South West NRM
Achieving sustainable landscapes for rural communities

South West NRM Plan 2015–2025

Achieving sustainable landscapes for rural communities

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Cover Photo courtesy Cathy Zwick.

Contents

Executive Summary

PART A:
INTRODUCING THE SOUTH WEST NRM PLAN 2015–2025

REGIONAL ASSETS

CLIMATE PROJECTIONS

CLIMATE RISKS

DRIVERS OF CHANGE

PART B:
BIG IDEAS FOR PROSPERITY & RESILIENCE – MANAGEMENT RESPONSE

SUMMARY OF OUTCOMES

STRATEGY 1: SUSTAINABILITY IN THE MULGA LANDS

Outcome 1.1
Collaborative Area Management
By or before 2020, to fully enclose seven CAM clusters and by or before 2025 to demonstrate improved productivity linked to NRM Plan Outcomes in Strategies 1 and 3 within exclusion fenced areas.

MANAGEMENT ACTIONS

Outcome 1.2
Vegetation and soils
By or before 2025 at least 50% of the 3-P pastures of the Mulga Lands will be in 'B' (good) condition or better; no more than 50% of the mulga resource will be grazed without a BMP grazing regime; and at least 50% of the Region's soils (area) will be managed using a BMP soils module to minimise soil loss.

MANAGEMENT ACTIONS

Outcome 1.3
Declared weeds and pests
By or before 2025, to have all agencies and all properties that are identified as critical in a weeds and pests operational program engaged in strategic management of weeds and feral animals.

MANAGEMENT ACTIONS

STRATEGY 2: OPPORTUNITY – EXPANDING OUTBACK HORIZONS

Outcome 2.1
Outback Experience: Sharing our natural and cultural assets
By or before 2020, to have the average visitor stay duration at five nights and the average visitor spend at $200 per night.

MANAGEMENT ACTIONS

Outcome 2.2
Remote Area Technologies
By or before 2025 to have South West Queensland recognised by government, industry and regional communities as a key locality for innovation in remote area technologies.

MANAGEMENT ACTIONS

Outcome 2.3
Belonging to land in Aboriginal Australia
By or before 2025, to be clearly demonstrating Aboriginal engagement in managing sites, landscapes and NRM activities within the region.

MANAGEMENT ACTIONS

Outcome 2.4
Promoting NRM in the South West
By or before 2025, in at least 50% of the projects being implemented under this NRM Plan, to have at least one party engaged to take the lessons and benefits elsewhere.

MANAGEMENT ACTIONS

STRATEGY 3: RESILIENCE

Outcome 3.1
Carbon management
By or before 2020, to have assessed the potential for carbon sequestration in the South West NRM Region and identified investment opportunities, and by or before 2020 to have trialled Carbon Grazing for improved productivity and soil system resilience.

MANAGEMENT ACTIONS

Outcome 3.2
Waters
By or before 2025, all GABSI target area bores have been capped and piped, and guidelines are available for protection of surface waters from stock, weed and pest damage.

MANAGEMENT ACTIONS

Outcome 3.3
Overabundant and invasive native species of flora and fauna
By or before 2020, in collaboration with agencies and industry, to have a broader suite of tools to address Invasive native species.

MANAGEMENT ACTIONS

Outcome 3.4
Natural system resilience
By or before 2025 to have identified and prepared guidelines for protective management of the critical areas of the landscape that provide ecological refuge and functional connectivity for the ecosystems of the South West NRM Region.

MANAGEMENT ACTIONS

Photo courtesy Cathy Zwick.

PART C:
MONITORING, EVALUATION AND ADJUSTMENT

STRATEGY 1

STRATEGY 2

STRATEGY 3

PART A:

INTRODUCING THE SOUTH WEST NRM PLAN 2015–2025

Our Place – Our Purpose

Queensland's South West is one of Australia's great outback landscapes – it has expansive land and sky and resilient people producing food and fibre in a landscape where the dinosaurs left their bones.

In this land of drought and flooding rain, regional natural resource management brings industry, government and the community together to combine our aspirations and efforts to care for the land and its people.*

Commitment to productive enterprise and rewarding outback lifestyles are at the core of life in the South West.

**Dorothea McKellar's My Country*

The South West Queensland Regional Natural Resource Management (South West NRM) Plan brings together the lived knowledge and experience of local people and the best science and technology. From this base, the Plan draws out real and solid outcomes to which all investments and efforts can be directed. To lay out the path to making these outcomes tomorrow's reality, the Plan gathers and organises the tasks and activities that the NRM community has identified.

Photo courtesy Cathy Zwick.

Glossary of abbreviations used in the South West NRM Plan

ACCU | Australian carbon credit unit
BMP | Best Management Practice
CAM | Collaborative Area Management
CFI | Carbon Farming Initiative
DNRM | Queensland Government Department of Natural Resources and Mines
EFWS | Early Flood Warning System
EHP | Queensland Government Department of Environment and Heritage Protection
DAF | Queensland Government Department of Agriculture and Fisheries
GABSI | Great Artesian Basin Sustainability Initiative
NRM | natural resource management
RCS | Resource Consulting Services
South West RED | South West Regional Economic Development Association
UQ | The University of Queensland
WoNS | Weeds of National Significance

South West NRM Plan preparation

In 2013 the Australian Government committed funding to NRM organisations, through its Clean Energy Future Fund, to include action to address climate change in their NRM plans. This funding allocation was referred to as Stream 1 funding. To support appropriate adaptation responses to climate change, funding was allocated to science organisations, such as CSIRO and the Bureau of Meteorology, to develop climate change projections and examine the potential impacts of climate change on Australia at the regional scale. This was referred to as Stream 2 funding, and its outputs have been used throughout this Plan.

The Stream 1 funding was accompanied by a clear set of principles[1] and their attributes to guide the work in relation to the Australian Government investment component of the overall Plan updating process.

The core significance of incorporating the effects of climate change needed to be integrated throughout the Plan, augmented by lessons learned from the Plan produced under the previous Natural Heritage Trust (NHT2) initiative within the joint Commonwealth/State Regional Natural Resource Management Framework.

1. Australian Government. nd. *Principles for the regional NRM Planning for Climate Change Fund (the Principles).* Available from **http://www.environment.gov.au/cleanenergyfuture/regional-fund/pubs/regional-fund-principles.pdf.**

The Stream 1 Principles are:

1. Plans identify priority landscapes for carbon plantings and strategies to build landscape integrity and guide adaptation and mitigation actions to address climate change impacts on natural ecosystems

    a) Planning processes identify opportunities and management strategies to maximise environmental benefits and landscape resilience, including biodiverse plantings, wildlife corridors, landscape connectivity and protection of remnant vegetation

    b) Planning processes recognise, provide guidance to avoid and mitigate potential risks and adverse impacts associated with carbon sequestration in the landscape, including impacts to biodiversity, water resources and production systems

    c) Planning processes identify priority landscapes for potential carbon sequestration opportunities, mitigation and adaptation in the context of improving landscape connectivity, resilience and wildlife corridors

2. Planning process is logical, comprehensive, and transparent

    a) Planning processes consider previous planning and are consistent with relevant jurisdiction specific planning requirements

    b) Planning processes are informed by a clear understanding of the regional stakeholder and community aspirations and objectives

    c) Planning processes demonstrate a clear understanding of the regional NRM organisation's business, roles and responsibilities

    d) Planning processes show evidence of cooperation for cross-regional climate change impacts and land use planning

    e) Adaptive planning responds to new information and guide improvements as knowledge improves

    f) Planning processes use information at an appropriate scale to spatially identify priority areas in the landscape for carbon sequestration projects and environmental co-benefits

    g) Planning processes demonstrate adaptive planning that responds to current and anticipated climate change research and additional information

3. Plans use best available information to develop actions and are based on collaboration with government, community and other stakeholders

    a) Plans demonstrate strategic alignment with relevant state and Commonwealth NRM policies (such as urban and regional planning, matters of National Environmental Significance, National Water Initiative and the National Wildlife Corridors Plan)

    b) Plans meaningfully engage community and stakeholders

    c) Where relevant, plans identify roles and responsibilities for partners in the region

    d) Plans integrate biophysical, socio-economic and climate change information to fine tune strategies for improving landscape connectivity, function and resilience.

The climate change projections provided under Stream 2 were used as the basis for a climate risk and vulnerability assessment (Appendix 1). The results of that assessment are directly reflected in this Plan.

Under the Australian Government's National Landcare Programme, clear expectations have been specified focusing particularly on accountability for outcomes and stakeholder engagement. In relation to regional NRM planning the expectation is that 'Regional NRM plans are robust and deliverable'.[2]

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2. Australian Government. nd. *Australian Government Performance Expectations for Regional NRM Organisations*. Available from **http://www.nrm.gov.au/system/files/resources/ceec015a-36da-4300-a5d4-2ca48900806e/files/regional-funding-performance-expectations.pdf.**

This expectation is supported by expected practices and advanced practices that demonstrate its achievement. These are:

Expected practices

For the past two years, the regional NRM organisation has a regional NRM plan that:

- is based on appropriate and best available scientific, economic and social information and has been updated in the last three years
- considers previous planning, is consistent with relevant jurisdiction-specific requirements and demonstrates strategic alignment with relevant Australian Government and state/territory NRM plans, policies, priorities and strategies and priority natural resource management issues identified by agricultural industries
- has been developed with comprehensive and documented engagement of the community, including landcare, Indigenous and industry groups and land managers
- has been developed using a process for determining NRM priorities, includes a framework that clearly identifies public and private benefit and where government intervention is required
- clearly articulates Indigenous land and sea management aspirations and participation and identifies strategies to implement them
- includes goals which are specific, measurable, achievable, realistic and time-bound
- includes mechanisms for evaluating effectiveness and implementing the findings
- identifies and establishes suitable partnerships and opportunities for collaboration to achieve NRM outcomes, including, where appropriate, through collaboration with other regional NRM organisations.

Advanced practices

All expected practices have been met for the past two years and in addition the regional NRM organisation has complied with at least three of the following:

- ongoing, regular mechanisms for active community participation and engagement in regional NRM plan implementation are established
- regional NRM plan supports relevant Indigenous land and sea management plans
- the regional NRM planning process includes an independent scientific review process
- mechanisms are included for ensuring that new information can be continually incorporated into implementation activities
- regional NRM plan demonstrates understanding of the socio-economic profile of the area
- clearly articulates measures to support Indigenous land and sea management aspirations and participation, including Indigenous employment and training opportunities

the regional NRM Plan is underpinned by relevant theme-based Sub-Strategies (or Action Plans) that are scientifically rigorous with strong community and stakeholder input.[3]

As part of its ongoing support for the regional NRM arrangements in Queensland, the Queensland Regional NRM Groups Collective provides NRM planning guidelines to promote best practice NRM planning. This provides regional NRM bodies with a common set of attributes that can be applied to both the planning process and plan content. The following table provides a visual map of the principles, standards and good practice exemplars established in the *Queensland Regional NRM Planning Guidelines*,[4] which have been reflected in this Plan.

3. ibid. pp. 2–33

4. Queensland Regional Groups Collective (RGC). 2012. *Queensland Regional NRM Planning Guidelines*, Queensland Regional Groups Collective, Toowoomba.

Table 1: Principles, standards and good practice exemplars prepared by Queensland Regional NRM Groups Collective and established in *Queensland Regional NRM Planning Guidelines*, adopted by South West NRM

This Plan will					
Support diverse investments	Broker collaborative action			Be an effective communication tool	Support accountable reporting
This Plan					
Articulates a regional vision	Identifies strategic outcomes and actions		Provides spatial products	Identifies priority knowledge needs	Documents MERI strategies	Identifies research priorities
Reflects community values & aspirations	Incorporates Indigenous and local knowledge		Uses relevant information & knowledge	Documents the plan logic	Uses best available science	Documents the evidence base
Community	**Key NRM stakeholders**			**Science**	
Improves community knowledge & capacity	Relevant to key stakeholder groups	Links to govt. policies, programs and plans	Clarifies roles and responsibilities	Adopts a systems approach	Identifies uncertainties
Engages the community	Engages key sectors	Engages government	Links across regions	Engages scientific community	Considers scenarios and risks

Engaged communities

South West NRM works with the community, Landcare groups, Traditional Owners, local government and industry groups to achieve sustainable NRM and fosters landcare and catchment management ethics. The organisation prides itself on being directed by its regional NRM Plan, which is intended to be a community-made plan that seeks to deliver strategic programs and actions to tackle regional natural resource issues.[5]

An important part of the planning process is engaging with the community to obtain feedback on NRM stakeholder priorities. During December 2013 and January 2014, South West NRM conducted regional workshops with the community and Traditional Owners to discuss climate change projections for this region and how impacts might affect the local environment, business enterprises, lifestyle and culture. Stakeholder suggestions were published in the report *Don't Camp in the Creek Bed: Planning for Climate Variability in South West Queensland.*[6]

Another stakeholder engagement workshop was conducted during June 2014 to obtain feedback from local and state government NRM stakeholders about potential adaptation responses to climate change, resilience actions and opportunities.

5. South West NRM Ltd. nd. Website homepage. Available from **http://www.swnrm.org.au/.**

6. South West NRM Ltd. 2014. *Don't Camp in the Creek Bed: Planning for Climate Variability in South West Queensland*. South West NRM. Charleville. Available from **http://www.southwestnrm.org.au/sites/default/files/uploads/managed/news/Don't%20Camp%20in%20the%20Creek%20%20%20January%202014%20version%20%284%29%20_0.pdf.**

Photo courtesy CathyZwick.

This feedback has been captured and published in *Risk and Resilience in NRM Planning: Addressing the drivers of change including the likely consequences of climate and seasonal variability.*[7]

Feedback captured from all workshops has been used to inform the Management Actions in Part B of this Plan. The NRM aspirations of stakeholders were numbered in the two reports for each stakeholder group, and they have been referred to in this Plan using that system for easy cross-referencing back to the reports.

The draft version of this Plan was released for public comment in February 2015 through the South West NRM website, accompanied by an online survey tool to capture stakeholder feedback. The draft Plan was amended in response to direct feedback from stakeholders and the collated feedback and free text comments gathered through the survey tool. The Plan was finalised through a series of meetings with staff, the Board of South West NRM, individual Board Members and key stakeholders in August 2015.

Looking ahead

South West NRM will continue its work with NRM stakeholders both within the region and across neighbouring NRM borders to engage, inform and promote best practice NRM strategies to ensure more resilient landscapes and natural waters. It will provide information about emerging developments and opportunities to increase on-property soil and vegetation carbon stores and landscape resilience. The engagement of Indigenous stakeholders and the coordination and facilitation of vertebrate pests and weed programs will remain high priorities.

Reliance on Australian and Queensland Government investment

The South West NRM Region is remote and isolated, with a sparse population and little access to private investment in public good initiatives. This Plan sets out a realistic, albeit ambitious scope of outcomes that build the resilience of the region's landscapes, NRM communities and its enterprises.

Achieving NRM outcomes in the South West NRM Region is almost entirely dependent on investments by the Queensland and Australian governments in enabling South West NRM to work with local land managers, the four local governments in the region, state agencies and other regional NRM bodies and community partners.

7. South West NRM Ltd. 2014. *Risk and Resilience in NRM Planning: Addressing the Drivers of Change Including the Likely Consequences of Climate and Seasonal Variability*. South West NRM. Charleville. Notes from meeting. (These notes area included in Appendix 2 of this Plan.)

Overview of the region and its assets

The South West NRM region covers an area of over 187,000 square kilometres and is home to approximately 10,000 people.

