National Park. The region attracted 426,000 visitors with a total of 690,000 overnight stays between 2010 and 2011 <sup>(28)</sup>. Annual surveys indicate that from 2010 to 2012 a total of 18 per cent of visitors to the area undertook water activities or sports, 12 per cent participated in fishing, 11 per cent bushwalked, 10 per cent held picnics or barbecues, and 6 per cent undertook some other outdoor activity <sup>(29)</sup>. Many visitor activities can place pressure on the River Murray and these impacts need to be managed. Examples of pressure include erosion from boat wash, loss of timber used for firewood and trampling of vegetation.

**Graph 6. Riverland main industries employing 2011 <sup>(16)</sup>**





### 3.8.1.3 Livelihoods

#### Industry and employment

Agriculture is the major employing industry of people over 15 years of age in the Riverland district (Graph 6). In 2011, 19 per cent of the population were employed in the agriculture, forestry and fishing industry. Other major contributors were health care and social services (12 per cent), retail trade (11 per cent), and manufacturing (10 per cent) <sup>(16)</sup>.

The major changes in employment between 2001 and 2011 were:

- a decline in agriculture from 28 per cent to 19 per cent
- a decline in manufacturing from 12 per cent to 10 per cent
- a decline in wholesale trade from 7 per cent to 3 per cent
- an increase in health care and social from 8 per cent to 12 per cent <sup>(16)</sup>.

The *Murray and Mallee Region Plan* identifies Berri and Renmark as locations to promote industrial growth <sup>(108)</sup>.

The *Riverland Regional Prospectus* seeks an increase in manufacturing outputs in excess of \$100 million and doubling of the current visitor nights to a total of 1.34 million per annum <sup>(91)</sup>.

#### Land use trends

In 2008 <sup>(20)</sup> the major land uses in the district were cropping (34 per cent), grazing of modified pastures (26 per cent), nature conservation (11 per cent) and irrigated perennial horticulture (6 per cent). The region also has a history associated with wine production and grape, citrus, stone fruit, almond and vegetable growing. Cropping and grazing occurs largely in the Northern Mallee landscape to the south of the river channel, although some occurs to the north. Between 2003 <sup>(21)</sup> and 2008 <sup>(20)</sup> the land area used for cropping increased from 15 per cent to 34 per cent, while the land area used for grazing of modified pastures decreased from 38 per cent to 26 per cent. It should be noted that these land uses may include land in a rotation system that is under another land use class at other times.

#### Landholder environmental issues

A 2010 <sup>(24)</sup> survey of commercial and lifestyle farmers in the Murray River corridor identified weed control, pest animal control and water quantity as the main issues impacting on their farming enterprise. Approximately 58 per cent of these landholders had taken steps to conserve native vegetation, including planting native trees and shrubs covering around 19 per cent of their total land area, and fencing 15 per cent of native vegetation on their land to permanently prevent stock access.

### 3.8.1.4 Community Adaptive Capacity Index

The adaptive capacity of the Riverland district community is substantially below the state average. Its vulnerabilities lie in a concentration of employment in one industry sector, an ageing population, a declining population, and a workforce with relatively low levels of formal qualification. Its strengths lie in its above average levels of volunteering, which is an indication of a socially cohesive community. There are communities within the region that present with significantly higher and lower capacities. A summary analysis done for each of the capitals in the district is provided below.

**Physical Capital Index:** remoteness, population size, population change and internet access

The district's physical capital is lower than the state average. It is comparatively remote, has below average internet access, a smaller than average population and has seen a decline in its population.

**Economic Capital Index:** household size economic diversity, median household income, income/housing cost, unemployment and mean

The district's economic capital is below the state average. It has a substantially low economic diversity due to employment being concentrated in the agriculture sector and sectors servicing the agricultural industry. Agriculture has experienced declining terms of trade and this is reflected in the substantially below average median household income and relatively high levels of unemployment. This is balanced by having an income to housing cost close to the state average and relatively small median household sizes.

**Human Capital Index:** percentage graduates, population 65 and over, percentage completed high school, one parent households, lone person households and females in non-routine occupations

The district's human capital is below the state average. It has a comparatively high proportion of elderly people, lone person households and single parent families. It also has a below average number of women in managerial or technical occupations and a substantially lower number of graduates and number of people who have completed high school.

**Social Capital Index:** voluntary work

The district's social capital is slightly above the state average. The level of volunteering is above average, which is an indication of a socially cohesive community.

# 4 The context of the plan

## 4.1 Supporting legislative and policy framework

The Regional NRM Plan is the primary document guiding the management of natural resources in the region, but it does not exist in isolation. The plan links with a range of other related plans, policies and legislation at the local, regional, state and federal scale. Some of the key relationships that directly impact on the form, content and implementation of the Regional NRM Plan are listed below.

### 4.1.1 Local

#### Local government development plans

The *Natural Resources Management Act 2004* seeks alignment between regional NRM plans and the development plans of the fifteen local in the SA MDB NRM region. Development has the potential to impact on natural resources and it is therefore important that development plans are consistent with the objectives of the NRM Act and regional natural resources management plans.

### 4.1.2 Regional

#### Water Allocation Plans

Water Allocation Plan (WAP) is a legal document that sets out the rules for managing the take and use of prescribed water resources to ensure resource sustainability. It is developed with the community, industry and key stakeholders for each water resource identified as being significant, or 'prescribed' under the *Natural Resources Act 2004*. A WAP ensures that the needs of the environment are taken into account when determining how much water is made available for consumptive purposes (licensed and non licensed). It sets the amount of water that will be available, how that water may be allocated to users, and the types of activities that are permitted with that water. Once prepared, a WAP is considered part of the Regional NRM Plan, but is prepared under a separate planning process and is adopted separately by the Minister for Sustainability, Environment and Conservation. There are currently six WAPs prepared in the SA MDB NRM Region which can be found at [www.naturalresources.sa.gov.au/samurraydarlingbasin/water/water-allocation-plans](http://www.naturalresources.sa.gov.au/samurraydarlingbasin/water/water-allocation-plans).

#### Kungun Ngarrindjeri Yunnan Agreement

The Kungun Ngarrindjeri Yunnan (KNY) Agreement seeks to enable active Ngarrindjeri participation in caring for the region by making Ngarrindjeri cultural values integral to all planning and management arrangements for the region's land and water. The KNY Agreement<sup>(92)</sup> was signed by the Government of South Australia and the Ngarrindjeri Regional Authority (NRA) in 2009. A taskforce of representatives from the State Government and the NRA was formed to support the implementation of commitments under the KNYA. The Agreement also acknowledges that it is

important for the Ngarrindjeri to gain economic benefit from the management of protected areas, including game reserves, marine parks, conservation parks and national parks.

#### First Peoples of the River Murray and Mallee Region Indigenous Land Use Agreement

In 2011, the First Peoples of the River Murray and Mallee Region were recognised as native title holders of approximately 260 square kilometres of land and waters in the Riverland. The First Peoples of the River Murray and Mallee Region subsequently entered into an indigenous land use agreement that sets out the terms of their ongoing relationship with other parties. This includes protocols for protecting sites and objects of significance, planning protocols for development activities and agreement on benefits to be granted to the native title holders, for example the transfer of several freehold blocks of land<sup>(94)</sup>.

#### Coastal Action Plans

Coastal Action Plans have been developed for defined coastal boundaries in South Australia on behalf of Natural Resources Management Boards and local government. The plans establish conservation priorities for places and areas within each coastal region, and outline suggested actions to address threatening processes. The *Limestone Coast and Coorong Coastal Action Plan and Conservation Priority Study (2011)* covers the area between the mouth of the River Murray and the South Australia and Victoria border. The *Southern Fleurieu Coastal Action Plan and Conservation Priority Study (2007)* covers the area between Hindmarsh Island and Sellicks Beach on the eastern side of the Gulf St Vincent.

#### Land and Water Management Plans

Land and Water Management Plans (LWMP) aim to improve the practices of the irrigation industry by limiting impacts on soil and water resources. There are 21 LWMP zones in the SA MDB NRM region and plans are based on guidelines developed by the SA MDB NRM Board and the Department for Environment, Water and Natural Resources. Effective engagement is required from a sufficient number of landholders to adopt and implement these plans in local areas within the region.

#### Regional Pest Management Plan

A key focus of this Regional NRM Plan is the effective management of threats to biodiversity and agricultural production arising from the impacts of pest plants and animals. This is supported by the Regional Pest Management Plan which identifies key land uses within the region and provides clear guidelines for prioritising pests within the identified land uses. The Regional Pest Management Plan takes a risk management approach that is consistent with state and national plans. The SA MDB NRM Board is one stakeholder involved in implementing the Regional Pest Management Plan by educating landholders on the benefits of investing in the control or removal of new and emerging priority pest species, and encouraging broad community participation in the management of widespread pests.

### **Regional Development Australia (RDA): Murraylands and Riverland Draft Regional Road Map 2013 - 2016**

The *Regional Development Australia Murraylands and Riverland: Draft Regional Road Map 2013 – 2016* <sup>(96)</sup> provides an overview of the challenges and opportunities for regional economic growth and development in the Murraylands and Riverland region. The Road Map outlines a vision for the Region, the role of the RDA, an analysis of the Region, regional priorities and RDA activities, which are reviewed and updated annually. The Road Map is consistent with the Council of Australian Governments' commitment to a common approach to promoting regional economic growth and guiding regional economic development.

### **Securing the future: A long-term plan for the Coorong, Lower Lakes and Murray Mouth**

The purpose of this plan is to provide a clear direction for the future management of the Coorong, Lower Lakes and Murray Mouth region. It is to be used as an active management document and will be regularly reviewed. While based on science and interpreted with local knowledge, the plan will also be responsive to cultural and community guidance and direction, new forms of governance, and the development of a close working relationship with the Ngarrindjeri Regional Authority <sup>(97)</sup>.