The region covers four catchments: the Bulloo, Paroo, Warrego, and Nebine/Mungallala/Wallam. The Paroo, Warrego and Nebine/Mungallala/Wallam catchments are part of the Murray–Darling Basin, and the Bulloo River is an internally draining river system (Figure 1).

The four main shires located in the South West NRM region are Qulipie, Bulloo, Paroo and Murweh. Parts of Balonne, Maranoa (Roma) and Blackall-Tambo shires are also located inside the boundaries of the South West NRM region.

The assets of the region can be categorised using the Five Capitals Model, developed by the Forum for the Future.[8] The Five Capitals Model identifies assets as being human, social, natural, manufactured (built or made) and financial.

In the South West NRM Region, the human assets are the families and individuals living and working in the region, and the social assets are the networks and communities to which those people belong, together with the culture and cultural heritage of the region, Aboriginal and non-Aboriginal. The natural assets include the pastures, soils and waters, the biodiversity of the region, its diverse landscapes and mineral resources and the fossils from past ages. The manufactured assets include capital assets such as homes, sheds, fences and industrial buildings, roads, rail and telecommunication infrastructure and equipment such as vehicles, tools and machinery. Financial assets include the equity in properties and enterprises, operating capital, cash flow, loans, insurance and savings.

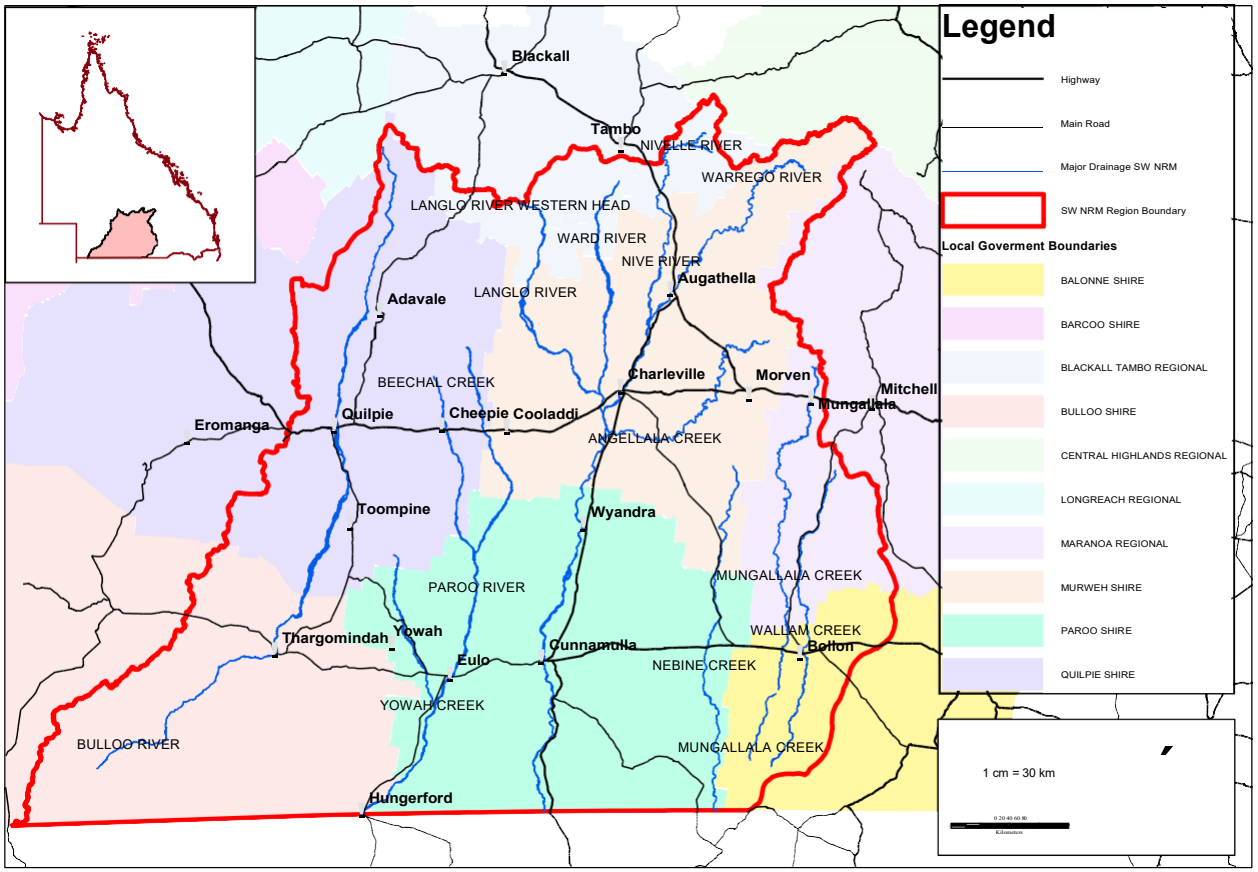

Figure 1: South West Regional NRM area

8. Forum for the Future. nd. *The Five Capitals Model – a framework for sustainability*. Forum for the Future. London. Available from **https://www.forumforthefuture.org/sites/default/files/project/downloads/five-capitals-model.pdf.**

Bulloo catchment

The Bulloo catchment extends north almost to Isisford and south to just beyond Milparinka in New South Wales. The catchment covers a total area of some 74,900 square kilometres, with the bulk of the area (approximately 74%) contained in Queensland.[9] The following information refers to the Queensland portion only.

Location

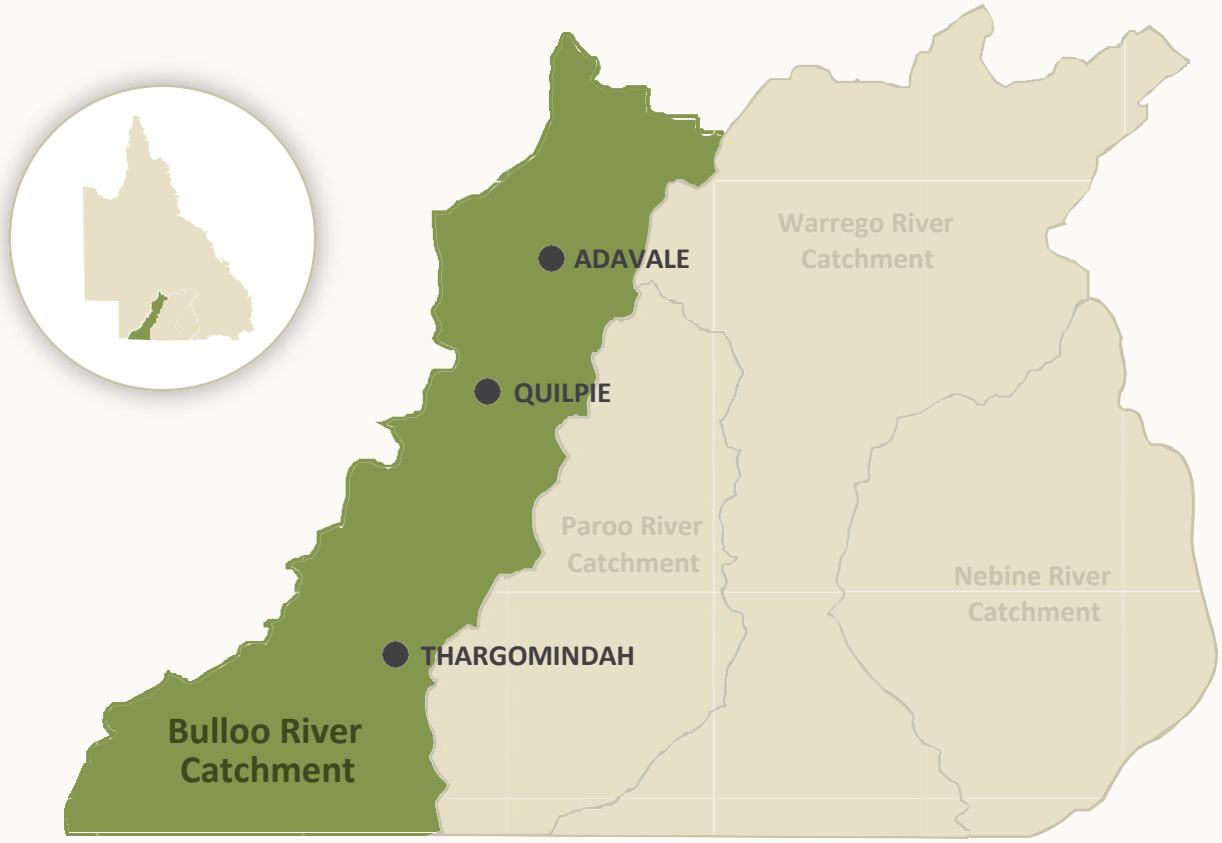

Figure 2: Bulloo catchment

River system

Major river: Bulloo River

Tributaries: Blackwater, Winbin, Leopardwood and Gumbo Gumbo creeks

The Bulloo catchment is an internally draining system located between the Lake Eyre and Murray–Darling basins.

9. Department of Natural Resources. 2000. *Land cover change in Queensland 1997–1999: a Statewide Landcover and Trees Study (SLATS) report*. September 2000, Department of Natural Resources, Brisbane.

Social factors

Three local governments are responsible for administering the Queensland portion of the Bulloo catchment: the councils of Blackall-Tambo Region and Quilpie and Bulloo shires.

The townships of Adavale, Quilpie and Thargomindah are contained within the Queensland section of the Bulloo catchment. The main administrative centre in the Bulloo catchment is Quilpie.

Vegetation

Mulga (*Acacia aneura*) shrubland is the predominant vegetation type in the Bulloo catchment. Mulga communities can range from open scrubland to tall, open shrublands, predominantly growing on red earths. There are also shallow red earth and lithosol residuals within the catchment that support a selection of bastard mulga, lancewood and bendee.[10]

The channels of the Bulloo River and its associated streams are fringed by a mixture of gidgee woodland to tall, open shrubland in the upper reaches of the catchment and eucalypt low open woodland to open forest in the middle and lower reaches. Dominant eucalypt species in the catchment are river red gum, coolabah and poplar box.[11]

In the lower reaches of the catchment, the Bulloo River is dominated by a large lateral dune system, which is vegetated by wetland communities.[12]

There are five wetlands within the Bulloo catchment listed in *A Directory of Important Wetlands in Australia.*[13] They are Bulloo Lake, Lake Bullawarra, Nooyeah Downs Swamps Aggregation, Bulloo Overflow and Lake Altibouka.

Climate

The Bulloo catchment is in an area of extremely variable rainfall. Annual average rainfall is in the range of 150 millimetres in the south-west corner to more than 500 millimetres in the headwaters of the Bulloo River. Over 70% of the area receives less than 300 millimetres per year.[14]

Industries

Grazing, of beef cattle and sheep for both wool and meat production, is the predominant industry in the catchment. Irrigated crops are almost non-existent. Opal mining in the catchment has made a significant contribution to the local economy.[15] The area is also a source of natural gas, with the Gilmore Gas Field located some 60 kilometres north-east of Adavale.[16] There is a growing push to build tourist interest and increase their stay in the region through projects being rolled out by South West Regional Economic Development Association Inc. (South West RED) relating to the Natural Sciences Loop in south-west Queensland. [17] Thargomindah is the first town in Queensland to embrace solar heat-pump hot water systems that harness water pressure from a well sunk into the Great Artesian Basin.[18]

10. Boyland, 1974 cited in Department of Natural Resources. 2000. *Land cover change in Queensland 1997–1999: a Statewide Landcover and Trees Study (SLATS) report.* September 2000, Department of Natural Resources, Brisbane.

11. Department of Natural Resources. 2000. *Land cover change in Queensland 1997–1999.* op. cit.

12. ibid.

13. Environment Australia. 2001. *A Directory of Important Wetlands in Australia*. Third Edition. Environment Australia, Canberra.

14. Department of Natural Resources. 2000. *Land cover change in Queensland 1997–1999.* op. cit.

15. ibid.

16. ibid.

17. *'Queensland Natural Sciences Loop: Astronomy, Birdwatching, Dinosaurs, Geology, History, Heritage, Wetlands,* Paroo, Bulloo, Quilpie and Murweh shire councils, 2012. Available from **http://www.murweh.qld.gov.au/the-natural-sciences-loop.**

18. Wikipedia. 2015. *Energy in Queensland.* Available from **https://en.wikipedia.org/wiki/Energy_in_Queensland.**

Photo courtesy Jed Sommerfield.

Nature conservation values

An array of significant fauna and flora species have been listed as being known to, likely to or may occur in the Bulloo catchment under either federal or state legislation.[19] Of particular interest in the Bulloo catchment are Idalia and Mariala National Parks and the Bulloo Lakes High Ecological Value Aquatic Ecosystem.

Fauna

- Grey grasswren (*Amytornis barbatus barbatus*)
- Painted honeyeater (*Grantiella picta*)
- Plains-wanderer (*Pedionomus torquatus*)
- Bridled nail-tail wallaby (*Onychogalea fraenata*)
- Greater bilby (*Macrotis lagotis*)

Flora

- Flame spider-flower (*Grevillea nematophylla*)
- Ooline (*Cadellia pentastylis*)
- *Xerothamnella parvifolia*
- *Rhaphidospora bonneyana*

19. Queensland Government. 2014. *Request a species list.* Available from **https://environment.ehp.qld.gov.au/report-request/species-list/.** Department of the Environment. 2015. *Protected matters search tool.* Australian Government, available from **http://www.environment.gov.au/webgis-framework/apps/pmst/pmst.jsf.** Walsh B and South West NRM. 2009. *Enhancing biodiversity hotspots along western Queensland stock routes.* Charleville, available from **http://www.southwestnrm.org.au/sites/default/files/uploads/ihub/pages-final-draft-stock-route-hotspot-report-10-sep-09pt1.pdf.** Department of Environment and Resource Management. 2010. *Back on track actions for biodiversity: Taking action to achieve species conservation in the South West Queensland Natural Resource Management region.* Queensland Government, Brisbane, available from **http://tinyurl.com/zj3yzek.**

Nebine/Mungallala/Wallam catchment

The Nebine catchment incorporates the catchments of Nebine, Mungallala and Wallam creeks and covers a total area of some 38,100 square kilometres, of which only 1% lies in New South Wales.

Location

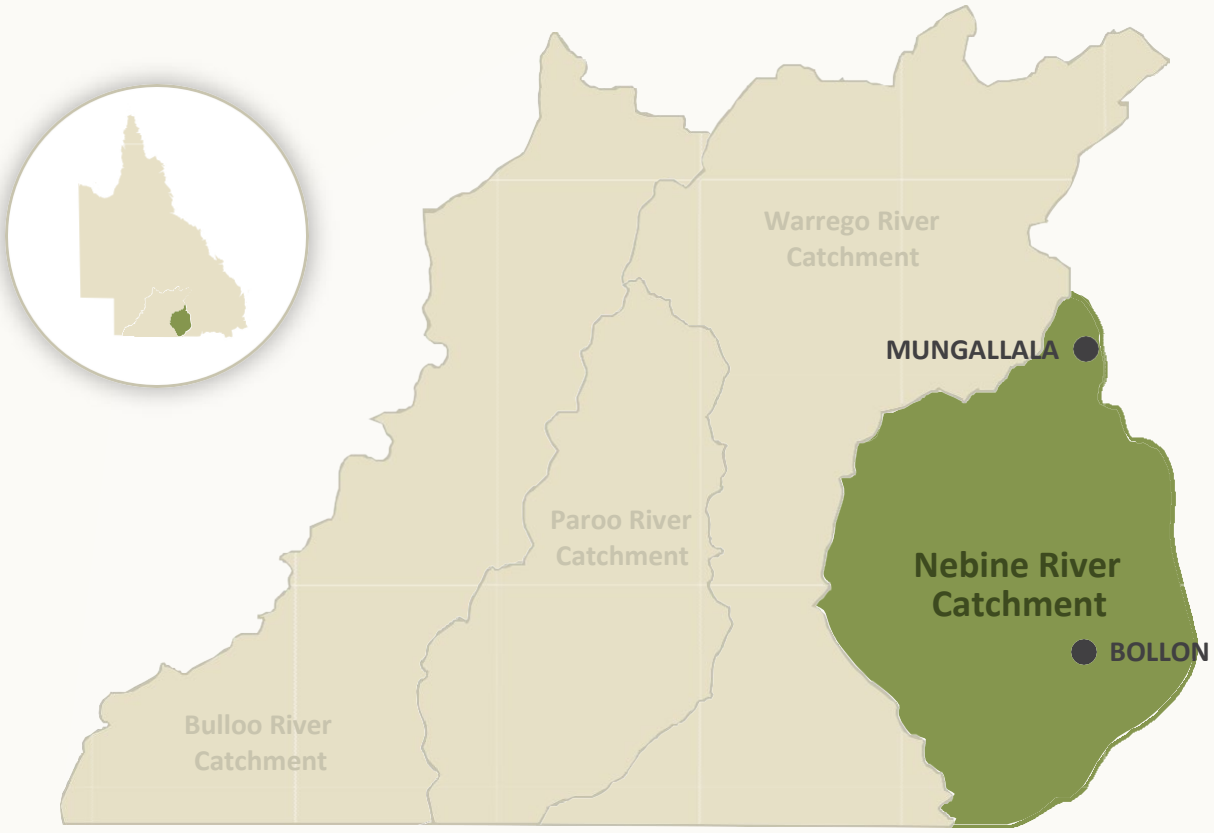

Figure 3: Nebine/Mungallala/Wallam catchment

River system

Major creeks: Nebine, Mungallala and Wallam creeks
Tributaries: Paterson Creek (Nebine)

Most of the streams in the Nebine catchment are ephemeral.[20]

20. Department of Natural Resources. 2000. *Land cover change in Queensland 1997–1999.* op. cit.

Photo courtesy Cathy Zwick.

Social factors

Bollon and Mungallala are the two townships located in the Nebine catchment. Mungallala is located on the banks of Mungallala Creek in the northern reaches of the catchment. Bollon is situated on the banks of Wallam Creek, approximately 100 kilometres west of St George.

The properties of Murra Murra and Bendee Downs are owned by the Kooma Traditional Owners.

Vegetation

The Nebine catchment is dominated by mulga (*Acacia aneura*) shrublands growing on the flat-to-undulating plains. Areas of bendee are also found in the catchment. Brigalow and Mitchell grass can also be found in the upper reaches of the catchment. Extensive clearing has significantly reduced natural stands of brigalow, and some of the remaining stands are listed as endangered.[21] Cypress pine woodland is supported in the sandhills of the major channels in the lower regions.[22]

In the southern and eastern sections of the catchment are a number of alluvial plains, which, due to their regular flooding, support low open gidgee forests.[23]

River red gum, coolibah and poplar box are the major species of trees found in the riparian communities along the channels. Grazing pressure has affected some poplar box, black box and coolabah communities and a saltbush and yarran community.[24]

Climate

The Nebine catchment is in an area with extremely variable rainfall. Annual average rainfall is in the range of 300 millimetres in the lower reaches to approximately 550 millimetres in the more elevated sections in the northern part of the catchment. Over 67% of the area receives less than 450 millimetres per year.[25]

Industries

Grazing, of beef cattle and sheep for both wool and meat production, is the predominant industry in the catchment. Irrigated crops are almost non-existent. There is a growing push to build tourist interest and increase their stay in the region through projects being rolled out by South West RED.

21. ibid.

22. Purdie and McDonald 1990, cited in Department of Natural Resources. 2000. *Land cover change in Queensland 1997–1999: a Statewide Landcover and Trees Study (SLATS) report.* September 2000, Department of Natural Resources, Brisbane.

23. Department of Natural Resources. 2000. *Land cover change in Queensland 1997–1999.* op. cit.

24. ibid.

25. ibid.

Photo courtesy Jed Sommerfield.

Nature conservation values

An array of significant fauna and flora species have been listed as being known to, likely to or may occur in the Nebine catchment under either federal or state legislation.[26] Of particular interest in the Nebine catchment are:

Fauna

- Painted honeyeater (*Grantiella picta*)
- Major Mitchell cockatoo (*Cacatua leadbeateri*)
- Koala (*Phascolarctos cinereus*)
- Squatter pigeon (*Geophaps scripta scripta*)
- Murray cod (*Maccullochella peelii*)
- Yakka skink (*Egernia rugosa*)
- Red goshawk (*Erythrotriorchis radiatus*)
- Australasian bittern (*Botaurus poiciloptilus*)
- Woma (*Aspidites ramsayi*)

Flora

- Ooline (*Cadellia pentastylis*)
- Austral cornflower (*Rhaponticum australe*)
- *Cyperus clarus*

Threatened ecological communities include:

- Brigalow (*Acacia harpophylla* dominant and co-dominant)
- Coolabah – black box woodlands of the Darling Riverine Plains and the Brigalow Belt South bioregions
- Weeping Myall woodlands.

Wallam Creek is the habitat of a significant koala population, which depends upon the abundant river red gum in the area, and over 110 species of birds have been recorded in the area, some of which are quite rare.

Thrushton National Park is located entirely within the Nebine catchment and contains a high diversity of vegetation types representative of the Mulga Lands bioregion. This park has a high scientific research value.

The Culgoa Floodplain National Park is partially contained within the Nebine catchment. Small portions of the Tregole National Park and Chesterton Range National Park are also contained within this catchment.

26. Queensland Government. 2014. *Request a species list*. op. cit.; Department of the Environment. 2015. *Protected matters search tool*. op. cit.; Walsh B and South West NRM. 2009. *Enhancing biodiversity hotspots*. op. cit.; Department of Environment and Resource Management. 2010. *Back on track actions for biodiversity*. op. cit.

Paroo catchment

The catchment covers more than 76,000 square kilometres of inland Australia and is the most westerly in the Murray-Darling Basin. The word 'Paroo' is a variation on the name of an Aboriginal Paakantji group, the Paruntyi.[27]

Approximately half of the Paroo catchment is contained in Queensland, all of which is within the South West NRM region. The following information refers to this Queensland portion only.

Location

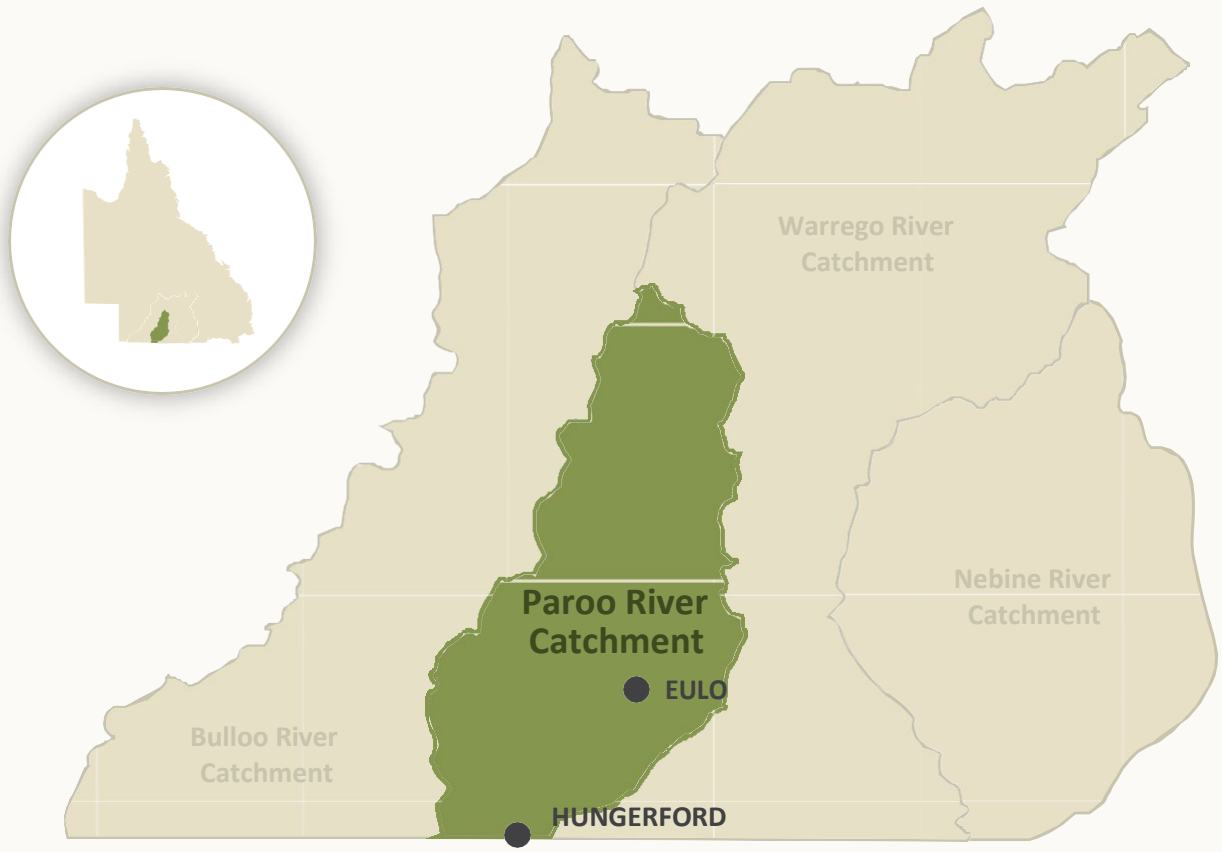

Figure 4: Paroo catchment

River system

Major River: Paroo River
Tributaries: Beechal, Yowah and Quilberry creeks and a section of Cuttaburra Creek

The Paroo River flows from its source in the Warrego Range and discharges onto a floodplain south of Wanaaring as it approaches the Darling River between Tilpa and Wilcannia.[28]

27. Australian Heritage Commission. 2000. *The Paroo River Catchment: Unique Australian Heritage*. Australian Heritage Commission. Canberra.

28. Department of Natural Resources. 2000. *Land cover change in Queensland 1997–1999*. op. cit.

Budjiti people are the traditional owners of the Currawinya Lakes area (near Hungerford). This area is significant to the Budjiti people for its religious, social, cultural and economic values.

Vegetation

Mulga (*Acacia aneura*) is the predominant vegetation type in the Paroo catchment. Mulga communities can range from open scrubland to tall, open shrublands. There are also dissected stony residuals within the catchment that support a selection of bastard mulga, lancewood and bendee.[29]

The channels of the Paroo River and its associated streams are fringed by a mixture of eucalypt and gidgee associations with the dominant eucalypt species in the catchment being river red gum, coolabah and poplar box.[30]

In the lower reaches of the catchment, the Paroo River loses its defined path and many types of wetland vegetation can be found, including black box, black wattle, grasses and forbs.

Climate

The Paroo catchment is in an area of low rainfall and high evaporation. Annual average rainfall is in the range of 200–400 millimetres, with almost 70% of the area receiving on average less than 300 millimetres per year.[31]

Industries

Grazing, of beef cattle and sheep for both wool and meat production, is the predominant industry in the catchment.[32] There are very few irrigated crops, with crop production generally restricted to small-scale operations, aimed at providing supplementary feed for stock. There is a growing push to build tourist interest and increase their stay in the region through projects being rolled out by South West RED relating to the Natural Sciences Loop in the South West Queensland region.

29. ibid.
30. ibid.
31. ibid.
32. ibid.

Photo courtesy Cathy Zwick.

Nature conservation values

An array of significant fauna and flora species have been listed as being known to, likely to or may occur in the Paroo catchment under either federal or state legislation.[33] Of particular interest in the Paroo catchment are:

Fauna

- Little pied bat (*Chalinolobus picatus*)
- Grey falcon (*Falco hypoleucos*)
- Major Mitchell cockatoo (*Cacatua leadbeateri*)
- Painted honeyeater (*Grantiella picta*)
- Australian painted snipe (*Rostratula australis*)
- Square-tailed kite (*Lophoictinia isura*)
- Freckled duck (*Stictonetta naevosa*)
- Peregrine falcon (*Falco peregrinus*)
- Murray cod (*Maccullochella peelii*) (unconfirmed reports of natural reintroduction through flood overflow)
- Yakka skink (*Egernia rugosa*)
- Night parrot (*Pezoporus occidentalis*)
- Red goshawk (*Erythrotriorchis radiatus*)
- Plains-wanderer (*Pedionomus torquatus*)
- Greater bilby (*Macrotis lagotis*)

33. Queensland Government. 2014. *Request a species list.* op. cit.; Department of the Environment. 2015. *Protected matters search tool.* op. cit.; Walsh B and South West NRM. 2009. *Enhancing biodiversity hotspots.* op. cit.; Department of Environment and Resource Management. 2010. B*ack on track actions for biodiversity.* op. cit.

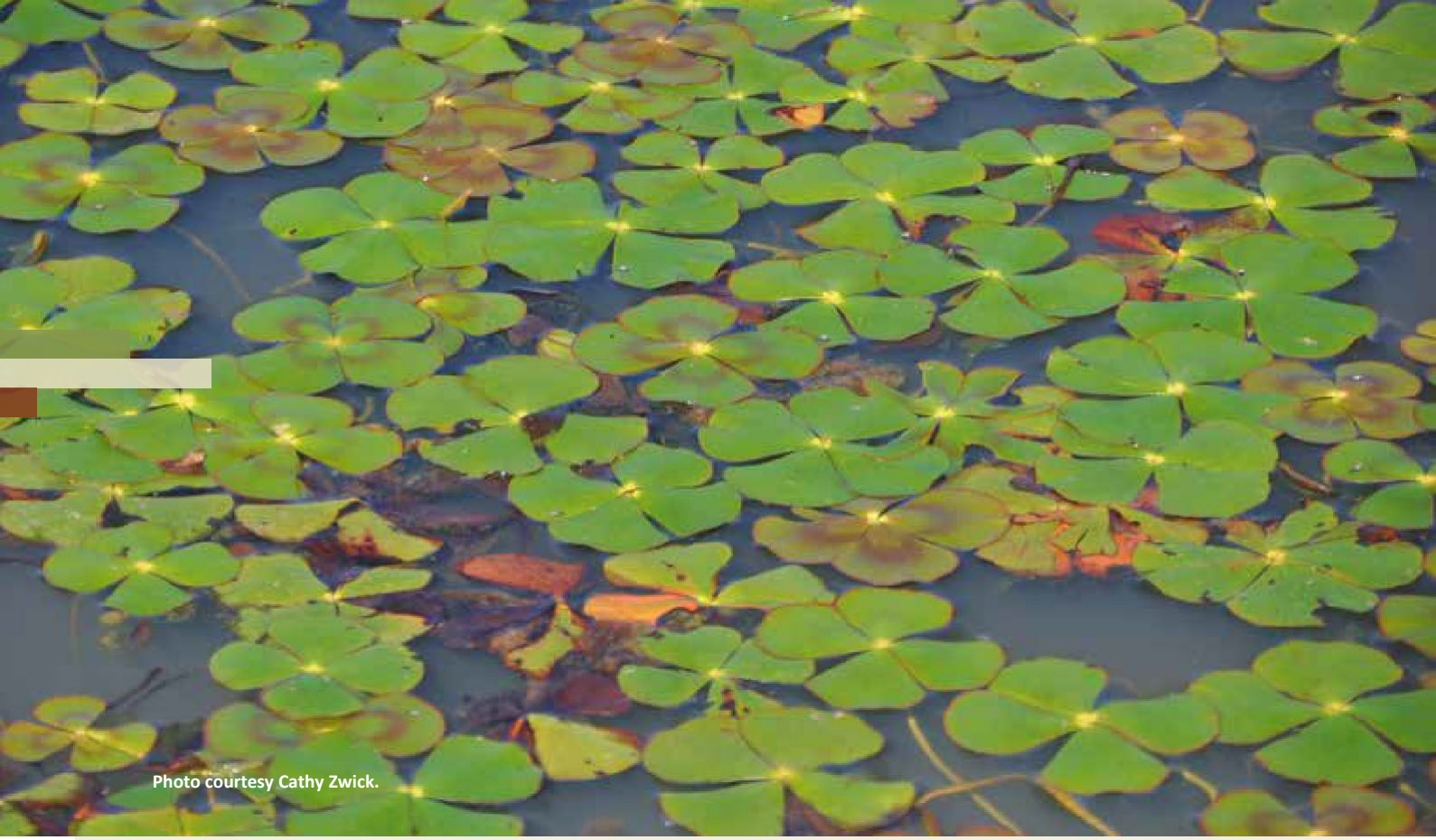

Photo courtesy Cathy Zwick.