## **4.1.3 State**

### **South Australia's Strategic Plan**

*South Australia's Strategic Plan* <sup>(40)</sup> is the key planning document of the Government of South Australia. It sets the strategic direction for the state across a wide range of social, economic and environmental areas. The plan was revised in 2011 in consultation with the community and includes 21 new targets. The targets for Climate Change Adaptation, Lose No Species, Sustainable Land Management, Marine Biodiversity, Nature Conservation, Recycled Stormwater and Wastewater, Sustainable Water Use, and River Murray (Flows and Salinity) must be recognised and addressed as appropriate in the Regional NRM Plan (refer Table 3. section 4.2).

### **State NRM Plan**

The State NRM Plan (*Our Place Our Future: State NRM Plan 2012-2017*) <sup>(12)</sup> is prepared by the State NRM Council as a requirement of the *Natural Resources Management Act 2004*. It contains state-wide policy for managing natural resources and provides a framework for regional natural resources management plans and state agency activities. The State NRM Plan includes a vision, three goals and fourteen targets that are associated with the assets of soil, water, biodiversity and people. The plan includes priority actions to strengthen the natural resources management system, along with seven principles to guide decision making and project development. A regional NRM plan must be consistent with the State NRM Plan (refer Table 4. section 4.2).

### **Department of Environment, Water and Natural Resources Corporate Plan 2012 – 2014**

The Department of Environment, Water and Natural Resources (DEWNR) works in partnership with the state's eight natural resources management boards to advise, inform and support community and government decision-making and deliver services to communities. The Corporate Plan <sup>(98)</sup> outlines DEWNR's role, approach, and priorities, along with the values and principles that guide the department's work.

### **South Australian legislation**

South Australia's legislative framework for the sustainable management of the state's natural resources includes the *River Murray Act 2003* (SA), *Environment Protection Act 1993* (SA) and *Natural Resources Management Act 2004* (SA). The *Natural Resources Management Act 2004* requires the Regional NRM Plan to be consistent with this legislation. A full list of relevant legislation is provided below under the heading 'Consistency with legislation and policy'.

### **The NRM Standard for South Australia**

The implementation of an NRM Standard for South Australia is identified as a priority within the State NRM Plan and is currently under development. The purpose of *The NRM Standard for South Australia* <sup>(99)</sup> is to ensure that there is consistency in how people manage natural resources across regions and within agencies. The NRM Standard is a checklist for all natural resources management practitioners that encourage adaptive management and continuous improvement.

### **Natural resources management: State and Condition Reporting Framework SA 2012**

The development of an integrated NRM Reporting Framework was identified as a priority within the *State NRM Plan 2012 – 2017*. A draft version that provides guidelines for reporting on the state and condition of natural resources was released by the Government of South Australia for trial implementation in 2012 <sup>(100)</sup>. Its implementation will provide regional and state-wide managers of natural resources with timely and accurate information to inform their planning, management and investment decisions.

### **Water for Good**

*Water for Good* (WfG) is South Australia's water security plan that aims to secure the future of the state's water to 2050 and beyond <sup>(101)</sup>. Released in June 2009, WfG outlines 94 actions aimed at ensuring that water supplies are secure, safe, diverse, reliable and able to sustain a growing population, as well as a growing economy in a changing climate. The plan also outlines how the state can recycle storm water and wastewater to take pressure off the River Murray and other rain-dependent sources of water.



## **A Climate Change Adaptation Framework for South Australia (August 2012)**

The climate change adaptation framework *Prospering in a Changing Climate* <sup>(102)</sup> is the South Australian Government's climate change adaptation strategy. It sets the foundation for South Australians to be better prepared for the impacts of climate change. The framework will guide actions taken by business, the community, non-government organisations, the research sector, local government and state government agencies to develop well informed and timely adaptation responses. The framework includes adaptation responses for the following areas of the SA MDB NRM Region:

- Adelaide Hills (part only)
- Barossa (part only)
- Fleurieu and Kangaroo Island (part only)
- Murray and Mallee
- Yorke and Mid North (part only).

## **Conserving Nature 2012 – 2020**

*Conserving Nature 2012 - 2020: A strategy for establishing a system of protected areas in South Australia* <sup>(103)</sup> guides the creation of the state's terrestrial and inland aquatic protected area system. The strategy has three main objectives:

1. conserve the full range of ecosystems
2. build the capacity of natural systems to adapt to climate change and other stressors
3. protect places of special meaning for people.

It assists decision-making by the state government, non-government organisations and others about where to establish new protected areas so that they achieve the best conservation and community outcomes.

## **No Species Loss: A Nature Conservation Strategy for South Australia (2007 – 2017)**

*The No Species Loss: A Nature Conservation Strategy for South Australia (2007-2017)* <sup>(104)</sup> outlines what is required within the next ten years to protect the state's species and ecosystems from further losses. It includes five goals that must be achieved to prevent species extinctions:

- conservation of South Australia's biodiversity
- community ownership and stewardship for biodiversity
- ecosystem knowledge that can influence decision making
- adjustment to the impacts of climate change
- active and integrated natural resources management partnerships.

The strategy also recognises that some of the damage done to native ecosystems may take hundreds of years to repair, if this is possible at all.

## **NatureLinks**

NatureLinks is a practical approach to conserving the state's native flora and fauna by managing and restoring large areas of habitat across the state within five broad 'biodiversity corridors'. The NatureLinks program is an initiative of the Government of South Australia and works in partnership with conservation organisations, landholders and local communities. There are two NatureLinks corridors within the SA MDB NRM region. The Cape Borda to Barossa NatureLink includes the south-west portion of the SA MDB NRM region. It stretches from Kangaroo Island and its surrounding waters across to the Fleurieu Peninsula, Mount Lofty Ranges, the greater Adelaide region and Barossa Valley, and includes the central and eastern waters of Gulf St Vincent. The River Murray to South-East NatureLink travels the full 650 kilometre length of the River Murray in South Australia to the Coorong and lakes area surrounding the river mouth, before continuing along the interlinking water courses that run to the Victorian border <sup>(105)</sup>.

## **Code of Practice for Fire Management on Public Land in South Australia**

South Australia has developed a Code of Practice for Fire Management on Public Land in South Australia that sets out how public land fire managers (DEWNR, SA Water and ForestrySA) and the Country Fire Service manage bushfire risk on public land. This code aims to strike a balance between the essential protection of life and property and maintaining and enhancing the long-term resilience of the South Australian environment. DEWNR also prepares Fire Management Plans for high risk regions across South Australia, including Billiatt District and Bookmark Mallee in the SA Murray-Darling Basin. These plans enable DEWNR to take a strategic approach to fire management activities such as prescribed burning, maintaining fire access tracks and infrastructure and fuel reduction works.

## **South Australia's Parks – Management Plans**

South Australia's parks include all reserves proclaimed under the *National Parks and Wildlife Act 1972* (NPW Act), Wilderness Protection Areas or Zones under the *Wilderness Protection Act 1992* (WP Act), Marine Parks under the *Marine Parks Act 2007* (MP Act) and Conservation Reserves dedicated to the Minister under the *Crown Land Management Act 2009* (CL Act). The SA MDB NRM region includes parks under each of these Acts. The NPW Act, WP Act and MP Act outline the requirements for the preparation of management plans for reserves, co-managed parks, Wilderness Protection Areas or Zones, and Marine Parks. Plans must, amongst other things, set forth proposals of the Minister in relation to their management (usually over a 10-year period). There is no legal requirement to prepare a management plan for a conservation reserve under the CL Act.

## Living with wildlife

Native animals are wild animals, whether they live in natural areas such as national parks and reserves, or in our own backyards. Many species are capable of surviving in cities, suburbs and towns. They have learned to rely on their instincts and a whole new range of behaviours to survive. While wildlife management is often thought of in terms of protecting and nurturing wildlife populations and the habitat they live in, wildlife management also includes managing conflict between wildlife and human interests. Within the SA MDB NRM region, changing land use and the increasing spread of suburbia means that wildlife compete with humans for food, water, refuge and space. A living with wildlife approach to how we think and interact with wildlife will be supported through the Regional Action Plan.

## Draft State Biosecurity Policy

The *Draft State Biosecurity Policy 2013-2016: growing sustainable regions* <sup>(95)</sup> was developed by the State Biosecurity Committee.

The policy's objective is to "protect and improve SA's economic, environmental, social assets and public health by preventing and reducing the negative impacts of pests and diseases, maintaining food safety and supporting responsible rural chemical use".

The policy is consistent with the principles and aims of the *Intergovernmental Agreement on Biosecurity* <sup>(106)</sup> and has the following five priority elements to inform planning and operations at the state and regional level:

- biosecurity risks to the integrity and reputation of SA's primary products, including food, are effectively managed
- government agencies will work together with industry and the community to enhance biosecurity
- government agencies will respond to pests and disease threats, food safety risks and contaminants through a coordinated and effective biosecurity system
- the spread of pests and diseases within SA will be managed to reduce economic, social and environmental impacts
- incursions of new pests and diseases will be detected early and contained to enable eradication whenever possible.

## South Australian Food Strategy 2010 – 2015

The gross state revenue raised from food has been growing at an average of 5 per cent per annum over the past decade and reached a record high of \$12.4 billion in 2008 to 2009. To remain internationally competitive, the food production industry must continue to meet consumer expectations by being sustainable, well managed and consumer driven. *The South Australian Food Strategy 2010 – 2015* <sup>(107)</sup> is applicable to the whole food value chain, starting from the consumer and working back through retail, distribution, processing and the producer. Six priorities for South Australian food provision have been developed by industry and government for the strategy.