Flora

- Salt pipe-wort (*Eriocaulon carsonii*)
- *Acacia ammophilla*
- Hawkweed (*Picris evae*)
- *Sclerolaena walkeri*

Threatened ecological communities include:

- The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin.

The Paroo catchment contains the entire Currawinya National Park (344,000 hectares, including the Boorara, Werewilka and Oolamon extensions) as well as a very small portion of Mariala National Park and part of Binya National Park. The Currawinya Lakes are Ramsar-listed.[34]

The Currawinya wetlands include five freshwater lakes, two saltwater lakes and many temporary small clay-pan lakes and swamps that appear following heavy rain. The area contains one of inland Australia's richest and most diverse series of wetlands. On occasions, these wetlands can provide habitats for more than 250,000 water birds, while regularly maintaining populations of up to 100,000 waterbirds from 41 species and the lakes form part of an inland route for migratory waters passing through arid Australia in autumn.[35]

There are six wetlands within the Paroo Catchment listed in *A Directory of Important Wetlands in Australia*,[36] as well as the Eulo Artesian Springs Supergroup, which is a collection of more than forty springs scattered in the area south-west of Eulo.

34. Ramsar. 2014. *Currawinya Lakes*, available from **http://www.ramsar.org/currawinya-lakes.**

35. ibid.

36. Environment Australia. 2001. *A Directory of Important Wetlands in Australia*. op. cit.

Warrego catchment

The Warrego River has its source in the Carnarvon Range at the most northerly point of the Murray–Darling Basin and meets with the Darling River upstream of Louth in New South Wales. The catchment covers a total area of some 78,400 square kilometres, of which 84% lies in Queensland. The Warrego catchment is the largest drainage system in the region.[37] The following information refers to the Queensland portion only.

Location

Figure 5: Warrego catchment

River system

Major River: Warrego River

Tributaries: Ward, Langlo and Nive rivers and Channin, Angellala and Chewin creeks

Distributary streams: Cuttaburra, Noorama and Widgeegoara creeks

37. Department of Natural Resources. 2000. *Overview of water resources and related issues: the Warrego/Paroo/Nebine catchments.* Department of Natural Resources, Brisbane.

Social factors

The towns and townships of Charleville, Cunnamulla, Augathella, Wyandra and Morven are contained within the Queensland section of the Warrego catchment. The major administrative centre in the Warrego catchment is Charleville.

The property of Mt Tabor is owned by the Bidjara Traditional Owners.

Vegetation

Mulga (*Acacia aneura*) shrubland is the predominant vegetation type in the Warrego catchment. Mulga communities can range from low, open forest to tall shrublands, predominantly growing on the flat-to-undulating plains. Areas of brigalow are found in the north of the catchment. The major channels also support cypress pine woodland, and gidgee can be found within the catchment floodplain areas.

Downstream, the Warrego River flows into channels and wetland areas where river red gum, coolabah and river cooba can be found.

Climate

The Warrego catchment is in an area of extremely variable rainfall. Annual average rainfall is in the range of 250 millimetres in the lower reaches to more than 650 millimetres in the more elevated sections. Over 42% of the area receives less than 400 millimetres per year.[38]

Industries

Grazing, of beef cattle and sheep for both wool and meat production, is the predominant industry in the catchment. Another important primary industry is the export of goat meat through Western Meat Exporters Pty Ltd, which is the largest goat processor in Australia and is located in Charleville. Tourism has made a significant contribution to the local economy. There is a growing push to increase the stay of tourists in the region through projects being rolled out by South West RED relating to the Natural Sciences Loop in the South West Queensland region.

38. ibid.

Photo courtesy Jed Sommerfield.

Nature conservation values

An array of significant fauna and flora species have been listed as being known to, likely to or may occur in the Warrego catchment under either federal or state legislation.[39] Of particular interest in the Warrego catchment are:

Fauna

- Collett's snake (*Pseudechis colletti*)
- Common death adder (*Acanthophis antarcticus*)
- Little pied bat (*Chalinolobus picatus*)
- Freckled duck (*Stictonetta naevosa*)
- Squatter pigeon (*Geophaps scripta scripta*)
- Yakka skink (*Egernia rugosa*)
- Murray cod (*Maccullochella peelii*)
- Koala (*Phascolarctos cinereus*)
- Northern quoll (*Dasyurus hallucatus*)
- Night parrot (*Pezoporus occidentalis*)
- Star finch (*Neochmia ruficauda ruficauda*)
- Plains wanderer (*Pedionomus torquatus*)
- Major Mitchell's cockatoo (*Lophochora leadbeateri*)
- Woma (*Aspidites ramsayi*)

39. Queensland Government. 2014. *Request a species list.* op. cit.; Department of the Environment. 2015. *Protected matters search tool.* op. cit.; Walsh B and South West NRM. 2009. *Enhancing biodiversity hotspots.* op. cit.; Department of Environment and Resource Management. 2010. *Back on track actions for biodiversity.* op. cit.

Photo courtesy CathyZwick.

Flora

- Shiny-leaved ironbark (*Eucalyptus virens*)
- Fuzzy box (*Eucalyptus conica*)
- Ooline (*Cadellia pentastylis*)
- *Rhaphidospora bonneyana*
- Hawkweed (*Picris evae*)
- *Grevillea nematophylla*
- *Xerothamnella parvifolia*

Threatened ecological communities include:

- Brigalow (*Acacia harpophylla* dominant and co-dominant)
- Coolabah – black box woodlands of the Darling Riverine Plains and the Brigalow Belt South bioregions
- Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin
- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar bioregions
- Weeping Myall woodlands.

Approximately 35,000 hectares of the Warrego catchment are conserved by Queensland and New South Wales state legislation. These areas include Tregole National Park, Morven Conservation Park and parts of the Chesterton Range National Park, Mariala National Park, Binya National Park and the Culgoa Floodplain National Park. Bush Heritage Australia manages Carnarvon Station, which includes management of the headwaters of the Warrego River, particularly Channin Creek.

Drivers of change in South West Queensland

Sustainable agriculture

Regional agricultural enterprises are subject to the ongoing influence of government policy changes in areas such as agricultural extension services, drought, rural leasehold land management, vegetation protection arrangements and water. Stock prices, the cost of freight, the roll-out of communication networks and infrastructure provision and maintenance all drive change in the region, in addition to market shocks from the live export issue and setbacks to kangaroo meat export opportunities.

A major challenge for the region is the significant number of unoccupied properties or absentee land owners. There are a number of reasons why properties are not occupied, ranging from landholders owning and running multiple properties and therefore only occupying one place that may or may not be in the region. Others have decided to move – to gain better opportunities for paid employment, schooling or health – and manage the property from afar. Current drought conditions have exacerbated this issue, resulting in people destocking and living elsewhere and bank foreclosures.

There has been an increase of foreign ownership of properties within the region over the past 5–10 years. High-quality properties from within a number of land types and localities have been acquired by investment/foreign owners and are bundled together as aggregations, meaning that one manager may be responsible for 8–10 properties. This leads to decreasing populations in small rural communities.

Minerals and energy

Development of natural gas resources has focused on the Gilmore Gas Field, and the road and pipeline needs of the Bellara Gas Field have led to enhanced infrastructure development.

Exploration of coal has increased, with coal exploration permits widespread in the region except for in the Paroo catchment.

A large-scale solar energy generation trial has been established at Thargomindah.

Climate and carbon

A major driver of change is the projected shift in the regional climate regime consistent with observed and modelled global warming and the intensification of weather events, especially rainfall events. Efforts to mitigate carbon emissions are being assisted by the emerging opportunities that flow from soil and tree carbon capture and sequestration and methane reduction.

There are currently 21 carbon sequestration projects in the region recorded on the national Emissions Reduction Fund project register,[40] two of which are registered with soil carbon methodologies. Of these 21 projects, seven have sold Australian carbon credit units (ACCUs) through the existing carbon market system.

40. Clean Energy Regulator. 2015. *Emissions Reduction Fund project register.* Australian Government, Canberra. Available from **www.cleanenergyregulator.gov.au/ERF/project-and-contracts-registers/project-register.**

Climate variability and trends in South West Queensland

The Stream 2 work[41] has provided downscaled climate change projections for each of the eight clusters of NRM regions across Australia. South West Queensland is the eastern-most NRM region in the northern portion of the Rangelands Cluster. The relevant Stream 2 findings are extracted below,[42] and they form the basis for the assessment of the climate change-related risks for NRM assets in the South West Region. The climate projections for the Rangelands Cluster are available in the report by Watterson et al. 2015[43] and from the Climate Change in Australia website.[44]

> In recognition of the impact of climate change on the management of Australia's natural resources, the Australian Government developed the Regional Natural Resource Management Planning for Climate Change Fund. This fund has enabled significant research into the impact of the future climate on Australia's natural resources, as well as adaptation opportunities for protecting and managing our land, soil, water, plants and animals.
>
> CSIRO and the Australian Bureau of Meteorology have prepared tailored climate change projection reports for each NRM cluster. These projections provide guidance on the changes in climate that need to be considered in planning.
>
> The projections in this report [Rangelands Cluster Stream 2 projections] are based on the outputs of sophisticated global climate models (GCMs). GCMs are based on the laws of physics, and have been developed over many years in numerous centres around the world. These models are rigorously tested for their ability to reproduce past climate. The projections in this report primarily use output from the ensemble of model simulations brought together for the Coupled Model Inter-comparison Project phase 5 (CMIP5) (Taylor et al. 2012), where phase 5 is the most recent comparison of model simulations addressing, amongst other things, projections of future climates. In this report, outputs from GCMs in the CMIP5 archive are complemented by regional climate modelling and statistical downscaling.
>
> The global climate model (GCM) simulations presented here represent the full range of emission scenarios, as defined by the Representative Concentration Pathways (RCPs) used by the IPCC, with a particular focus on RCP4.5 and RCP8.5. The former represents a pathway consistent with low-level emissions, which stabilise the carbon dioxide concentration at about 540 ppm by the end of the 21st century. The latter is representative of a high-emission scenario, for which the carbon dioxide concentration reaches about 940 ppm by the end of the 21st century.
>
> Projections are generally given for two 20-year time periods: the near future 2020–2039 (herein referred to as 2030) and late in the century 2080–2099 (herein referred to as 2090).
>
> For each variable, the projected change is accompanied by a confidence rating. This rating follows the method used by the IPCC in the *Fifth Assessment Report*, whereby the confidence in a projected change is assessed based on the type, amount, quality and consistency of evidence (which can be process understanding, theory, model output, or expert judgment) and the degree of agreement amongst the different lines of evidence (IPCC, 2013). The confidence ratings used here are set as *low, medium, high* or *very high*.[45]
>
> The following projected effects of climate change are those set out in the Rangelands Cluster Stream 2 Report (directly quoted[46]), adjusted for relevance to the South West Queensland NRM Region.

41. As described in the 'Plan preparation' section at the beginning of this report, Stream 2 funding was allocated to science organisations, such as CSIRO and the Bureau of Meteorology, to develop climate change projections and examine the potential impacts of climate change on Australia at the regional scale.

42. Watterson, I. et al. 2015. *Rangelands Cluster Report, Climate Change in Australia Projections for Australia's Natural Resource Management Regions: Cluster Reports.* Eds. Ekström, M. et al., CSIRO and Bureau of Meteorology, Australia. Available from **http://www.climatechangeinaustralia.gov.au/media/ccia/2.1.5/cms_page_media/172/RANGELANDS_CLUSTER_REPORT_1.pdf.** pp. 2–4.

43. ibid.

44. Climate Change in Australia. 2015. *Climate Change in Australia: Projections for Australia's NRM Regions.* Available from: **http://www.climatechangeinaustralia.gov.au/en/climate-projections/future-climate/regional-climate-change-explorer/clusters/?current=RA&popup=true&tooltip=true**.

45. Watterson, I. et al. 2015. *Climate Change in Australia Projections.* op. cit. pp. 2–4.

46. ibid. pp. 4–5.

Higher temperatures

Temperatures in the Rangelands have been increasing since national records began in 1910, especially since 1960. From 1910–2013, mean surface air temperature has increased by 1.0 °C in the North and 0.9 °C in the South using a linear trend.

Continued substantial increases for the Rangelands for mean, maximum and minimum temperature are projected with *very high confidence*. This takes into consideration the robust understanding of the driving mechanisms of warming as well as the strong agreement on direction and magnitude of change amongst GCMs and downscaling results.

For the near future (2030), the mean warming is around 0.6 to 1.4 °C above the climate of 1986–2005, with only minor differences between RCPs. The projected temperature range for late in the century (2090) shows larger differences with 1.5 to 3.1 °C ... and 3.1 to 5.6°C ... for RCP8.5.

Hotter and more frequent hot days, less frost

A substantial increase in the temperature reached on the hottest days, in the frequency of hot days and in the duration of warm spells is projected with *very high confidence*, based on model results and physical understanding ...

Less rainfall ... in spring. Changes in other seasons are unclear

... natural variability of rainfall has been high ... especially in recent decades.

We have *high confidence* that natural climate variability will remain the major driver of rainfall changes by 2030 (annual-mean changes of ± 10 %, and seasonal-mean changes of about ± 20%).

... Decreases are ... projected ... but with *medium confidence* only. The range for spring for 2090 under RCP8.5 is −55 % to +25 % ...

Changes to rainfall in other seasons, and annually, by 2090 are possible, but the direction of change cannot be reliably projected given the spread of model results. Such contrasts highlight the need to consider the risk of both a drier and wetter climate in impact assessment in the Rangelands.

Increased intensity of heavy rainfall events, changes to drought less clear

Understanding of physical processes and high model agreement gives us *high confidence* that the intensity of heavy rainfall events will increase. There is *low confidence* in the magnitude of change and the time when any change may be evident against natural variability.