## The Planning Strategy for South Australia

The Planning Strategy for South Australia outlines the state government's direction for land use change and development within South Australia. The strategy has various volumes covering different geographic areas of the state and includes the 30 Year Plan for Greater Adelaide <sup>(71)</sup> and the Murray and Mallee Regional Plan <sup>(108)</sup>. The 30 Year Plan for Greater Adelaide identifies Mount Barker, Murray Bridge, Goolwa and Hindmarsh Island as strategic new growth areas for steady population growth, the construction of additional homes and creation of jobs for South Australia. The Murray and Mallee Regional Plan identifies Berri, Murray Bridge, Monarto, Renmark and Tailem Bend as locations to promote industrial growth as part of their coordinated and integrated vision for development and land use in the region. Planning directions outlined in the Planning Strategy are translated into local policy by councils and incorporated into local government development plans. Each volume of the Planning Strategy is reviewed every five years

### 4.1.4 Federal

#### Basin Plan and *Water Act (Commonwealth) 2007*

The Commonwealth's *Water Act 2007* established the Murray-Darling Basin Authority (MDBA) with functions and powers to ensure that the Murray-Darling Basin is managed in an integrated and sustainable manner. A key management tool is the Murray-Darling Basin Plan. The plan <sup>(85)</sup> sets sustainable limits on the volume of water that can be taken from surface and groundwater systems across the Basin. Water resource plans need to comply with the Plan's provisions for South Australia and be in place by 1 July 2019. The water resource plans will be made up of one or more water allocation plans and water quality management plans, as well as other relevant policies and plans. Water allocation plans will incorporate many of the requirements of the Basin plan, including rules for complying with new sustainable diversion limits, planning for environmental outcomes and water trading rules. *The Murray-Darling Basin Plan: South Australian Implementation Strategy 2013-2019* outlines the key actions that will be pursued to ensure the Basin Plan is fully integrated into South Australia's water management arrangements. The Regional NRM Plan must be consistent with the relevant provisions of the Basin plan (refer to section 4.2 of this document).

### Caring for our Country 2013-2018

The Australian government's Caring for our Country initiative aims to ensure the environment is healthier, better protected, well-managed and can provide essential ecosystem services in a changing climate.

*The Caring for our Country investment priorities for 2013 to 2018* are focused under two streams. The Sustainable Agriculture stream, delivered by the Department of Agriculture, Fisheries and Forestry, will support work to achieve a sustainable, productive and resilient agricultural base for Australia. The Sustainable Environment stream, delivered by the Department of Sustainability, Environment, Water, Population and Communities, will support work that contributes to the government's objectives for improved outcomes at landscape, seascape and ecosystem scales, while continuing to meet legislated responsibilities <sup>(109)</sup>.

### National Water Initiative

The National Water Initiative (NWI) is an intergovernmental agreement to improve water management across Australia. The agreement was established in 2004 and set out to achieve a nationally compatible market, regulatory and planning based system for managing surface and groundwater resources for rural and urban use. The NWI includes objectives, outcomes and agreed commitments across eight inter-related elements of water management, including improved river flows, water use efficiency and re-use of urban storm-water and grey-water <sup>(110)</sup>.

### National Water Quality Management Strategy

The *National Water Quality Management Strategy* (NWQMS) was developed by the Australian and New Zealand governments. It aims to protect the nation's water resources by improving water quality, while supporting the businesses, industry, environment and communities that depend on water for their continued development. The strategy outlines a step by step process for planning, implementing and managing water quality projects. Natural resources management programs and projects that address water quality should involve processes that are consistent with the framework established by the NWQMS. <sup>(111)</sup>

### National Food Plan: Our food future

The Australian Government has developed Australia's first *National Food Plan* <sup>(112)</sup> to help ensure that the government's policy settings are right for Australia over the short, medium and long-term. The vision for Australia's food system is a sustainable, globally competitive, resilient food supply supporting access to nutritious and affordable food. The plan sets goals for the nation for 2025 under the themes of growing exports, thriving industry, families and communities, global food security, and sustainable food.



### National Wildlife Corridors Plan

The *National Wildlife Corridors Plan*<sup>(114)</sup> is the Australian Government's framework to retain, restore and manage ecological connections in the Australian landscape. It lays the foundation for a new, collaborative, whole-of-landscape approach to biodiversity conservation that is based on voluntary cooperation and the efforts of communities, landholders, governments and industry. The role of the Australian Government is to enable and coordinate the efforts of all participants. A five-point plan of action will help implement the plan, including developing and supporting corridor initiatives, establishing enduring institutional arrangements, promoting strategic investment in corridors, working with key stakeholders and supporting regional natural resources management planning, and monitoring and evaluation reporting.

### Australia's Biodiversity Conservation Strategy (2010 – 2030)

*Australia's Biodiversity Conservation Strategy 2010-2030*<sup>(115)</sup> provides a framework for conserving Australia's biodiversity over the coming decades. It ensures that implementation is a shared responsibility across all levels of government, the community and the private sector. The strategy highlights three priorities for action to help stop the decline in Australia's biodiversity:

1. engaging all Australians
2. building ecosystem resilience
3. getting measurable results.

### Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)

The *Environment Protection and Biodiversity Conservation Act 1999* is the Australian Government's central piece of environmental legislation. It provides a framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places which are referred to as "matters of national environmental significance". The Act establishes a process for the assessment of proposed actions that are likely to have a significant impact on these species, communities or places, and the process for creating recovery plans. Recovery plans set out the research and management actions necessary to stop the decline and support the recovery of listed threatened species or threatened ecological communities. The aim of a recovery plan is to maximise the long term survival of a threatened species or ecological community in the wild.

### Australian Weeds Strategy 2007

The *Australian Weeds Strategy 2007*<sup>(116)</sup> aims to minimise the impact of weeds on Australia's environmental, economic and social assets. It provides guidance for all parties involved in weed management and identifies priorities for management across Australia. The strategy has three goals and is underpinned by seven broad weed management principles. The three goals are:

1. prevent new weed problems
2. reduce the impact of existing priority weed problems
3. enhance Australia's capacity and commitment to solve weed problems.

### Australian Pest Animals Strategy 2007

The focus of the *Australian Pest Animal Strategy 2007*<sup>(117)</sup> is to address the undesirable impacts caused by exotic vertebrate animals (mammals, birds, reptiles, amphibians and fish) that have become pests in Australia, and to prevent the establishment of new exotic vertebrate pests. The strategy is based on 12 key principles, including using good science to underpin management, using a risk management approach, building capacity to manage pests, prevention and early intervention, and developing a clear understanding of the roles and responsibilities of all parties involved.

### National Bushfire Management Policy

The Australian Government and state and territory governments have developed the *National Bushfire Management Policy*<sup>(118)</sup> with supporting strategies to guide the development of effective and ecologically sustainable fire regimes in Australia. The policy prioritises the protection of life, but also identifies the need to consider the provision of ecosystem services. The policy contains a vision and fourteen national goals to support implementation. While the policy largely covers public lands, the general issues and principles apply more widely. In South Australia, Ecological Fire Management Guidelines have been developed for all fire-prone vegetation types that occur in agricultural areas of the State.



## 4.2 Consistency with legislation and policy

The detailed connection between the Regional NRM Plan and other plans and Acts is outlined here.

### South Australia's Strategic Plan

South Australia's Strategic Plan 2011 <sup>(40)</sup> sets social, economic and environmental targets for the state. In doing so, it sets a framework for the future activities of South Australian Government agencies and authorities, as well as for businesses and the entire community. The Regional NRM Plan must recognise and address these state policy directions. South Australia's Strategic Plan

sets out six interrelated priorities with associated visions and targets for the measurement of success. The Regional NRM Plan directly contributes to the priorities of Our Community and Our Environment. Table 3 shows how the targets of this plan contribute to the relevant targets in South Australia's Strategic Plan.

**Table 3. Alignment of Resource Condition Targets in the SA MDB NRM Plan <sup>(33)</sup> with targets in South Australia's Strategic Plan (40)**

South Australia's Strategic Plan (SASP) Targets		SAMDB NRM Plan Resource Condition Targets										
		P1	P2	P3	W1	W2	W3	B1	B2	L1	A1	A2
SASP Vision: we are connected to our communities and give everyone a fair go.												
23	Social participation											
24	Volunteering											
27	Understanding of Aboriginal culture											
28	Aboriginal Leadership											
SASP Vision: South Australian's think globally, act locally and are international leaders in addressing climate change.												
59	Reduce greenhouse gas emissions											
62	Adapt to climate change											
SASP Vision: we look after our natural environment.												
69	Lose no species											
70	Sustainable land management											
71	Marine biodiversity											
72	Nature conservation											
SASP Vision: we value and protect our water resources.												
73	Recycled stormwater											
74	Recycled wastewater											
75	Sustainable water use											
76	River Murray - flows											
77	River Murray - salinity											

## Our Place Our Future: State NRM Plan 2012-2017

The *Our Place Our Future: State Natural Resources Management Plan South Australia 2012-2017* (State NRM Plan)<sup>(12)</sup> was prepared by the NRM Council as a requirement under the *NRM Act 2004*. It contains strategic policy at the state-level for managing South Australia's natural resources and provides a broad framework for both regional NRM plans and state agency activities. A regional NRM plan must be consistent with the State NRM Plan, pursuant to Section 75 of the *Natural Resources Management Act 2004* (refer to Table 4).

**Table 4. Alignment of Resource Condition Targets in the SA MDB NRM Plan with Guiding Targets of the State NRM Plan<sup>(12)</sup>**

State NRM Plan Guiding Targets		SAMDB NRM Plan Resource Condition Targets										
		P1	P2	P3	W1	W2	W3	B1	B2	L1	A1	A2
1	Ensure people are better informed and improve capacity in NRM decision making.											
2	Involve more people in the sustainable management of natural resources.											
3	Improve institutional and organisational capacity to support people to manage natural resources.											
4	Improve capacity of individuals and community to respond to climate change.											
5	All NRM planning and investment decisions include ecological, social and production considerations.											
6	Maintain the productive capacity of our natural resources.											
7	Improve soil and land condition.											
8	Increase extent and improve condition of native vegetation.											
9	Improve condition of terrestrial aquatic ecosystems.											
10	Improve condition of coastal and marine ecosystems.											
11	Increase understanding of the condition of landscapes.											
12	Improve the conservation status of species and ecological communities.											
13	Limit the establishment of pests and diseases and reduce the impacts of existing pests.											

 Primary alignment  Secondary alignment

### State Legislation

The Regional NRM Plan is consistent with relevant sections of the following South Australian Acts, pursuant to section 75 of the *Natural Resources Management Act 2004*:

- *Coast Protection Act 1992*
- *Development Act 1993*
- *Environment Protection Act 1993*
- *Marine Parks Act 2007*
- *Mining Act 1971*
- *National Parks and Wildlife Act 1972*
- *Native Vegetation Act 1991*
- *Natural Resources Management Act 2004*

### River Murray Act 2003 (SA)

The *River Murray Act 2003 (SA)* provides for the protection and enhancement of the River Murray and related areas and ecosystems. While the Act primarily deals with activities, it includes a set of objectives for River Murray river health, environmental flows and water quality. Regional NRM plans relating to the River Murray are required to promote these objectives, pursuant to Section 87 of the *Natural Resources Management Act 2004* (refer to Table 5).

### Basin Plan and the *Water Act (Commonwealth) 2007*

This Regional NRM Plan must be consistent with the relevant provisions of the Basin Plan, pursuant to Part 2 of the *Water Act 2007 (Commonwealth)* and Section 87(b)(ii) of the *Natural Resources Management Act 2004 (SA)*. Alignment will also be demonstrated through the preparation of water resource plans that are compliant with the Basin Plan. The following elements of the Basin Plan<sup>(85)</sup> must be addressed in the Regional NRM Plan and water allocation plans:

- risk assessments for water resource plan areas
- inclusion of a water quality plan within a water resource plan
- long-term average sustainable diversion limits for each resource unit, including ground and surface water resource units in South Australia
- arrangements to ensure sufficient flow to deliver critical human water needs (River Murray only)
- rules for the trading of water in the Basin
- planning and management of environment water monitoring, evaluation and reporting.



**Table 5. Alignment between the River Murray Act 2003 (SA) and the SA MDB NRM Plan's Resource Condition Target**

River Murray Act 2003 Objects (S.6) and Objectives (S.7) (abridged)		SAMDB NRM Plan Resource Condition Targets										
		P1	P2	P3	W1	W2	W3	B1	B2	L1	A1	A2
6(1)(a)	Protect, restore and enhance the River Murray, and sustain physical, economic and social wellbeing											
6(1)(b)	Ensure development benefits or protects the River Murray and economic, social and physical wellbeing											
6(1)(c)	Development/activities with adverse affects on the River Murray are prevented/regulated/ended											
6(1)(d)	Promote ecologically sustainable development (ESD) principles for use and management of River Murray											
6(1)(e)	Ensure new legislation/strategies reflect significance and wellbeing of the River Murray											
6(1)(f)	Respect interests and aspirations of indigenous people and their ability to contribute to ESD principles											
6(1)(g)	Respect interests of community and ability to contribute to ESD in relation to use and management											
6(1)(h)	Ensure future health; recognise importance of the River Murray											
7(2)(a)	Key habitat features maintained, protected and restored to enhance ecological processes											
7(2)(b)	River Murray environments, especially high value, are protected/restored											
7(2)(c)	Extinction of native species in the River Murray is prevented											
7(2)(d)	Barriers to migration of species in the River Murray system avoided/ overcome											
7(3)(a)	Ecological significance of flow regime reinstated/ maintained											
7(3)(b)	Murray Mouth kept open											
7(3)(c)	River Murray system connectivity significantly improved											
7(4)(a)	Water Quality improved to sustain ecological processes/ environmental values/ productive capacity											

Primary alignment      Secondary alignment

Continued next page



**Table 5. Alignment between the River Murray Act 2003 (SA) and the SA MDB NRM Plan's Resource Condition Target**

River Murray Act 2003 Objects (S.6) and Objectives (S.7) (abridged)		SAMDB NRM Plan Resource Condition Targets										
		P1	P2	P3	W1	W2	W3	B1	B2	L1	A1	A2
7(4) (b)	Impact of salinity minimised											
7(4) (c)	Nutrient levels managed to prevent algal blooms and impacts on ecological processes, etc.											
7(4) (d)	Impact of pollutants on the River Murray system minimised											
7(5) (a)	Responsive and adaptable approach to management of the River Murray											
7(5) (b)	Community's knowledge of River Murray system utilised to promote proper management of system											
7(5) (c)	Community interests considered and appropriate participation in management processes											
7(5) (d)	Importance of healthy river to economic, social and cultural prosperity of community recognised											



# 5 Methods, concepts and approaches

## 5.1 Landscapes, Livelihoods and Lifestyles: attributes of a socio-ecological approach

Natural resources management strives to achieve a balance between our collective need for resources and the needs of our environment. When practiced in an integrated way, natural resources management can improve both ecosystem resilience and agricultural productivity. However, natural resources management is a complex adaptive process that continually changes in ways that are not always easy to predict.

The Regional NRM Plan sets the strategic context and direction to maintain and improve the landscapes in the SA MDB NRM region in the context of the following livelihood, lifestyle and cultural values (refer also to Figure 8):

1. Lifestyle, spiritual and cultural values relate to the intrinsic value placed on areas, including community identity, landscape amenity, community needs and aspirations, and a sense of place.  
*Attributes: recreation, amenity, cultural identity and education*
2. Resource use values have an economic basis and relate to how people make a living.  
*Attributes: resource uses of major natural resource-based industries such as agriculture (dairy, cropping, grazing and horticulture), forestry, fishing, mining, tourism and conservation*
3. Landscape values relate to eco-system services and natural resource function and health.  
*Attributes: natural resource supply, natural resource health, soils, biodiversity, rivers, wetlands and estuaries*

## 5.2 A resilient approach to managing natural resources

A resilient approach to managing natural resources includes paying attention to drivers and change processes, treating socio-ecological systems as complex adaptive systems characterised by cycles and uncertainty, and considering social systems and ecosystems as coupled and co-evolving<sup>(6)</sup>. Local communities that understand the ecosystem drivers that relate to their region are able to anticipate and plan for the future by working within the processes of natural change.

“Resilience” as applied to ecosystems, or to integrated systems of people and the natural environment, has three defining characteristics:

1. the amount of change the system can undergo and still retain the same controls on function and structure

2. the degree to which the system is capable of self-organisation
3. the ability to build and increase the capacity for learning and adaptation.

Restoring or maintaining systems to a more desirable state can be complex, expensive or impossible. It is better to identify critical thresholds before they are crossed. This requires an understanding of what drives changes to the state of a system in order to design projects and programs that manage those drivers.

### State and transition models

State and transition models are used to describe a system’s dynamics and are an intuitive, flexible and transparent approach to conceptualising a decision problem<sup>(120)</sup>. They illustrate knowledge on the different “states” of a system based on how it responds to change in key drivers. States vary in their structure and function and also in their ability to resist change. State and transition models help distil thinking about the management requirements to either maintain or transition an asset into a desired state. State and transition models have wide-spread application ranging from health, economics and environment.