We have *low confidence* in projecting how the frequency and duration of extreme meteorological drought may change, although there is *medium confidence* that under RCP8.5 the time spent in drought will increase by 2090.

Little change in wind speed

The median for projections of seasonal mean surface wind speed indicate little or no change throughout the 21st century ...

Based on global and regional studies, tropical cyclones are projected to become less frequent, but with increases in the proportion of the most intense storms (*medium confidence*).

Photo courtesy CathyZwick.

Photo courtesy CathyZwick.

Increased solar radiation in winter and reduced humidity throughout the year

Little change is projected for solar radiation for 2030 (*high confidence*) ...

We have *medium confidence* in little change in relative humidity for 2030. For 2090, based on model results and physical understanding, there is *medium confidence* in a decrease in relative humidity in summer and autumn, and there is *high confidence* in a decrease in winter and spring (about −5 to 0 % under RCP4.5 and −10 to 0 % under RCP8.5) [...].

Increased evaporation rates, and reduced soil moisture, changes to runoff less clear

Projections for potential evapotranspiration indicate increases in all seasons, with the largest absolute rates in summer by 2090 (*high confidence*). However, despite high model agreement, we have only *medium confidence* in the magnitude of the projected change due to shortcomings in simulation of observed historical changes.

Soil moisture projections suggest overall seasonal decreases by 2090, but predominately in winter ... (*medium confidence*). These changes in soil moisture are strongly influenced by those in rainfall, but tend to be more negative due to the increase in potential evapotranspiration. For similar reasons, runoff is projected to decrease, but only with *low confidence*. Furthermore, these estimates are based only on large-scale considerations. More detailed hydrological and environmental modelling is needed to assess local changes to these variables.

A harsher fire weather climate in the future

Bushfire in the Rangelands depends highly on fuel availability, which mainly depends on rainfall. For most of this cluster [the Stream 2 Rangelands cluster], extensive bushfire activity occurs after extended wet periods. These lead to vegetation growth that burns after the wet period ends. There is *high confidence* that climate change will result in a harsher fire-weather climate in the future, due to higher temperature and lower rainfall. But there is *low confidence* in the magnitude of fire weather projections. When bushfires occur, more extreme fire behaviour can be expected.

Risk to regional NRM assets from climate change

Even within the highly variable natural climate of South West Queensland, with its largely intact landscapes and natural systems, the projected changes in climate present significant challenges to vulnerable assets. As a counterpoint to these challenges, carbon storage in the vegetation and soils presents an environmental and economic opportunity for the region.

Stream 2 generated a useful general guidance document to assist in assessing the risks to and vulnerabilities of NRM assets in remote and marginalised regions.[47]

The risk and vulnerability framework used for this Plan identifies where each of the projected climate change–related hazards poses a risk of causing harm to each of the region's NRM assets (see Risk Assessment in Appendix 1). Those risks were then rated according to the likelihood of the harm occurring and the severity of that harm if it occurs. The risks were rated as:

- being able to be addressed within established management practices
- being operationally critical
- being enterprise critical (see Risk Rating Matrix in Appendix 1 for calibration definitions).

The vulnerability of the asset to harm from the hazard was then rated according to the asset's exposure and sensitivity to harm from the hazard, offset by the asset's adaptive capacity (Appendix 1).

The Climate Change Risk and Vulnerability Assessment that was written to support this Plan recognised a range of risks beyond risks that would normally be addressed by established management responses (Appendix 1).

In summary, the significant emerging risks have been identified as follows:

Human assets

People working in the open air are likely to be increasingly exposed to heat stress, and it is as likely as not that families will consider leaving the region, preferring to live in cooler places.

While it is considered unlikely that flood events from more intense rainfall will cost people's lives, because the consequence is so severe, any increase in this risk needs to be recognised and addressed.

Social assets

Increased demand on disaster management resources to prepare for, respond to and recover from fires and floods presents a risk that needs to be anticipated across the South West Queensland landscape. While vulnerability to the risk of inadequate disaster management resources is moderated by the robust national *Australian Emergency Management Arrangements*,[48] movement of people away from the region increases the demand on those remaining to fulfil roles and provide services within their local communities, including participation in rural fire brigades.

Natural assets

The region's pastures, waters and stock are all subject to increasing risk, particularly risk of reduced productivity owing to more hot days, hotter hot days and longer warm spells. Owing to their greater sensitivity to heat and moisture stress, native pastures may be at greater risk than buffel grass pastures. There may also be differential benefits to C_4 photosynthesis pathway species, such as the spear grasses, over C_3 grasses, such as Mitchell grass species, that could result in a trend towards less nutritious native species pasture composition.

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47. Measham TG (2014) *Australian rangelands and climate change – guidance to support adaptation: Addressing climate adaptive capacity, resilience and vulnerability of people in remote and marginalised regions*. Ninti One Limited and CSIRO. Alice Springs. Available from **http://www.nintione.com.au/resource/AustralianRangelandsAndClimateChange_GuidanceToSupportAdaptation.pdf.**

48. Australian Government Attorney-General's Department. 2014. *Australian Emergency Management Arrangements*. Australian Government, Canberra. Available from **https://www.ag.gov.au/EmergencyManagement/Tools-and-resources/Publications/Documents/Handbook-series/handbook-9-australian-emergency-management-arrangements.pdf.**

Woody weeds, macropods (kangaroos and related species) and wild dogs increase as a risk to the region's enterprises that are reliant on natural assets as those assets come under increasing temperature and moisture stress.

The risks to the region's biodiversity include wildlife mortality events and reduction in wetlands. These risks will be met with natural environmental responses, which will be exacerbated by feral animal predation and competition for water by stock and macropods.

Invasive success by cacti is a growing risk for enterprise and biodiversity as climatic conditions become increasingly favourable for these plants.

Photo courtesy CathyZwick.

The region's soils are subject to increased erosion from more intense rainfall events, and this is exacerbated by reduced vegetation cover, which generates a consequential risk of increased turbidity of natural surface waters.

Groundcover in the region is at increased risk of reduced grass and herb material due to the projected hotter weather, and the projected harsher fire weather increases the risk that combustible groundcover, including logs, dead fire fuel and living grass and herbs, may be lost.

Risks to pastoral resources across the Australian rangelands have also been identified through the Stream 2 processes. These are extracted below from Bastin et al. (2014).[49]

49. Bastin G, Stokes C, Green D and Forrest K. 2014. *Australian rangelands and climate change – pastoral production and adaptation*. Ninti One Limited and CSIRO, Alice Springs. Available from **http://www.nintione.com.au/resource/AustralianRangelandsAndClimateChange_PastoralProduction.pdf.**

Hotter maximum temperatures and increased frequency and duration of heatwaves will place greater emphasis on human safety and wellbeing and animal welfare (particularly when stock is being handled). Both aspects may need to be more formally recognised and planned as part of routine station management.

Longer periods of hotter weather will also require increased robustness in stock water supply. There will be a reduced safety margin around existing supplies as livestock consume more water in such periods. Repairs following failure will become more time critical before stock risk perishing or being exposed to conditions that threaten their welfare and production. Human occupational health and safety will also be paramount when attempting repairs to failed water infrastructure during heatwaves.

Increased rainfall intensity has the potential to damage station infrastructure and increase erosion. The latter can be partly mitigated by maintaining minimum critical levels of ground cover on the most vulnerable soil types. Reducing the actual and financial risk of infrastructure damage may require its relocation to less vulnerable areas, a degree of over-engineering (by present-day standards) and increased use of insurance.

Higher temperatures negatively affect pasture growth by reducing the efficiency with which plants use water, but this will be partly offset by the beneficial effects of rising atmospheric CO_2 on pasture. Tropical and subtropical grasses with the C_4 photosynthetic pathway are likely to expand ranges southward at the expense of existing C_3 grasses. The digestibility and nutritive value of pastures are likely to decline from the combined effects of rising temperatures, increasing CO_2 and increases in C_4 grasses, so overall animal production may decrease. This can be alleviated for cattle by introducing/increasing Bos indicus genetics and increased use of nutritional supplements. C_4 grasses are more flammable, and more extensive and frequent fires that burn hotter may result.

Longer periods of hotter weather will also potentially require an increase in watering points to enable stock to utilise all areas of paddocks without walking significant distances from water.

Climate-related impacts on native species appear to be most significant for plants, snails and reptiles, with moderate impacts likely for mammals, and low impacts on birds and frogs.[50]

Built assets

Increased demand on and damage to groundwater access points and their surrounding areas and infrastructure – bores, pipes, troughs and bore-drains – is a significant risk in hotter conditions.

Harsher fire weather and flood rain events present an increasing risk to infrastructure, especially widely distributed water infrastructure and fencing.

Financial assets

Equity in properties, loans and borrowing capacity, and operating capital and cash-flow all face increasing risk from reduced enterprise productivity and fire- and flood-related costs.

50. Pavey CR. 2014. *Australian rangelands and climate change – native species*. Ninti One Limited and CSIRO, Alice Springs. Available from **http://www.nintione.com.au/resource/AustralianRangelandsAndClimateChange_NativeSpecies.pdf.**

Photo courtesy Cathy Zwick.

PART B:

BIG IDEAS FOR PROSPERITY AND RESILIENCE - MANAGEMENT RESPONSE

Summary of outcomes

STRATEGY 1: Sustainability in the Mulga lands

(Better managing current activities)

1.1 Collaborative Area Management

By or before 2020, to fully enclose seven CAM clusters and by or before 2025 to demonstrate improved productivity linked to South West NRM Plan Outcomes in Strategies 1 and 3 within exclusion fenced areas.

1.2 Vegetation and soils

By or before 2025 at least 50% of the 3-P pastures of the Mulga Lands will be in 'B' (good) condition or better; no more than 50% of the Mulga resource will be grazed without a BMP grazing regime; and at least 50% of the Region's soils (area) will be managed using a BMP soils module to minimise soil loss.

Note: Standards for land condition and its assessment in the Queensland context are comprehensively set out in the *Guidelines for determining land condition.*[51]

1.3 Declared weeds and pests

By or before 2025, to have all agencies and all properties that are identified as critical in a weeds and pests operational program engaged in strategic management of weeds and feral animals.

STRATEGY 2: Opportunity – expanding outback horizons

(Making the most of existing and emerging opportunities)

2.1 Outback Experience: Sharing our natural and cultural assets

By or before 2020, to have the average visitor stay duration at five nights and the average visitor spend at $200.

2.2 Remote Area Technologies

By or before 2025 to have South West Queensland recognised by government, industry and regional communities as a key locality for innovation in remote area technologies.

2.3 Belonging to land in Aboriginal Australia

By or before 2025, to be clearly demonstrating Aboriginal engagement in managing sites, landscapes and NRM activities within the region.

2.4 Promoting NRM in the South West

By or before 2025, in at least 50% of the projects being implemented under this Plan, to have at least one party engaged to take the lessons and benefits elsewhere.

51. Department of Natural Resources and Mines. 2013. *Guidelines for determining land condition*. Queensland Government. Brisbane. Available from **https://www.dnrm.qld.gov.au/ data/assets/pdf_file/0017/110474/guidelines-determining-land-condition.pdf**.

STRATEGY 3: Resilience

(Improving capacity to resist and recover from projected changes)

3.1 Carbon management

By or before 2020, to have assessed the potential for carbon sequestration in the South West NRM Region and identified investment opportunities, and by or before 2015 to have trialled Carbon Grazing for improved productivity and soil system resilience.

3.2 Waters

By or before 2025, all Great Artesian Basin Sustainability Initiative (GABSI) target area bores have been capped and piped, and guidelines are available for protection of surface waters from stock, weed and pest damage.

3.3 Overabundant and invasive native species of flora and fauna

By or before 2020, in collaboration with agencies and industry, to have a broader suite of tools to address invasive native species.

3.4 Natural system resilience

By or before 2025 to have identified, and prepared guidelines for protective management of, the critical areas of the landscape that provide ecological refuge and functional connectivity for the ecosystems of the South West NRM Region.

Photo courtesy CathyZwick.

The strategies and outcomes proposed in this Plan align with the plans, policies and legislation of government agencies and other organisations. The plans, policies and legislation that this Plan aligns with are identified in Appendix 3: Linkages and alignment of the South West NRM Plan with other plans, policies and legislation.

STRATEGY 1: Sustainability in the Mulga Lands

Context

While the South West NRM region is dominated by the Mulga Lands Bioregion, 'Mulga Lands' is extended here to its broadest meaning as a synonym for 'the bush'. In vernacular language, 'going up the mulga' means 'going bush'. Therefore, this section refers to the whole of the South West NRM region. The term also points to the challenges of working and living in a remote area. Using the term Mulga Lands helps to differentiate this region within the vast rangelands of the Australian outback, of which South West Queensland is an important NRM region.

Central to the region's economy, community, culture and historical identity is primary production. This industry is the region's top employer, engaging 22.6% of the workforce.[52]

Whereas the industry's relatively low use of chemicals has a negligible impact on air and water quality, the real challenge lies in broadscale adoption of land management practices to nurture landscape resilience and sustain productivity in a highly variable regional climate that masks, as it probably will for many years into future, an underlying warming, drying trend linked to global warming. Additional pressure from the introduction of hardier stock, such as Brahman cattle (*Bos indicus*) and the potential expansion of goat production[53] in the region, coupled with current and projected climate conditions, may lead to a further decrease in groundcover, an increase in soil degradation and erosion, increased water turbidity and increased success by pest animals and plants, especially cacti. With the Mulga Lands Bioregion being Queensland's most degraded bioregion, and very difficult to rehabilitate,[54] the adoption of best practice agricultural management systems is a critical priority. South West NRM will continue promoting landscape resilience strategies and Carbon Farming Initiatives (CFIs), particularly soil sequestration projects.

New primary production opportunities emerged during the mid-1990s in the industry of farmed and wild-capture goats and kangaroo wild game. In 2009, while Charleville's goat meat industry was enjoying its status as the world's largest goat meat exporter, the kangaroo industry collapsed due to Russia's ban on Australian kangaroo meat, citing high levels of *E. coli* and salmonella as the reason. At industry peak, Russia had accounted for 70% of Australia's kangaroo export market. Although the Australian Government invested over $400,000 in addressing the hygiene issue, Russia remains unconvinced and resolute in its stance. Another lucrative export was kangaroo leather. Overcoming the negative reaction to harvesting an iconic Australian emblem remains problematic.[55]

Today, the large kangaroo populations are having a severe impact on the financial productivity of the pastoral industry with a total annual impact of $44.1 million: kangaroos cost graziers an estimated $15.5 million; the cost to crop farmers is estimated at $11.9 million; and fencing damage costs $16.7 million.[56] This assessment, however, does not take into account any of the benefits of having kangaroos in the landscape,[57] which include the role they play in the regeneration of native grasses, reduction of the risk of wildfires and protection of habitat from the invasion of non-native herbivores. As a native animal, the kangaroo has been part of the Australian environment for 50 million years and is a critical component of the ecosystems it lives in.

52. Queensland Government. 2014. *Queensland Regional Profiles: South West Regional Planning Area*. Queensland Government's Statistician's Office, Queensland Treasury and Trade, Brisbane. Available from **http://statistics.qgso.qld.gov.au/qld-regional-profiles**.

53. Queensland Government. 2009. *South West Regional Plan: Planning for a stronger, more liveable and sustainable community*. Queensland Government Department of Infrastructure and Planning, Brisbane. p. 19. Available from **http://www.rda-ddsw.org.au/fileadmin/user_upload/South_West_Queensland_Regional_Plan.pdf**.

54. ibid.