### Drivers of change

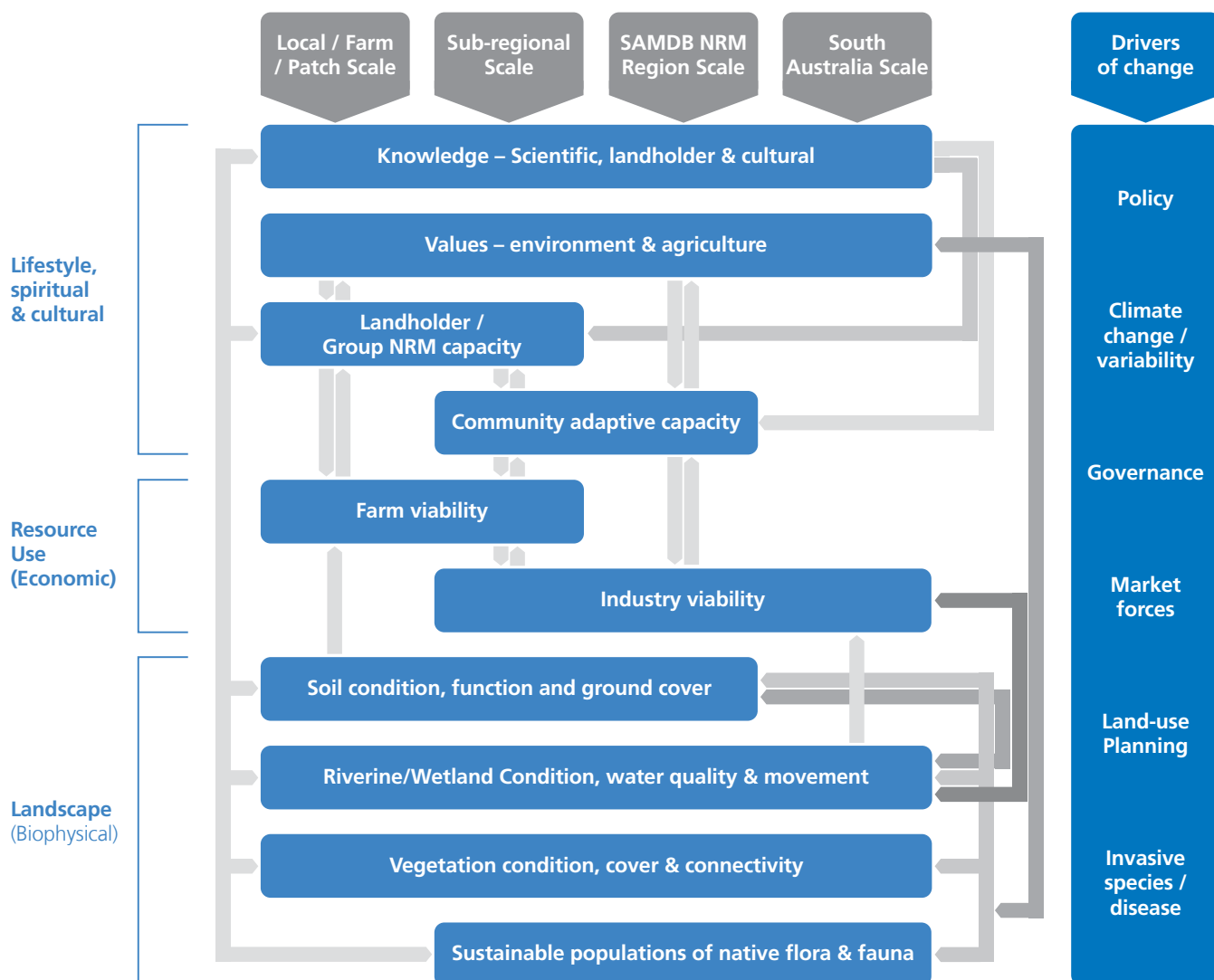
Both natural and human-induced actions can drive direct or indirect change in a system<sup>(6)</sup>. A direct driver explicitly influences ecosystem processes and can be categorised as physical or biological, such as changes in land-use or the introduction of a pathogen or invasive species. Indirect drivers operate by altering one or more direct drivers. For example, global drivers such as changes in demography, technology, policy and perverse subsidies can encourage an unsustainable use of resources. These drivers of change can be slow forces like changes to climate, or rapid “shocks” such as floods and bushfires. Drivers of change are usually unpredictable and complex in their origins and interactions. They also operate at different scales and to varying degrees.

### Identifying local threats and developing priority actions

Local threats are the result of drivers of change that impact quickly and directly on our socio-ecological landscapes. While these drivers often cannot be influenced directly, the threats they create can be managed. The concept of resilience thinking is to focus management on a smaller number of threats that control the way complex systems function and the thresholds within which the system can continue to function in a desired way.

The Strategic Plan and the Regional Action Plan focus on the critical actions necessary to protect some of the region’s most important natural resource assets. Using this approach the Regional Action Plan will identify critical thresholds that are immediate priorities for natural resources management intervention.

Figure 8. Diagram showing different relationships between systems (modified from Central West Catchment Action Plan 2011 – 2021) <sup>(119)</sup>





### 5.3 Evidence-based approach

An “evidence-based approach” uses the best available science or evidence in making decisions. In order to achieve defined objectives, decision-makers need to know the likely outcomes, risks and uncertainties of alternative actions <sup>(121)</sup>. Limited resources should be invested in activities that the evidence shows to be effective, or more likely to be effective. Decisions and subsequent management practice should be accountable and underpinned by appropriate rationale so that these reasons can be traced, checked and justified. Documented responses from previous studies provide a solid foundation for allocating scarce resources and can reduce the time taken to develop optimal management policies. Properly designed evaluations include the following elements <sup>(122)</sup>:

1. experiments with adequate statistical power to detect effect sizes and distinguish between alternative hypotheses
2. methodical reviews of research conducted according review standards
3. clarifying what is driving changes to a system
4. assembling and evaluating data
5. interpreting and translating results into formats useable by decision-makers
6. disseminating knowledge gained through the evaluation.

#### Evidence- based practice and adaptive management

Adaptive management is an iterative process that provides a foundation for making decisions on the management of natural resources. An adaptive management approach involves developing standards of evidence, creating an evidence and assessment library, developing conceptual models and producing case studies of real-life natural resources management planning decisions <sup>(122)</sup>. These case studies should be developed in partnership with resource scientists and land managers to ensure they address practical issues that land managers face. Properly designed monitoring programs should manage uncertainty and improve future management decisions as new information comes to light. Central to the adaptive management approach is a robust and effective decision support system which needs to effectively capture, store and interpret information and management and investment decisions <sup>(121) (123)</sup>.

One way to improve the standard, transparency and defensibility of natural resources management planning decisions is to combine adaptive-management with evidence-based practices <sup>(122)</sup>. Using well supported conceptual models of the system; evidence-based methods can identify different options for management interventions, provide the evidence for hypothesized responses, and provide scientists and managers with confidence in proposed models. Using evidence-based practice can play an important role in supporting the adaptive management cycle. The role of neutral research advice is imperative in this process as it provides guidance on:

1. how to judge what is ‘best available science’
2. how decision-makers can get this knowledge
3. how to integrate this knowledge into decision-making.

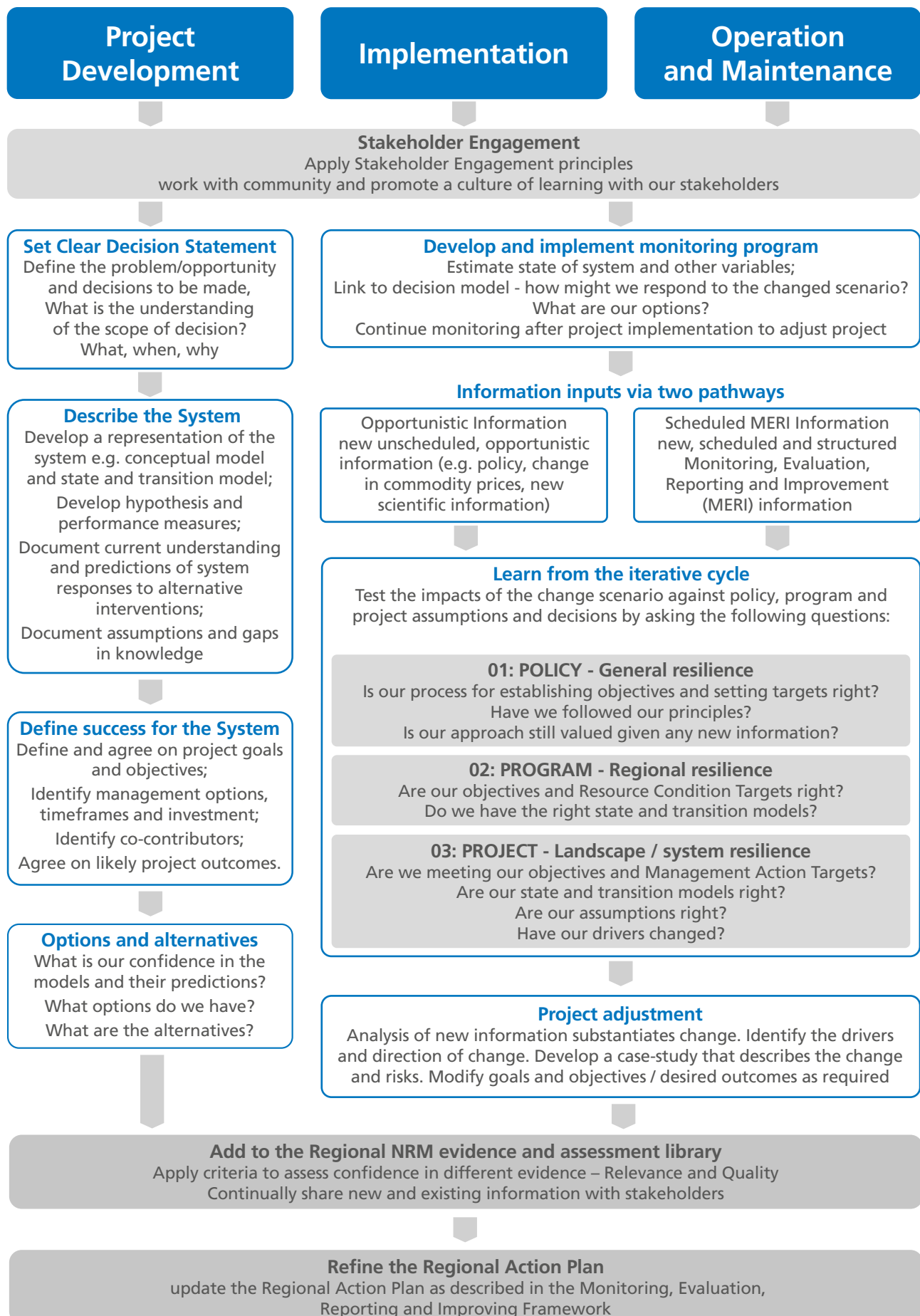
#### Applying an adaptive management framework

There is often a high degree of urgency associated with interventions to preserve natural resources, so developing certainty on a management response is not always possible given time and resource constraints. An adaptive management framework recognises that there are uncertainties in science, technology, the economy and politics and is therefore based on the following core principles to ensure an effective, flexible approach <sup>(123)</sup>:

1. promote stakeholder engagement, all-of-government collaboration and conflict resolution throughout planning processes by formulating goals and objectives
2. employ a formal science-based approach to developing system models and hypotheses and assess scientific and technical decisions likely to affect goals and objectives. This means being clear about the current understanding of the system being managed and predictions of how the system is expected to respond to the implementation of proposed projects and programs
3. incorporate flexibility and robustness throughout the project cycle, including planning, design and implementation. Allow for adjustments to be made as more is known about how the system responds to management intervention
4. continually incorporate scientific information into the decision making process to allow for changes as implementation proceeds. Link active monitoring of the systems to goals and objectives and assess and use these monitoring results to improve understanding
5. seek to use the most cost-effective approach to maximise system resilience.

A suggested step-by-step framework for an adaptive management approach is outlined in Figure 9.

Figure 9. Framework for an adaptive management approach <sup>(124)</sup> <sup>(125)</sup> <sup>(123)</sup> <sup>(4)</sup>



## 5.4 A framework for monitoring, evaluation, reporting and improvement in the SA MDB Region

Natural Resources SAMDB implements monitoring, evaluation, reporting and improvement (MERI) processes and programs in order to activate the adaptive management cycle. The purpose of this MERI framework is to provide strategic direction to the future content of a revised MERI plan.

The MERI Plan is a detailed document which includes:

- background on external and internal drivers for MERI
- the strategic direction for MERI in the region
- planning processes, goals and targets that the MERI Plan seeks to address
- elements of the Natural Resources SA MDB MERI approach, i.e. the various MERI activities undertaken
- the implementation program for the Natural Resources SA MDB MERI Plan.

Since the release of the 2009 Regional NRM Plan, Natural Resources SA MDB has undertaken several evaluation activities. The lessons learnt from these activities have influenced the following key guiding principles for the MERI Plan. The MERI Plan should:

- be useful and relevant to decision makers and planning activities
- be simple and communicable, affordable and practical
- use multiple lines of evidence, including qualitative and quantitative information
- use participatory processes and work together to share knowledge and experience
- develop a MERI philosophy, culture, understanding and broad participation at all levels of NRM
- create a flexible MERI approach to account for changing individual and organisational needs
- create ways to effectively and efficiently manage and share data, information and knowledge.

The main objectives of the MERI plan are to provide Natural Resources SAMDB with a process to:

- monitor the state and condition of natural resources in the region (relevant to the region's Resource Condition Targets) in order to improve our understanding of landscape dynamics and systems, and to evaluate the impact of our interventions
- assess progress towards the achievement of Management Action Targets through participatory processes by collating and evaluating multiple 'lines of evidence'
- evaluate and report on organisational and project performance to inform the annual planning and investment cycle
- provide effective and efficient reporting feedback to meet federal and state requirements enhance decision making at all levels of natural resource planning by contributing to an evidence based approach.

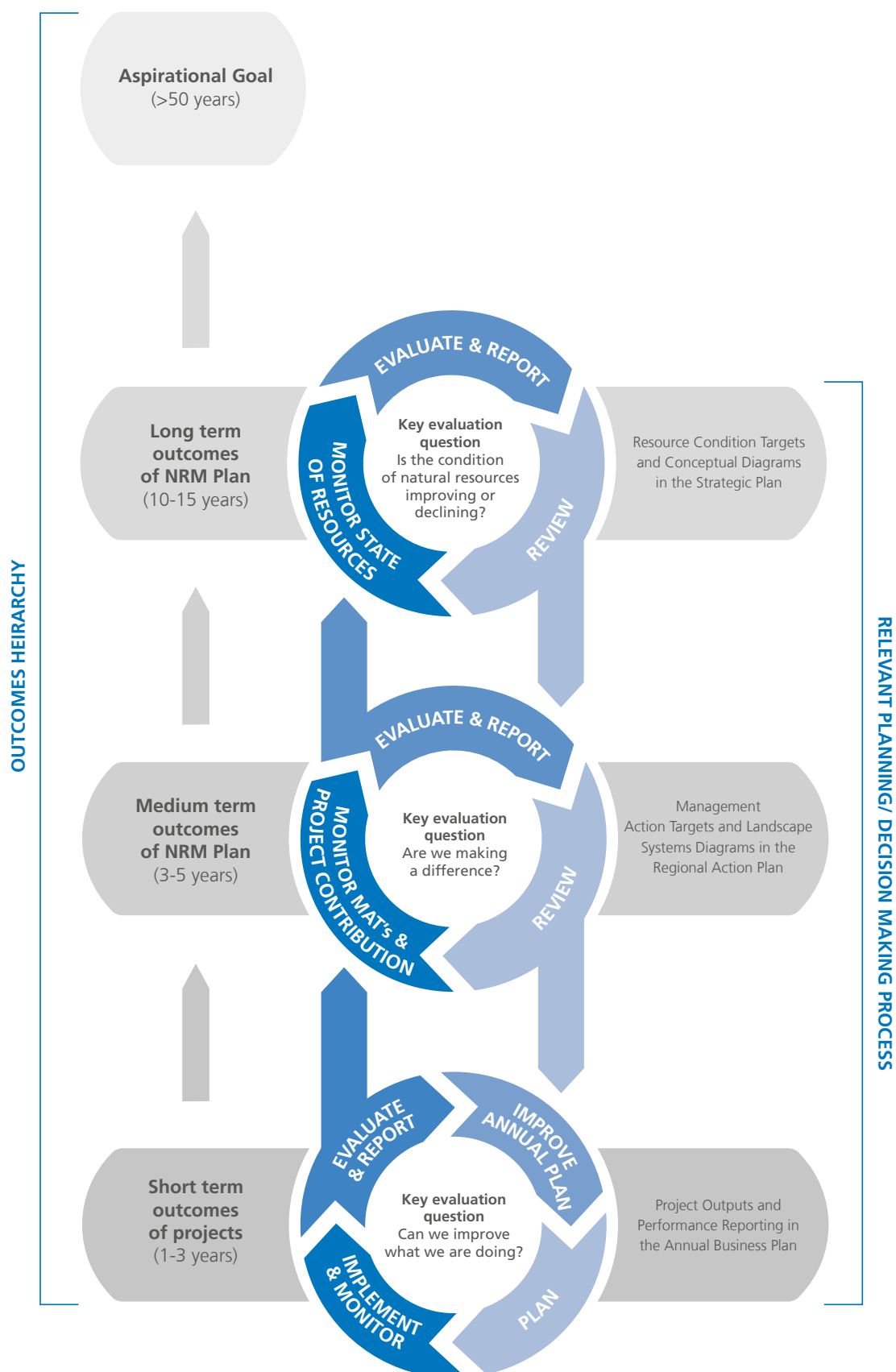
The MERI plan seeks to ensure transparency and accountability to all funders, partners, stakeholders and the community.

MERI concepts are well integrated into the existing business processes of Natural Resources SA MDB, however it is important to remain clear of the purposes. There are 3 levels of MERI in the existing NRM Planning cycle as outlined in Figure 10.

There are some significant challenges to implementing MERI in the management of natural resources, including:

- the length of time to detect changes in resource condition is usually far greater than the process required to make judgements about the impact of the actions taken and associated reporting
- monitoring is undertaken by many natural resources management partners. The task of coordinating data into relevant evidence for decision making at appropriate scales is very difficult. Great effort is needed to coordinate monitoring programs to provide more useful, scalable, priority data
- there are always new technologies, science and opinions about how to best monitor natural resources. Not all of these options are cost effective or achievable and it is important to commit to collecting data for long timeframes to detect changes
- finding the balance between how much is invested in MERI implementation versus the potential value of those resources invested 'on ground'.

Figure 10. Three levels of monitoring, evaluation, reporting and improvement (MERI)





## 5.5 Implementing the Regional NRM Plan

The Regional NRM Plan takes a new systems approach that describes how our landscapes work and interact. The function of systems will be further described in the Regional Action Plan, which will also describe where and how interventions need to happen. The systems approach affects the processes that are required to effectively implement the Regional NRM Plan by influencing:

1. the way priorities are set
2. the types of actions that might be implemented
3. the way stakeholders and community groups might be involved
4. the partners that might be involved to deliver the best results
5. the types of evidence and knowledge needed to analyse, understand and communicate how our landscapes function.

Key delivery partners that will contribute to the implementation of priority actions will be identified in the Regional Action Plan. The establishment of an Implementation Group is proposed to oversee the delivery of the Regional NRM Plan in the SA MDB NRM region in consultation with the SA MDB NRM Board. One of the first tasks of the group will be to develop governance structures and processes that will ensure actions are implemented in a way that is consistent with the goals and targets set for our natural resources. The group will establish a collaborative and united approach with the community to implement, review and refine the regional planning process. It will function as a delivery broker and provide support in overseeing the coordination of an all-of-government, all-of-community approach to stakeholder engagement, collaborative priority setting, investment planning, monitoring and evaluation, adaptation, and reporting <sup>(126)</sup>. The group will also be responsible for delivering an investment prospectus that will support new investment opportunities in the region.

### Method to identify implementers, partners and collaborators

1. Identify the priorities – which SA MDB NRM priorities are of concern to stakeholders and communities?
2. Identify who has a vested interest – how do stakeholders and the community's policy, planning and investment priorities align with the natural resources management priorities identified by Natural Resources SA MDB?
3. Identify priorities that overlap – identify which Natural Resources SA MDB priorities overlap with stakeholders.
4. Identify which priority actions are important – use priority actions to guide the development of stakeholder and community on-ground actions.
5. Identify what resources are available – cost the levels of investment and the capacity that stakeholders and communities have to contribute towards implementing priorities. Identify a time scale for implementation and "fit-for-purpose" monitoring and evaluation requirements.
6. Identify the scope for partnerships and collaboration – identify the roles and responsibilities of stakeholders, communities and Natural Resources SA MDB in meeting regional targets.