55. Boom K. 2012. *Australia's commercial kangaroo industry: Hopping to nowhere*, The Conversation. Available from **http://theconversation.com/australias-commercial-kangaroo-industry-hopping-to-nowhere-9624,** partly based on the author's article 'Pest and resource: a legal history of Australia's kangaroos', 2012, *Animal Studies Journal* 1(1), pp. 17–40.

56. ibid.

57. ibid.

Challenges that regional grazing and farming enterprises are currently facing as a result of changes in government policy include reduced agricultural extension services and the cessation then reactivation of the GABSI program. Other challenges include low cattle prices, the live export issue, high and increasing costs of freight, the closing of the rail line to stock trains, and the quality of roads in western Queensland.

Landholders are always seeking ways to adapt and become more resilient to cope with variability in seasons; however, not all adapt easily, and the emotional and financial strain has been well documented[58].

Scenario modelling has the potential to provide a powerful decision-making tool to assist land managers with their strategic planning and prioritisation of sustainable agricultural practices to increase landscape resilience while improving productivity.

The projected shift in the regional climate is likely to have significant impacts on the region's agricultural enterprises. The region can expect reduction in native pasture growth and ground cover and increased dominance of exotic weed species that have a superior capacity to acclimatise to more extreme conditions. One of the major threats comes from invasive cacti (*Opuntia spp., Cylindropuntia spp*.), due to its unique cortical bundle vascular system, which allows the plant to flourish in extremely hot, dry climatic conditions.

The reduction in bore drains prompts the need for strategically placed bore watering points and careful monitoring and control over these points using fencing and other strategies as a measure to control kangaroo and feral animal numbers, while providing enough water for other native wildlife and stock.

More hot days, hotter hot days and longer warm periods will increase heat stress on stock. They will also impact on people, particularly those on the land who work outside. More shaded areas will be needed, whether through organic means (tree planting) or construction (sheds, lean-tos, etc.). Protective outdoor clothing will continue to be of paramount importance, as will other protective clothing and practices required by workplace health and safety.

Hotter temperatures will also accelerate plant development (crops, pasture, groundcover), as the time between plant establishment and harvest/grazing will be reduced. Accelerated growth means less time for the plant to accumulate solar radiation, reducing its capacity for greater yield of nutritional value.[59]

Buffel grass (*Cenchrus ciliaris*) is an introduced, summer-growing, perennial pasture species that has been welcomed by graziers in South West Queensland because of its economic availability as well as its ability to adapt and acclimate to local conditions and those expected under climate change. Distribution modelling and plant physiological studies show its ability to maintain competitiveness and response to higher temperatures and fire under increased CO_2, ensuring its continued presence in Australia into the future. This makes it an attractive fodder plant in the likely loss of other palatable grasses under projected climates.[60] It poses a significant threat to native biodiversity, as indicated in modelling and distribution studies, which indicate its southward spread in Australia by 2070.[61] Continued support of this species as a staple pasture species in South West Queensland is likely to increase tension over time with southern regions anxious to protect their high value nature conservation areas.[62]

Increased evaporation will reduce the time between droughts. This occurs because, for any given amount of preceding rainfall, soil moisture deficit will be reached at a faster rate.[63]

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58. Rickards, L. 2011. *Critical Breaking Point: the effects of climate variability, climate change and other pressures on farm households.* Birchip Cropping Group. Victoria. Available from **https://www.researchgate.net/publication/268146675_Critical_Breaking_Point_The_effects_of_climate_variability_climate_change_and_other_stressors_on_farm_households_Final_Report**

59. Howden M. 2014. 'IPCC Report'. Radio interview with Libby Price, *ABC Rural* 107.3, 5 April. (Dr Howden is a major contributor to the Intergovernmental Panel on Climate Change (IPCC) Second, Third and Fourth Assessment reports.) Audio available from **http://mpegmedia.abc.net.au/rn/podcast/2014/04/cbt_20140405.mp3**.

60. Scott JK. 2014. Cenchrus ciliaris *(buffel grass) and climate change*. CSIRO Ecosystem Sciences, Wembley, WA. p. 1.

61. Scott JK. 2014. *Australian rangelands and climate change* – Cenchrus ciliaris *(buffel grass)*. Ninti One Limited and CSIRO, Alice Springs.

62. South Australia has a *Buffel Grass Strategic Plan 2012–2017* (**http://pir.sa.gov.au/ data/assets/pdf_file/0019/237340/SA_Buffel_Grass_Strategic_Plan.pdf**) which proposes a state-wide zoning scheme and management strategies to address the Buffel grass risk identified through climatic modelling.

63. Howden, op. cit.

Photo courtesy CathyZwick.

Higher evaporative demand on pasture and crops increases the plant's transpiration, resulting in a reduction of the plant's water-use efficiency for any given amount of rainfall. This results in reduced production[64] and increases the need for extra plant-available water. The impacts on stock are similar: as perspiration increases, the animal's water-use efficiency reduces, placing more pressure on water supplies, especially the Great Artesian Basin because of the need for increased draw on bore water. To address the impact of drought and consequent need for extra water, it is essential to consider water supply options and the best method of distributing that supply across the landscape in order to maximise efficient use of water.[65]

Projections show an increase in the likelihood of more intense rainfall events. Damage from these events will be caused by flooding and lightning strike. These will impact on:

- soil through erosion and scouring
- stock without safe, dry refuge
- pasture, due to water saturation and washout
- farm infrastructure from high winds, lightning strike and flooding.

Other risks include the potential spread of mosquito-borne viruses and the increased invasive success of exotic fish, especially European carp (*Cyprinus carpio*), when flooding waters break banks resulting in cross-catchment flow, as well as from stagnant water-ponding after these events. The spread of weed seeds will be another likely result from flooding. This will impact on plant biodiversity and composition due to changes in competition between weeds and native plants.

64. ibid.

65. ibid.

1.1 Collaborative Area Management

Background information

In response to mounting challenges faced by landowners, South West NRM facilitated the establishment of the Collaborative Area Management (CAM) strategy. This innovative project allows for the establishment of high integrity fencing constructed around a group of properties. The erection of this style of fence around large areas of land rather than individual properties means landholders can share resources and mitigate common issues within the closed area as a group.

This was seen as a practical way for geographically clustered groups of landowners to collaborate on and address shared issues such as wild dog control, management of macropod numbers, feral pest and weed mitigation and fire management. Although these issues are currently identified as high priority, the scope of CAM has the potential to extend to whatever the participants within the CAM groups decide is their priority.

In 2013, two trial sites were established at Morven and Mungallala South to gain proof of concept of CAM, by demonstrating strong economies of scale and value for money in strengthening the profitability and productivity of grazing enterprises while improving landscape biodiversity and natural assets within the collaboratively managed area. Perimeter fences around both of these CAM groups were completed by December 2014.

Subsequently, South West NRM secured a further $3.825 million through a Queensland Government grant to establish an additional five CAM groups to expand proof-of-concept trials across additional areas within the South West NRM region.

As at September 2015, three CAM clusters have been enclosed, with a further four in various stages of development. Monitoring for productivity increases commenced in early 2014, with components of a monitoring program set up for one of the CAM clusters. Monitoring from such an early point in the project has allowed for the collection of baseline data to which further observations can be compared.

In a Tambo newsletter, the following progress and aspirations of the Tambo South CAM were reported:

> Members of the group, their staff and neighbours are all working together supplying labour, machinery and equipment for the erection of this fence. Many already have indicated that they will return to running a sheep enterprise once more. It would be wonderful to have once again a shearing team in Tambo.[66]

While the prospect of being able to re-establish the sheep industry in the region is very exciting, the cost of doing so needs to be carefully assessed. For example, the area west of Charleville was primarily devoted to wool production during the 1950s when Australia was 'riding on the sheep's back', but at that time wethers cost a fraction of what they cost today. The question now is whether the current market can support the outlay of restocking to full sheep production, plus converting cattle fences to sheep fences and rehabilitating degraded yards. This is all grist for the mill in establishing the benefits CAM offers.

66. 'South Tambo Cluster Group Fence' in *The Grasslands Whisperer,* June 2014, issue 180, p. 26.

Outcome 1.1 – Collaborative Area Management

By or before 2020, to fully enclose seven CAM clusters and by or before 2025 to demonstrate improved productivity linked to South West NRM Plan Outcomes in Strategies 1 and 3 within exclusion fenced areas.

Management actions

1. Support landholders to lower total grazing pressure across large areas of agricultural land within CAMs and other participating areas contained within exclusion fencing.
2. Support landholders to demonstrate, within CAM and other participating areas contained within exclusion fencing, an increase in:
   - ground cover condition
   - perennial grass species
   - soil stability
   - moisture penetration

   and a reduction in:
   - invasive weeds
   - feral animals (particularly wild dogs)
   - macropods.
3. Develop a strategy of collaborating with other regions to encourage broader funding for CAMs. This is a benefit for producers across a wider area and promotes cross-region collaboration.
4. Develop decision-making tools such as spatial mapping to assist with implementing sustainable environmental and agricultural projects.
5. Support landholders who demonstrate an increase in biodiversity within CAMs and other participating areas contained within exclusion fencing.

The stakeholder workshops mentioned at the beginning of this document resulted in the reports *Don't Camp in the Creek Bed: Planning for Climate Variability in South West Queensland*[67] and *Risk and Resilience in NRM Planning: Addressing the drivers of change including the likely consequences of climate and seasonal variability*.[68] The stakeholder aspirations raised in those reports have been addressed in the Evaluation of Effectiveness section in Part C. For this Outcome, responses are given in particular to Community and other NRM Stakeholder Aspirations requesting:

i. more assistance to establish more CAMs[69]

ii. collaboration with DAF [Queensland Government Department of Agriculture and Fisheries], Leading Sheep[70], Australian Wool Innovation and others to develop and implement strategies to support and grow the sheep industry, particularly through CAM clusters; and identification of reasons for decline of sheep industry through monitoring and evaluation and facilitate implementation of actions and strategies to address decline.[71]

67. South West NRM Ltd. 2014. *Don't Camp in the Creek Bed.* op. cit.

68. South West NRM Ltd. 2014. *Risk and Resilience in NRM Planning.* op cit.

69. South West NRM Ltd. 2014. *Don't Camp in the Creek Bed,* op. cit., Community Aspiration 8, p. 18.

70. A network of Queensland sheep and wool businesses that aims for a more profitable Queensland sheep and wool industry through new technologies, knowledge and skills: **http://www.leadingsheep.com.au/**.

71. South West NRM Ltd. 2014. *Risk and Resilience in NRM Planning.* op. cit., Queensland Government Agency Aspiration 9, pp. 2–3.

Photo courtesy Jed Sommerfield.

1.2 Vegetation and soils

Background information

In addition to mulga, a type of acacia that is an excellent fodder source during drought,[72] the South West NRM Region has significant pastures of Mitchell grass and *Aristida/Bothriochloa* that support browsing and grazing by sheep, cattle, goats and native species. Introduced buffel grass (*Cenchrus ciliaris*) has become the most important sown pasture in arid to semi-arid regions because of its ability to thrive in 400–800 millimetres of rainfall and acclimate in hotter temperatures[73] as well as the relatively cheaper cost of seed: $5–15/kg for buffel compared to $25–50/kg for native pasture seed such as Mitchell grass. Local landowners prefer to sow native seed, but are not able to do so because of prohibitive cost and inability to obtain sufficient quantities.

Although buffel is highly valued as pasture in arid and semi-arid zones, it is equally recognised in other regions as one of Australia's serious environmental weeds. Its robustness could render it too high a risk as a pasture option, as containment in target areas will become increasingly difficult with projected national temperature increases and declines in rainfall, as shown in modelling and distribution research indicating its southward spread by 2070.[74]

This scenario points to the need for more intensive investment in production of native pasture seed and more vigilance in containment of buffel grass and weed species. The special implications relating to buffel grass under projected climate change in the rangelands has been examined as a Stream 2 project, which offered the following insights:

> Buffel grass (*Cenchrus ciliaris*) has been shown to acclimate to higher temperatures and to maintain competitiveness and response to fire under increased CO_2, conditions expected under climate change.
>
> Distribution modelling and plant physiological studies indicate that the current region of buffel grass presence in Australia will remain suitable under future climates, thus maintaining or increasing (due to loss of other palatable grasses) its importance for agriculture.
>
> Modelling the distribution of buffel grass indicates a southward spread in Australia by 2070. This represents a particular threat to the high value nature conservation in areas such as the Great Western Woodlands, the Alinytjara Wilurara Natural Resources Management Region and the Great Victoria Desert bioregion.
>
> Containment strategies for buffel grass are required for high value environmental assets, given that eradication will be impossible without unsustainable resources. Likewise control is likely to be very difficult, if not impossible, in

72. Department of Primary Industries. 1990. *Economic Profile of Graziers in the Queensland Mulga Region: a summary report.* Queensland Government, Brisbane. p. 1. Available from **http://www.southwestnrm.org.au/sites/default/files/uploads/ihub/economic-profile-graziers-queensland-mulga-reigon-summary-report.pdf**.

73. Department of Agriculture and Fisheries. 2013. *Buffel grass in south Queensland.* Queensland Government. Available from **http://www.daff.qld.gov.au/plants/field-crops-and-pastures/pastures/buffel-grass**.

74. Scott JK. 2014. *Australian rangelands and climate change*–Cenchrus ciliaris *(buffel grass)*. op. cit. Refer to page 7 for research findings on buffel physiology and likely spread indicated by modelling and distribution studies.

areas where the plant is already widespread. This makes containment the best strategy for new infestations, given that reinvasion is highly likely.

There is a risk that many plant species will not survive in a future climate that is hotter and drier. If buffel grass proves to have greater resilience than other plant species then it might form the basis for a novel ecosystem. Research is needed into ways that buffel grass can be managed to maximise its value to other components of the ecosystem.

Research is also needed into the genetic diversity in buffel grass with a view to identifying genotypes that are invasive and/or suitable for pasture improvement under climate change. [75]

The 3-P (perennial, palatable, productive) grasslands of the region are particularly sensitive to climatic conditions and total grazing pressure; while they respond well to good seasons, they do not persist well in dry conditions. Therefore, the land condition assessment of these grasslands tends to reflect seasonal conditions, even though the 3-P seed bank may be present.

State-wide high-level information collated about land condition in 2008–13 indicated the overall land condition of most (85%) leasehold land, which covers more than 60% of the area of Queensland, was good, with most leases (89%) having land types that are unstable (not in good condition) or vulnerable (susceptible to damage from management of climate conditions), many (65%) having land types where the pasture is unstable or vulnerable, and most (89%) having declared pest plants to some extent.

In the Mulga Lands Bioregion, the land types most frequently not in good condition were, in this order, frontage/alluvial, woodlands/forests, jump-ups/hard country and sandplains/inland dune fields. The causal attributes driving land condition in these land types were shown in the scores for pasture and adjusted biodiversity as set out in the *Guidelines for determining land condition*.[76]

Advice through Stream 2 indicates:

> Longer term adaptation may require a fundamentally more conservative approach to stocking rates, adjusting stocking rates as local pasture productivity changes (whether increases or decreases) and increasing the robustness of pastures by encouraging regeneration of palatable perennial forage (where possible). Repairing formerly productive, but now degraded, country may also have increased prominence as maximising rain use efficiency becomes more important through increased evaporation and reduced soil water availability.[77]

75. ibid. p. 4.