## 6 Glossary

**Acid sulfate soils:** the common name given to soils and sediments containing iron sulfides, the most common being pyrite. When exposed to air due to drainage or disturbance, these soils produce sulfuric acid, often releasing toxic quantities of iron, aluminium and heavy metals.

**Agricultural system:** a united assemblage of interacting and interdependent components within a prescribed area that achieve a specified agricultural objective, such as dairying, grazing and cropping.

**Agricultural zone:** generally areas south of Goyder's line with annual rainfall greater than 250 millimetres.

**Aquatic ecosystems:** an ecosystem located in a water body. The two main types are marine and freshwater ecosystems.

**Aquifer:** a layer of permeable rock, sand, or gravel through which groundwater flows and containing enough water to supply wells and springs.

**Australian Land Use and Management (ALUM) Classification (version 6):** a nationally consistent system for collecting and presenting land use information. The ALUM Classification has five primary levels of land use distinguished in order of generally increasing levels of intervention or potential impact on the natural landscape.

**Biophysical landscape:** A heterogeneous area of local ecosystems and land uses that is of sufficient size to achieve long term outcomes in the maintenance and recovery of species or ecological communities, or in the protection and enhancement of ecological and evolutionary processes.

**Biosecurity:** the management of risks and potential harm to people, our environment and economy from pests and diseases, or misuse of agricultural and veterinary chemicals.

**Biosequestration:** see Carbon sequestration.

**Biota:** all living organisms in a given area, including fungi, bacteria and algae.

**Capacity building:** programs that identify and seek to address factors that limit a community's ability to achieve sustainable natural resource outcomes.

**Carbon farming:** the reduction of carbon pollution by farming in a way that captures and holds carbon in vegetation and soils.

**Carbon bio-sequestration:** the absorption of carbon dioxide from the atmosphere by living trees and vegetation.

**Catchment:** the area of land determined by topographic features within which rainfall will contribute to runoff at a particular point.

**Climate change:** a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods (United Nations Framework Convention on Climate Change).

**Climate variability:** natural alterations in the earth's climate (United Nations Framework Convention on Climate Change).

**Coastal ecosystems:** an ecosystem that is located in a coastal

environment, bounded by the coastal land margin and the continental shelf. A coastal ecosystem may include dunes, sandy beaches, limestone cliffs, rocky shores, estuaries and lakes. Off shore it may include reefs, seagrass beds and upwellings.

**Community values:** a community's most deeply held shared ideals and beliefs.

**Conceptual model:** a visual representation of a system, its essential characteristics and how attributes interconnect. They are designed to evolve over time to capture new knowledge that increases understanding of a system.

**Confinement feeding:** the removal of livestock from the paddock into containment for maintenance feeding, where all feed and water are brought to the animal.

**Connectivity:** the extent to which patches of similar or complementary ecosystems are connected for the purpose of animal movement, for plant and animal reproduction, and for supporting ecosystem resilience. Connectivity can be improved by establishing corridors and by providing protection from pests and predators.

**Conservation status:** the listing of a taxon on state, Australian or international conservation lists according to the threat to its viability.

**Consumptive use:** the use of water for irrigation, industry, urban and stock and domestic use, or other private purposes (MDBA 2013).

**Corridor:** a linear habitat that may link patches of habitat in the landscape and be a pathway for movement of wildlife (MCMA 2013).

**Diadromous:** Fish that spend portions of their life cycle in fresh and salt water.

**Drawdown:** a drop in the level of a watertable as a result of the formation of a cone-shaped depression caused by multiple wells pumping water from an aquifer at a withdrawal rate that exceeds the natural recharge rate.

**Driver (of change):** issues or threats that push a particular characteristic of a system towards or away from a point where, once crossed, a system will change to a different state (from which it may be difficult or impossible to return).

**Dryland agriculture:** rain-fed agriculture practised in areas where crop or pasture production is limited to that part of the year when rain falls.

**Dryland salinity:** the process whereby salts stored below the surface of the ground are brought close to the surface by the rising watertable. The accumulation of salt degrades the upper soil profile, with impacts on agriculture, infrastructure and the environment.

**Ecological communities:** unique and naturally occurring groups of plants and animals.

**Ecologically sustainable development:** the use, conservation, development and enhancement of natural resources in a way that meets economic, social and physical needs, while sustaining the potential of natural resources to meet the reasonably foreseeable needs of future generations; safeguarding the life-supporting capacities of natural resources; avoiding, remedying or mitigating any adverse effects of activities on natural resources.

**Ecosystem:** a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.

**Ecosystem health:** a measure of an ecosystem's structural intactness and integrity of ecological processes.

**Ecosystem services:** the full suite of benefits that human populations gain from a particular type of ecosystem, such as maintenance of climates; provision of clean water and air; pollination of crops and native vegetation; fulfilment of people's cultural, recreational, spiritual and intellectual needs; provision of options for the future.

**Emergent vegetation:** aquatic plants which have roots in the sediment of a stream but stems which extend through and above the water. The leaves and flowers of these plants are above the water surface (EPA 2013).

**Environmental flow:** the share of water provided and managed for the environment to protect river health.

**Environmental values:** aspirations of the community in regard to the Region's natural resources.

**Environmental water:** water provided to wetlands, floodplains or rivers to achieve a desired outcome, including benefits to ecosystem functions, biodiversity and water quality and health (MDBA 2013).

**Environmental water requirements:** the water regime needed to sustain the ecological values of water-dependent ecosystems, including their processes and biological diversity, at a low level of risk.

**Ephemeral:** short-lived; temporary.

**Ephemeral flows:** stream flows that only endure for a short time following a heavy rainfall event. The stream channels are often not well defined.

**Estuary:** a partially enclosed coastal body of water that is permanently, periodically, intermittently or occasionally open to the sea, within which there is a measurable variation in salinity due to the mixture of seawater with water derived from or under the land.

**Evidence based approach:** the conscientious, explicit and judicious use of the current best evidence in making decisions.

**Extinction debt:** concept of future extinction of species due to events in the past.

**Farm forestry:** land management practice in which farmers cultivate trees in addition to their other productive activities (MCMA 2013).

**Farm succession:** the process concerned with the transfer of management control of a farm.

**Fire regime:** the history of fire in a particular vegetation type or area, including the fire frequency, interval, intensity, extent and seasonality of burning (Brooks, et al., 2004).

**Floodplain:** any area of land adjacent to a watercourse, lake or estuary that is periodically inundated with water and includes any other area designated as a floodplain by a natural resources management plan, or by a development plan under the Development Act 1993 (Natural Resources Management Act 2004).

**Flow regime:** the description of the characteristic pattern of a river, wetland or tributary's flow quantity, timing and variability.

**Fragmentation:** The division or separation of natural areas by the clearance of native vegetation for human land uses, isolating remnants and species and affecting genetic flow (DEH 2007b).

**Global warming:** the gradual increase of the Earth's average surface temperature due to greenhouse gases in the atmosphere.

**Goyder's Line:** a boundary line across South Australia set in 1866 that follows a distinct change in the natural vegetation. It is composed mainly of mallee scrub to the south and salt-bush to the north. In general, the line represents the demarcation of a long-term average rainfall of 10 inches (254 millimetres) and indicates the reliable limit of land for agriculture (e.g. cropping).

**Grazing modified pastures:** Land use class under the Australian Land Use and Management classification version 6 (ALUM) - Pasture and forage production, both annual and perennial, based on significant active modification or replacement of the initial vegetation. Land under pasture at the time of mapping may be in a rotation system, so that at another time the same area may be, for example, under cropping.

**Grazing natural vegetation:** Land use class under the Australian Land Use and Management classification version 6 (ALUM) - Land uses based on grazing by domestic stock on native vegetation where there has been limited or no deliberate attempt at pasture modification. Some change in species composition may have occurred.

**Grey water:** all non-toilet household wastewater, i.e. from showers, baths, hand basins, washing machines, laundry troughs, dishwashers and kitchen sinks.

**Groundwater:** water occurring naturally below ground level, or water pumped, diverted or released into a well for storage underground.

**Groundwater recharge:** the process whereby water below the land surface is replenished by either direct infiltration of rainfall or by leakage from surface water bodies like streams or lakes.

**Heritage Agreement:** a private conservation area established by agreement between the landholder and the Minister for Sustainability, Environment and Conservation for the protection of native plants and animals.

**Horticulture:** the art, industry and science of plant cultivation.

**Hydrological flow regime:** the flow regime applicable to a particular watercourse or aquatic ecosystem as it varies by seasonal and more episodic climatic events (e.g. periodic severe flooding or drought). It may be a natural regime or man-managed (e.g. by weir pool manipulation). It also includes the water quality dimensions associated with particular flow periods.

**Hydrology:** the science that describes and analyses the occurrence of water in nature and its circulation near the surface of the earth.

**Intensive animal production:** Land use class under the Australian Land Use and Management classification version 6 (ALUM) - intensive forms of animal production (excludes associated grazing/pasture). Agricultural production facilities such as feedlots, piggeries, etc. may be included as tertiary classes.

**Irrigated modified pasture:** Land use class under the Australian Land Use and Management classification version 6 (ALUM) - Irrigated pasture production, both annual and perennial, based on a significant degree of modification or replacement of the initial native vegetation. This class may include land in a rotation system that may be under cropping at other times.

**Irrigated perennial horticulture:** Land use class under the Australian Land Use and Management classification version 6 (ALUM) - irrigated crop plants living for more than two years that are intensively cultivated, usually involving a relatively high degree of nutrient, weed and moisture control.

**Irrigated production:** for the purposes of this plan, refers to the land use classes under the Australian Land Use and Management (ALUM) classification's broad category (iv) - production from Irrigated Agriculture and Plantations where water is applied to promote additional growth over normally dry periods, depending on the season, water availability and commodity prices.

**Irrigated seasonal horticulture:** Land use class under the Australian Land Use and Management classification version 6 (ALUM) - irrigated crop plants living for less than two years that are intensively cultivated, usually involving a relatively high degree of nutrient, weed and moisture control.

**Lake:** a natural lake, pond, lagoon, wetland or spring (whether modified or not) that includes part of a lake or a body of water designated as a lake by a natural resources management plan, or by a Development Plan under the Development Act 1993 (Natural Resources Management Act 2004).

**Landscape and Systems Approach:** looks across large, connected geographic areas to more fully recognise natural resource conditions and trends, natural and human influences, and opportunities for natural resources management. It seeks to identify important ecological values as well as detecting changes in natural resources that may not be evident when managing smaller, localised areas.

**Management Action Target (MAT):** short to medium term targets over a 3 to 5 year timeframe measuring progress towards improving condition of natural resources and achieving Resource Condition Targets.

**Marsh / wetland:** Land use class under the Australian Land Use and Management classification version 6 (ALUM) - marsh and/or wetland that is used for conservation, production or intensive uses.

**Mesic:** characterised by, or requiring, a moderate amount of water.

**Native (flora, fauna, vegetation, ecosystem, biota):** occurs naturally in South Australia.

**Natural resource assets:** people, land, water, biodiversity and atmosphere.

**Natural resources:** soil, water resources, geological features and landscapes, native vegetation, native animals and other native organisms, and ecosystems (Natural Resources Management Act 2004).

**Natural resources management:** an approach to managing our environment that strives to achieve a balance between our collective need for resources and the needs of our environment. Natural resources include air, water, land, soil, plants, animals and micro-organisms, and the ecosystems they form.

**Natural systems:** Systems defined by interactions between topography, geology, climate and biological organisms (plants, animals, bacteria, etc.). Natural systems include ecosystems, land systems, catchments, basins, bioregions and districts. Natural systems are used for human benefit including settlement, industry, tourism and recreation, and in some cases are retained in a natural state to protect their biodiversity values.

**Nature conservation:** Land use class under the Australian Land Use and Management classification version 6 (ALUM) - protected area including Strict Nature Reserves, Wilderness Areas, National Parks, protected natural features, habitat / species management areas, protected landscapes, and other conserved areas.

**Non-wetting soils:** soils which resist wetting when dry. It is mainly a feature of sandy surface horizons and is generally caused by an organic coating on sand grains.

**NRM community:** For the purposes of this plan, the NRM community includes organisations and individuals directly involved in natural resources management. It includes local, state and federal governments, and non-government organisations such as local action planning groups, landcare groups, conservation bodies, traditional owners, industry groups, education and research institutions and individuals. The NRM community also extends to other regional natural resources management bodies that we have a close working relationship with.

**NRM district:** districts within the South Australian Murray-Darling Basin which are based on Natural Resources Management Group boundaries pursuant to the Natural Resources Management Act 2004. There are four natural resources management districts defined for the purposes of this plan: Ranges to River, Mallee Coorong, Rangelands and Riverland.



**Other minimal use:** Land use class under the Australian Land Use and Management classification version 6 (ALUM) - land that is largely unused (in the context of the prime use) but may have ancillary uses. This may be the result of a deliberate decision by the manager or the result of circumstances. The land may be available for use but for various reasons remains 'unused'.

**Pastoral zone:** generally areas north of Goyder's line with annual rainfall less than 250 millimetres per annum. The pastoral zone is commonly called the rangelands.

**Prescribed Water Resource:** a water resource declared by the Governor to be prescribed under the Natural Resources Management Act 2004, and may include surface water, watercourses and underground water (to which access is obtained by prescribed wells). Prescription of a water resource requires that future management of the resource be regulated by a licensing system.

**Protected area:** An area of land and/or sea specifically dedicated to the protection and maintenance of biological diversity and natural and associated cultural resources, and managed through legal or other effective means (DEH 2007b).

**Ramsar convention:** the Convention on Wetlands, signed in Ramsar, Iran, in 1971 providing the framework for the conservation and use of wetlands and their resources. Ramsar sites are Wetlands of International Importance created under the convention.

**Recharge area:** the area of land from which water from the surface (rainfall, streamflow, irrigation, etc.) infiltrates into an aquifer.

**Refugia:** places where animals and plants can survive when times are hard. They are vital for the long-term survival of species as they sustain populations which can breed and repopulate larger areas when conditions improve (MDBA 2013).

**Relictual:** a group of animals or plants that exists as a remnant of an earlier time surviving in an environment that has undergone significant change.

**Riparian zones/areas:** that part of the landscape adjacent to a water body that influences and is influenced by watercourse processes.

**Runoff:** water flowing over land or in a natural or manmade drain after having fallen as rain or hail, or having precipitated in any other manner.

**Rural:** an area that is not part of an "urban" area, and includes populations of less than 1,000 people (generally described as Australian Bureau of Statistics "Localities" and "Remainder of State/Territory". See "Urban Centres and Localities".

**Resilience:** The capacity of complex systems (social, economic or environmental) to respond and adapt to external shocks and disturbances without losing their essential functions and identity (State NRM Plan SA 2012-2017).

**Saline discharge:** the process whereby excess groundwater containing dissolved salts rises close to the land surface, resulting in dryland salinity problems. Saline discharge occurs into waterways when saline groundwaters enters the river channel.

**Salinisation:** the process whereby land or water resources become adversely affected by high levels of salt (usually sodium chloride) that inhibit normal ecosystem functioning (including crop production). Salinisation often results from salts that are naturally present in the landscape being mobilised as the result of human activity.

**Salt interception:** the practice of intercepting saline groundwater (either naturally occurring or irrigation induced) before it can discharge into rivers, onto floodplains or otherwise impact on natural resource assets.

**Socio-ecological approach:** recognises that humans (socio-economic systems) are embedded within the environment (ecological systems). Socio-ecological systems thinking tells us that the human components of a system depend on and influence the function of the non-human ecological components and vice versa.

**Socio-economic:** of or involving both social and economic factors.

**Soil acidity:** a soil giving an acid reaction throughout most or all of the profile – precisely, below a pH (in water) of 7.0; practically, below a pH of 6.5. Soil acidity becomes a problem when the pH drops below 5.5.

**State and transition model:** a way of describing the processes that occur within a system (social, economic or environmental) and how actions contribute to desired outcomes. They aim to represent the different states that a system can be in and what makes it transition from one state to another.

**Stormwater:** the surface water runoff that occurs after rain.

**Stubble retention:** a conservation farming practice which involves the retention of stubble either in or on the soil, between harvest and the sowing of the subsequent crop. This is done primarily to protect the soil against erosion but also to conserve moisture (EDSCB 2002).

**Sustainable diversion limits (SDL):** reflect an environmentally sustainable level of water use (or 'take'). An environmentally sustainable level of take (ESLT) is the amount of water that can be taken for town water supplies, industry, agriculture and other human or 'consumptive' uses, while ensuring there is enough water to achieve healthy river and groundwater systems (MDBA 2013).

**Sustainable limits:** Limits to the use of, or impact on, natural resources beyond which they may be damaged and unable to recover, that is, exceeding an ecosystem's resilience.

**System:** a group of independent but interrelated elements comprising a unified whole. A system may be described by its dominant social, economic and/or environmental characteristics (e.g. marine ecosystem, agricultural system).

**Threatened ecological community:** ecological community classified as being threatened by extinction and listed as Vulnerable, Endangered, Critically Endangered or Presumed Extinct (under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999).

**Threatened species:** plants or animals that are listed as rare, vulnerable, endangered, critically endangered or extinct in the wild

as per the National Parks and Wildlife Act 1972 (SA) or Environment Protection and Biodiversity Conservation Act 1999 (Cwlth).

**Total grazing pressure:** The combined grazing pressure that all domestic and wild animals exert on the vegetation, soil and water resources of a bio-physical system.

**Transport and communication:** Land use class under the Australian Land Use and Management classification version 6 (ALUM) - land used for airports/aerodromes, roads, railways, ports and water transport, and navigation and communication.

**Tributary:** a watercourse (rivers, creeks, and streams) that flows into another watercourse.

**Urban Centres and Localities:** Urban Centres and Localities (UCLs) are a geographical unit that statistically describe Australian population centres with populations exceeding 200 persons. They are designed for the release of data from the Census of Population and Housing, and are derived from analysis of the data within Statistical Areas Level 1 (SA1s) from the 2011 Census. Centres with a core urban population of 1000 persons or more are considered to be Urban Centres, while smaller centres with populations of 200 persons or more and a core urban population below 1000 persons are considered to be Localities (ABS 2011).

**Vegetation communities:** broad groupings of native vegetation species and/or associations based on the dominant overstorey species.

**Wastewater:** Water that has been used for domestic or industrial purposes and is then discharged as waste.

**Water allocation plan (WAP):** a statutory document under the Natural Resources Management Act 2004 that establishes appropriate water extraction and management regimes by defining the 'sustainable limit' of a prescribed water resource.

**Water repellance:** 'non-wetting' property of a soil or material that slows or prevents entry of water when initially dry.

**Water resource:** a watercourse or lake, surface water, underground water, stormwater and effluent.

**Water Use Efficiency (WUE):** a simple measure of crop production per unit of water applied. The focus is usually on increasing WUE to make better use of scarce rainfall or irrigation waters.

**Water-dependent ecosystem:** a surface water or a ground water ecosystem and its natural components and processes that depends on periodic or sustained inundation, waterlogging or significant inputs of water for its ecological integrity. It includes an ecosystem associated with a wetland, a stream and its floodplain, a lake or a body of water (whether fresh or saline), a salt marsh, an estuary, a karst system, or a ground water system (Commonwealth Water Act 2007).



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