76. Department of Natural Resources and Mines. 2013. *Guidelines for determining land condition.* op. cit.

77. Bastin et al. 2014. *Australian rangelands and climate change – pastoral production and adaptation*. op. cit.

Outcome 1.2 – Vegetation and soils

By or before 2025 at least 50% of the 3-P pastures of the Mulga Lands will be in 'B' (good) condition or better; no more than 50% of the mulga resource will be grazed without a BMP grazing regime; and at least 50% of the Region's soils (area) will be managed using a BMP soils module to minimise soil loss.

Management actions

1. Prepare a regional assessment of land condition
2. Work with stakeholders to extend the Grazing Best Management Practice (BMP) tool to the South West Region, including the development of a module for the management of mulga.
3. Develop partnerships with industry and researchers to trial innovative practices that will enhance sustainability in grazing enterprises.
4. Partner with land managers to deliver on-ground practices that improve natural resource management.
5. Support initiatives to grow business opportunities that utilise or protect the natural resources of South West Queensland. This may be achieved by:
    - Responding to NRM stakeholder Community Aspirations, which include:
        - *Investing in market research into the kangaroo meat market with a view to re-establishing the industry in this region*[78]
        - *Accessing financial support to sink communal bores*[79]
    - Facilitating landcare practices across the region
    - Enhancing land managers' skills in NRM through information sessions, workshops and demonstration field days. NRM stakeholders have requested education on the following topics:
        - *Increasing ground cover*
        - *Latest research on more suitable pasture species*
        - *Water-harvesting methods*
        - *Water-capture and -ponding techniques (including contouring and keyline systems)*
        - *Soil-retention techniques (including blade-ploughing and ripping).*[80]

78. South West NRM Ltd. 2014. *Don't Camp in the Creek Bed*, op. cit. Community Aspiration 9, p. 18.
79. South West NRM Ltd. 2014. *Don't Camp in the Creek Bed*, op. cit. Community Aspiration 3, p. 11.
80. South West NRM Ltd. 2014. *Don't Camp in the Creek Bed*, op. cit. Community Aspiration 6a and 6b, pp. 15–16.

1.3 Declared weeds and pests

Background information

Climate change is listed as a key threatening process in the federal *Environmental Protection and Biodiversity Conservation Act 1999*. Accordingly, the Weeds of National Significance (WoNS) program supports overarching action plans developed by federal, state and territory governments and is incorporating climate change adaptation strategies into invasive plant management programs.[81]

More vigilant monitoring of weed spread and species displacement, quarantining and filtering methods are being called for due to increasing pressure of potentially new and changed levels of weed impacts on the regional environment. A concerning feature of national climate change modelling is the southerly movement of both native and introduced plant species, with the main threat of species migration coming from neighbouring regions in Australia.[82] Discussions about a formal regional strategy for pest animal and weed management have occurred, and some steps have been taken to achieve this outcome.

While increased storm intensity and flooding predicted under climate change increase the potential for wider distribution of weed seeds, they also increase the likelihood of the wider spread of other threatening species, such as mosquito-borne viruses and invasive feral fish such as carp and tilapia, which will create new ecosystems:

> Novel ecosystems are already a reality in the Australian environment. The new species assemblages due to changed distributions of both alien and native species will lead to the formation of novel ecosystems. A new management approach will be needed.[83]

Many invasive plants and weed species have an advantage over native species and crops, in that their rate of response to increased temperatures, changed rainfall, increased CO_2 levels, more extreme weather, more frequent frosts, changed phenology and changed land use is expected to be faster. They are therefore formidable competitors for limited resources, and their spread and subsequent displacement of native species is likely to result in a loss of native biodiversity. One of the greatest threats for South West Queensland comes from the spread of cacti.[84] Cats, goats, pigs and rabbits are expected to decline in abundance under projected climate shifts; detailed assessment of invasive species provided for the rangelands are available in Pavey and Bastin (2014).[85]

The terminology used under Queensland's *Land Protection (Pest and Stock Route Management) Act 2002* and the obligations imposed by that legislation will change on the commencement of the state's *Biosecurity Act 2014,* expected to commence no later than 1 July 2016.

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81. Weeds Australia. nd. *WoNS position on Climate Change.* Available from **http://www.weeds.org.au/climatechange.htm.**

82. Scott JK, Murphy H, Kriticos DJ, Webber BL, Ota N and Loechel B. 2014. *Weeds and Climate Change: supporting weed management adaptation*. CSIRO, Australia. p. 4.

83. ibid.

84. ibid.

85. Pavey CR and Bastin G. 2014. *Australian rangelands and climate change – invasive animals.* Ninti One Limited and CSIRO, Alice Springs. Available from **http://www.nintione.com.au/resource/AustralianRangelandsAndClimateChange_InvasiveAnimals.pdf**.

Currently, South West NRM funding for weed control is targeted at Classes 1–3 weeds and WoNS in South West Queensland. The following table provides a prioritised list:

Table 2: Priority weeds

Priority	Weed	Threatened asset
1a	Prickly acacia (*Acacia nilotica*) **(Class 1 WoNS)**	• Exists in South West NRM region in upper Bulloo catchment • Has the potential to spread over the entire region causing negative environmental, economic and social impacts
1b	Hudson pear (*Cylindropuntia rosea* and *Cylindropuntia tunicata*) **(Class 1 WoNs)**	• Rare in Queensland; best control is prevention as it has the potential to cause impacts to whole of state • Destroys native pastures • Its sharp spines threaten native animals, bush walkers and farm animals • Spines can penetrate boots and tyres
2	Water lettuce (*Pistia stratiotes*) **(Class 1)**	• Currently only found on the Warrego River weir near Cunnamulla • Has the potential to infest much of the South West NRM region • If infestation occurs, the weed would have high negative impacts on the economic, environmental and social values of infested waterways
3	Mesquites (*Prosopis spp.*) **(Class 2 WoNS)**	• Main infestation of mesquite in the region is present on the Bulloo River in Quilpie Shire • Several other infestations are found in the region, generally being of a localised nature • Causes major negative economic and environmental impacts
4	Parkinsonia (*Parkinsonia aculeata*) **(Class 2 WoNS)**	• Main infestations are in the Bulloo, Warrego and Paroo catchments in the Paroo and Quilpie shires
5	Parthenium (*Parthenium hysterophorus*) **(Class 2 WoNS)**	• Upper Bulloo in the Quilpie Shire, Murweh Shire and Maranoa Shire
6	Rubber vine (*Cryptostegia grandiflora*) **(Class 2 WoNS)**	• Potential for establishment is highest in the north-east of the region
7	Mother of millions (*Bryophyllum delagoense*) **(Class 2 Declared pest)**	• All catchments (Bulloo, Warrego and Paroo) in the Paroo, Murweh and Quilpie shires
8	Coral cactus (*Opuntia cylindrical*) **(Class 2 WoNS)**	• Currently mapped as occurring in less than 10% of the region • Listed as an emerging threat under the former DNRW's Pest Offensive

Priority vertebrate pest species active in the region are wild dogs, carp, feral pigs, feral cats, foxes and rabbits. Carp are regulated under Queensland's *Fisheries Act 1994* and will be transferred to the *Biosecurity Act 2014*. Cane toads are now established, with populations in the Carnarvon Range in the headwaters of the Warrego River system. Brumbies have been a significant threat, particularly to plant diversity and water quality in the Carnarvon Range.

Table 3: Pest animals and threats

Priority	Pest animals	Threatened asset
1	Wild dogs	• Prey on livestock, resulting in loss of agricultural and lifestyle opportunities • Damage dingo population through competition and hybridisation • Prey on native fauna – cross-bred individuals, large packs and heavily built wild dogs contribute to impact
2	Feral pigs	• Degrade habitat, especially riparian areas • Prey on native fauna and domestic livestock • Spread diseases and biosecurity risks • Damage habitat of the grey grasswren (Bulloo) • Damage population of endangered species salt pipe-wort (*Eriocaulon carsonii)*
3	Wild cats	• Impact on native fauna via direct predation, competition and parasite transmission
4	Foxes	• Prey on native fauna and domestic livestock • Damage the population of the greater bilby and the Australian painted snipe (*Rostratula australis*)
5	Carp	• Rapidly outnumber native fish and dominate aquatic communities • Destructive feeding habits that muddy water and uproot aquatic vegetation, resulting in less light penetration, decreased plant growth and lower oxygen levels
6	Rabbits	• Compete with native fauna and domestic stock for resources • Cause long-term damage to structure of vegetation communities and soil stability, resulting in land degradation • Threaten habitat of grey grasswren (*Amytomis barbatus barbatus*) (Bullo), and greater bilby
7	Cane toads	• Cane toads eat a wide variety of prey, breed opportunistically, have a far greater fecundity than native anurans and develop rapidly, particularly in warmer waters • They are considered to be an extreme generalist, with a tolerance for a broad range of environmental and climatic conditions and able to potentially occupy many habitats • There is considerable concern over the impact of the cane toad on native species, particularly invertebrate communities, through predation and competition • Most significantly, they possess highly toxic chemical predator defence mechanisms, and many scientific and anecdotal reports exist of deaths of native predators that have attempted to consume cane toads • Cane toads are slowly entering the SWNRM region from the north, around the Canarvon Range in the upper headwaters of the Warrego catchment.
8	Brumbies	• Brumbies have adverse impacts on soil stability for soil compaction and increased erosion potential. • Tramping of isolated natural springs especially in the threaten ecological communities in the north east of our region, such as at Mt Tabor, an Indigenous land corporation property managed in partnership with the native title claimants: the Bidjara people, as well as impacting on the mound springs (the Eulo supergroup) found in the Paroo Ramsar and HEVAE (high ecological value aquatic ecosystem). • Brumbies are highly mobile through the landscape and are very difficult to eradicated using trapping methods, most ideal and human action is aerial destruction. • Possible biosecurity threat for Hendra virus which is transmissible to humans.

Outcome 1.3 – Declared weeds and pests

By or before 2025, to have all agencies and all properties that are identified as critical in a weeds and pests operational program engaged in strategic management of weeds and feral animals.

Management actions

1. Collaborate with the Department of Science, Information Technology and Innovation to access remote sensing imagery and methods to detect and map Weeds of National Significance across the South West NRM region, to track the current situation and ensure changes over time can be monitored.

2. Develop partnerships with land managers, local weed and pest management groups, the community and local shire councils to establish a collaborative regional weed and animal pest management program across NRM and council boundaries. This may include:

   – *Collaborating with Biosecurity Queensland and other stakeholders to monitor, evaluate and add emerging pest species to pest management plans*[86]

   – *Collaborate with Biosecurity Queensland and other stakeholders to increase surveillance opportunities through the use of South West NRM's Indigenous cactus control team*[87]

   – *Investigating the use of biological control opportunities*[88]

   – *Investigate installation of wash-down bays on main roads to curb weed spread*[89]

   – *Supporting electrofishing programs.*[90]

3. Promote on-ground activities that contain and eradicate weed and animal pest infestations.

Photo courtesy CathyZwick.

86. South West NRM Ltd. 2014. *Risk and Resilience in NRM Planning*, op. cit., Queensland Government Agency Aspiration 5, p. 2.

87. ibid., Queensland Government Agency Aspiration 7, p. 2.

88. ibid.

89. South West NRM Ltd. 2014. *Don't Camp in the Creek Bed*, op. cit., Community Aspiration 7, p. 17.

90. Norris A, Hutchison M, Chilcott K and Stewart D. 2014. *Effectiveness of carp removal techniques: options for local governments and community groups.* Invasive Animals CRC. Canberra.

STRATEGY 2: Opportunity – Expanding Outback Horizons

Context

At a meeting in June 2014 conducted by South West NRM with local and state government stakeholders, South West NRM staff and members of the board, robust discussion focused on how we could do things in the South West to achieve the following desirable objectives:

- Keep young people in the region
- Seek new investment from outside
- Investigate new ways of doing things to increase business effectiveness, including use of remote technology
- Work together to share and build skills, with an emphasis on cooperation, not competition
- Build effective NRM networks and alternative contacts.

The themes and associated actions in Strategy 2 seek to achieve these objectives.

Photo courtesy CathyZwick.

2.1 Outback Experience: Sharing our natural and cultural assets

Background information

Tourism in the South West region makes a significant contribution to the regional economy. Tourism is increasingly being viewed as a valuable income for the region, as indicated by the launch of the Natural Sciences Loop in 2014, which was a collaborative effort between South West RED and the Queensland Government's tourism department. Local businesses that benefit directly include hotels/motels, caravan parks, farm stay accommodation and tours, local shops, service stations, coffee shops and mechanics.

The region is rich in biodiversity, with native and naturalised vegetation communities supporting more than 90% of the regions grazing activities and providing a unique regional identity. Tourists visit the region for the "Outback experience" which is tied to the vast and contrasting landscapes under big skies and welcoming nods from friendly locals. Tourism information is collected for local government areas in the region and information about the number of nights visitors stay in the region, average spend per visitor and total number of visitors to the region can be found in Table 4.

Table 4: Tourism information for the South West region[91]

Shire	Murweh	Paroo Bulloo Quilpie	Balonne
Visitors ('000)	64	45	62
Average stay (nights)	2.4	4.2	3.3
Spend per visitor ($)	$293	$502	$398
Spend per night ($)	$121	$117	$121

***Note:** These figures are based on local government areas and do not represent the exact tourism data for the South West NRM region. These figures represent the main shires located fully or partially within the South West NRM boundary.*

There is increasing awareness among rural stakeholders of the need to collaborate and value-add to their tourist product to make a more competitive bid for the finite tourist dollar and draw business from traditional coastal tourist hotspots to the outback. In recognition of this need, the South West Regional Economic Development Association Inc. (South West RED) was formed in 1992, to advise businesses and to package – across local council boundaries – the tourist product of exposure to various sites, activities and culture. South West RED is a collaboration between the councils of Bulloo, Murweh, Paroo, Quilpie, Balonne and Maranoa Shire Councils and has access to state government funding and advice through the Queensland Department of State Development. The South West RED Management Board represents people from council, business industry, community organisations, government and tourism across an area of 232 square kilometres, which extends west to the South Australian border, north to and including Augathella and south to the New South Wales border, taking in a wider area than just the South West NRM region.[92]

An early collaborative achievement between South West RED and the Queensland Government's tourism department was the establishment of the Queensland Natural Sciences Loop, which was launched in 2014. The loop boasts a well-researched itinerary of natural wonders for visitors to self-explore. It encompasses astronomy, geology, hydrology, meteorology, biology, paleontology and history, set within the diverse landscapes and communities of Charleville, Quilpie, Eromanga, Thargomindah and Cunnamulla.[93]

On a more individual level, there is also growing interest among landholders in the region towards opening up areas of their properties to ecotourism, nature-based tourism, farm tours and farmstays as a means of income diversification. The private and public benefit derived from intact ecosystem services is recognised locally, and many of the region's migratory bird species draw

91. Tourism and Events Queensland. 2016. Tourism profiles. Available from **http://www.http://teq.queensland.com/en-CA/Research-and-Insights/Domestic-Research/Tourism-Profiles**

92. Cunnamulla Visitor Information Centre. 2015. *South West RED.* Available from **Cunnamulla Visitor Information Centre.**

93. *Queensland Natural Sciences Loop*. op. cit.

worldwide interest and are protected by the international Ramsar Convention.[94] The diverse range of ecosystems and floristic diversity in South West Queensland provides habitat for an extensive variation in rangeland and wetland wildlife, including a large number of native rangeland mammals, which are small, nocturnal and burrowing. Some of these are listed as nationally rare, threatened or endangered and require active management to prevent their extinction.

These opportunities could be combined with NRM initiatives by identifying on-farm tourist experiences in each of the seven shires and regions and providing cross-regional promotion to visitors, potentially facilitating capacity-building and knowledge-brokering opportunities to people both within and external to the region.

Fossicking for opals at Quilpie is an important activity that adds to the outback tourism experience of the region.

Photo courtesy Jed Sommerfield.

Outcome 2.1 – Outback Experience: Sharing our natural and cultural assets

By or before 2020, to have the average visitor stay duration at five nights and the average visitor spend at $200.

Management actions

1. Support community groups as well as tourism groups and agencies to promote and increase utilisation of the region's natural assets. This may include:
   - *Supporting the work of the Outback Gondwana Foundation: the proposed Eromanga Natural History Museum (Stages 1 and 2) and its associated paleontological work in South West Queensland*
   - *Providing opportunities for Outback Gondwana Foundation staff to guest speak at South West NRM's 'Caravan of Collaboration' to inspire and educate landholders and members of the public about what to look for and how to identify dinosaur, megafauna and microfauna remnants on their properties and in the region*
   - *Promoting and facilitating partnerships and cooperation in tourism packaging and branding.*
2. Support funding applications for research into natural sciences in the region to grow tourism opportunities.
3. Support participation in the QTIC Tourism Indigenous Employment Champions Network.[95]
4. Collaborate with tourist bureaux on activities that will add value to the tourist experience. This may include:
   - *Engaging landholders through South West NRM's communication channels to become identifiers of opportunities on their properties.*

94. Department of the Environment. 2011. *Currawinya Lakes (Currawinya National Park)*. Australian Government. Available from **http://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=43.**

95. Queensland Tourism Industry Council. 2015. *Tourism Indigenous Employment Champions Network*. QTIC. Available from **https://www.qtic.com.au/project-service/tourism-indigenous-employment-champions-network**.

Photo courtesy Trader Schmidt.

2.2 Remote Area Technologies

Background information

People in South West Queensland have been demonstrating their willingness to embrace emerging technology as a way of enhancing their business, lifestyle, culture and safety through such innovations as:

- the hydro-electric power project at Thargomindah, which harnesses water pressure from a well sunk into the Great Artesian Basin to generate electric power
- the use of technologies (such as Google Earth) and night-vision cameras (to better understand the behaviour of animal pest species and their interactions with non-target species and stock) as property management tools
- the Murweh Shire Council's current review of hard waste and sewerage systems, with a view to creating artificial wetlands and other opportunities such as recycling of paper and cardboard[96]
- trialling of drone technologies by state government agencies and the neighbouring NRM region Desert Channels Queensland for land management support (weed infestation location and spraying)
- the collaborative effort between Queensland Fire and Emergency Services, Bulloo Shire Council, Murweh Shire Council, Paroo Shire Council, Quilpie Shire Council and South West NRM to establish and maintain the region's Early Flood Warning System, which forewarns towns and isolated property owners about dangerous levels of water over crossings and down rivers. This is achieved through the use of remotely operating cameras, weather stations and river height sensors at strategic points in South West Queensland, which feed images and data into an automated website and alert system. This Early Flood Warning System (EFWS) is currently operational and available on South West NRM's website.[97]

The number of landowners using technology in the South West NRM region is increasing. A prime example of recent uptake of digital technology is the issuing of 54 motion-activated security cameras by South West NRM to landowners since August 2014, to monitor feral animal behaviour and population. More cameras are required to meet the demand.

96. South West NRM Ltd. 2014. *Risk and Resilience in NRM Planning*, op. cit., p. 3.

97. South West NRM Ltd. nd. *Early Flood Warning System and River Height Measurements.* South West NRM Ltd. Available from **http://www.southwestnrm.org.au/content/early-flood-warning-system-and-river-height-measurements.**

Outcome 2.2 – Remote Area Technologies

By or before 2025 to have South West Queensland recognised by government, industry and regional communities as a key locality for innovation in remote area technologies.

Management actions

1. Collaborate with shire councils and other stakeholders to investigate recycling programs and renewable energy opportunities, particularly those relating to solar. This may include:
   - *Collaborating with shire councils and schools to investigate programs for recycling paper and cardboard*
   - *Working with stakeholders to develop local power generation initiatives*
   - *Facilitating interagency workshops and/or information sessions to educate about recycling and/or renewable energy opportunities. This may include organising a seminar with guest expert/s on current trends in recycling programs to educate council stakeholders across the five shires about requirements of various recycling programs (these could include tyres, scrap steel, old batteries and paper).*
2. Collaborate with stakeholders to investigate communications and monitoring technologies to assist remote families and enterprises. This may include:
   - *Developing opportunities for increased internet and mobile phone services*
   - *Developing opportunities for drone-based inspection of fences and waters.*
3. Promote remote technologies is a focus for the next Leading Sheep project 2015–2018. Work with the Queensland Department of Agriculture and Fisheries to collaborate on such projects.
4. Seek and support opportunities to trial and promote emerging technologies that benefit agricultural producers.
5. Continue maintaining and value-adding to the EFWS. This may include:
   - *Continuing to maintain and keep the EFWS operational*
   - *Establishing baselines to enable text and email alerts to be sent to key emergency services personnel*
   - *Establishing baselines and protocols to enable alerts to be sent to graziers about flow events that may affect their activities*
   - *Adding automated road closure signs to critical crossings*
   - *Adding rain gauges to suitable locations that are lacking them*
   - *Enabling key council and SES personnel to monitor water levels when needed*
   - *Refining warning levels to better support response decision-making.*

See the Evaluation of Effectiveness section in Part C for this Outcome for responses to Community Aspiration 4 requesting key rivers and creeks in South West Queensland be equipped with automated flood warning systems and that they be monitored and maintained regularly.[98]

98. South West NRM Ltd. 2014. *Don't Camp in the Creek Bed*, op. cit., Community Aspiration 4, p. 14.

Photo courtesy CathyZwick.

2.3 Belonging to land in Aboriginal Australia

Background information

The Murray–Darling Basin Authority and the Northern Basin Aboriginal Nations recognise eight nations for the South West NRM Region: Kooma, Bidjara, Kunja, Mardigan, Budjiti, Kullilli, Murrawarri and Boonthamurra. Each identify with their parts of the country and endeavour to keep their culture alive. This means there are identifiable Elders who speak for the country and can pass on their insights to the wider community.

Their heritage is evident throughout the region, with burial grounds, fish traps, stone arrangements, camp sites and art work still prevalent at numerous sites across the country. Several accomplished Aboriginal artists, writers and singer/songwriters are active in the region.

One of the core areas of investment for South West NRM is to work with Aboriginal people to increase opportunities for engagement, education and employment in NRM and connection to country.

By using existing funding and accessing grants, South West NRM seeks to evolve a multifunctional approach to engaging, educating and employing Aboriginal workers.

Aboriginal cultural connection is poorly recognised in natural resource and infrastructure decision-making in South West Queensland. The following management actions are in response to Traditional Owner aspirations that were captured in 'Yarning with Traditional Owners in South West Queensland: Planning for Climate Variability in South West Queensland'.[99] Their aspirations can be summarised as:

- inclusion in holistic management of water and landscape management
- greater access to employment opportunities
- raising awareness about Aboriginal peoples' culture and connection to the environment.

99. South West NRM Ltd. 2014. *Don't Camp in the Creek Bed*, op. cit., pp. 30–43.

Outcome 2.3 – Belonging to land in Aboriginal Australia

By or before 2025, to be clearly demonstrating Aboriginal engagement in managing sites, landscapes and NRM activities within the region.

Management actions

1. Work with schools to engage Traditional Owners in storytelling to embed culture, history and on-country knowledge into local education and tourist opportunities.
2. Establish a specialist position to actively build and support Aboriginal engagement in NRM activities, planning and decision-making across the region.
3. Engage with Traditional Owners' Incorporated and unincorporated bodies about South West NRM projects to:

    a) grow Traditional Owner capacity and self-determination

    b) foster an Indigenous Ranger Program over time. This may include:

    - *Training Aboriginal people from each of the eight groups in the South West NRM region to participate in a weed and pest control team at various stages*
    - *Fencing projects to protect springs, water holes and riverine systems as well as sacred sites and other cultural and ecological priority areas; value-adding to the CAM program by employing Aboriginal fencing contractors*
    - *Planting trees*
    - *Working with the Kooma and Bidjara peoples to seek the reintroduction of endangered native animals onto Aboriginal-owned land*
    - *Capturing change over time at sites established for reintroduction of endangered native animals onto Aboriginal owned areas to build knowledge about processes that improve ecological and social benefit.*

2.4 Promoting NRM in the South West

Background information

The business of South West NRM is directed by the South West NRM Plan, which is intended to be the main community-made plan that delivers strategic programs and actions to tackle regional natural resource issues.

South West NRM's methods of information dissemination are determined by:

a) available communications infrastructure (particularly the internet)

b) travel time and distance

c) stakeholder preference.

The percentage of people who have access to the internet in South West Queensland is lower than the State percentage: in 2011, the percentage of total occupied private dwellings in South West Queensland with an internet connection was 62.6% compared to the State's 78.3%.[100]

This level of internet access does not necessarily guarantee good communication: during regional workshops conducted in March 2014, some attendees who had internet access said they still preferred to receive hardcopy newsletters, with their reason being the slowness of downloading graphics, which often resulted in their computers timing out.

These figures and feedback indicate that to reach maximum stakeholder numbers, it is necessary for South West NRM to continue with traditional methods of information delivery (hardcopy newsletters, flyers, newspaper stories and radio) as well as electronic methods such as the organisation's website, Facebook, Twitter, e-newsletters, email and phone calls.

As the South West NRM region spans 11% of the state's area, consideration is also given to the distances stakeholders should be expected to travel and the time it takes to attend South West NRM workshops.

Other opportunities to spread awareness of NRM throughout the region include sponsoring NRM activities through schools and other public events and opportunities.

As this outcome introduces a 'paying it forward' approach to actively diffusing and spreading awareness of the lessons and benefits of projects, there is no baseline information beyond the narrative of legacy benefits from more than a decade of active engagement across stakeholder groups, members of which are project participants.

100. Queensland Government Statistician's Office. 2015. *Queensland Regional Profiles* [Statistics search on 'Regional Planning Area', 'South West']. Queensland Treasury and Trade, Brisbane. p. 10. Available from **http://statistics.qgso.qld.gov.au/qld-regional-profiles**.

Photo courtesy CathyZwick.

Outcome 2.4 – Promoting NRM in the South West

By or before 2025, in at least 50% of the projects being implemented under this Plan, to have at least one party engaged to take the lessons and benefits elsewhere.

Management actions

1. Support and facilitate education and communication about NRM, including promotion of South West NRM and the services it offers.
2. Collaborate with government agencies and other organisations to increase industry stakeholder awareness of NRM issues and opportunities. This may include:
   - *Collaborating with Leading Sheep, Meat & Livestock Australia and AgForce events.*
3. Facilitate community-based engagement with South West NRM programs and activities through public events and opportunities. This will include:
   - *Continuing to sponsor the annual Pest Storytelling Program within schools.*
4. Continue improving South West NRM's 'Three Rivers, Three Creeks' communications strategy, with actions including:
   - *Producing and disseminating quarterly editions of the organisation's newsletter Three Rivers Three Creeks (total of 20 issues over five years)*
   - *Increasing use of email alerts to spread awareness of activities and achievements*
   - *Updating the South West NRM website regularly with updates and new information about NRM planning as well as emerging technologies and resilience strategies to mitigate impacts of climate change and variability, and the lessons learnt from on-ground works and field trials*
   - *Conducting four workshops per year with industry, local, state and federal agencies for information sharing and collaboration (total of 20 workshops over five years)*
   - *Delivering 40 property mapping packages to regional land managers per year (total of 200 over five years)*
   - *Building an effective database of NRM stakeholders and contact details*
   - *Providing umbrella support to Landcare interest organisations in South West Queensland (there are over 60)*
   - *Community and Queensland Government Aspiration: Working with the community to establish an alert program to increase surveillance of pest species to reduce delays in notifying Biosecurity Qld.*

STRATEGY 3: Resilience

Context

South West Queensland is rich in natural assets of local, regional, national and international significance. This Plan aims to recuperate the health of the region's natural resources by promoting best practice agricultural management systems and establishing ongoing mitigation efforts to reduce the impacts of climate change to strengthen the region's natural resilience and sustainability.

Photo courtesy CathyZwick.

A combination of issues that impede facilitation of landscape connectivity and resilience programs across the South West NRM Region include:

- the large size of the region, which is approximately 11% of Queensland, in the hands of relatively few landholders, some of whom manage their properties from outside the region and/or as substantial property aggregations. (The land in the region is 94.6% privately owned and predominantly used for cattle- and sheep-grazing enterprises, with only 5.4% being public/national park land.)
- that the South West NRM Region is dominated by the Mulga Lands Bioregion (74% in Qld and 26% in NSW), with more than 20% of the bioregion having been cleared for high pasture utilisation, including consumption of leaf litter, leaving 'little chance of recovery from historic degradation'.[101]

It is therefore important to recognise that, when rolling out landscape resilience projects for public benefit, the task is fundamentally dependent upon the assistance of landholders; and that most of them are operating with thin margins on low-output country. This is why it is imperative that landowners and managers have a firm understanding of the private benefit (improved and sustainable production) that is achievable through landscape resilience projects and that these projects are well worth urgent attention, particularly in responding to increasingly variable climate conditions.

101. Department of the Environment. 2008. Mulga Lands bioregion. In Bastin G and ACRIS Management Committee, *Rangelands 2008 – Taking the Pulse*. Published on behalf of the ACRIS Management Committee by the National Land & Water Resources Audit, Canberra. pp. 1 and 7. Available from **http://www.environment.gov.au/system/files/resources/a8015c25-4aa2-4833-ad9c-e98d09e2ab52/files/bioregion-mulga-lands.pdf**

3.1 Carbon management

Background information

Semi-arid regions in Australia and around the world have the potential to play a growing role in carbon management. It is understood that 'more work is urgently needed to research the best ways to manage these areas, and whether we can increase their soil and vegetation carbon stores as part of our climate mitigation efforts'. The many environmental and economic long-term benefits of 'greening Australia', include 'better protection for soils, increased soil-water holding capacity and soil fertility, and more plant feed to sustain larger animal populations'.[102]

In 2013, South West NRM committed to investigating and focusing on Carbon Farming Initiative (CFI) opportunities with the broadest application and potential to benefit the greatest number of landholders in the region, while offering the best outcomes for improving the resilience of the landscape and biodiversity of the region.

The CFI methodologies that have the greatest potential to do this are 'Native forest from managed regrowth', 'Human-induced regeneration of a permanent even-aged native forest', and 'Sequestering carbon in soils in grazing systems'.[103]

South West NRM has been working with industry on the development of soil sequestration arrangements that are appropriate for any grazing enterprise that can commit to running a closed rotational grazing system. Carbon sequestration dovetails with the strategy that South West NRM has been facilitating and promoting in recent years, which is the use of exclusion fencing to control grazing pressure (see 1.1 Collaborative Area Management in Strategy 1). Five very appealing factors about soil carbon sequestration are:

1. Soil carbon can put dollars in the pockets of all grazing enterprises that have the capacity and interest to run a closed rotational grazing system. (Income from soil carbon has the potential to be comparable to livestock gross margin per hectare across a wide range of grazing lands.)
2. Soil carbon is a substantial terrestrial carbon pool. Grazing lands hold a key to meeting national and international targets, as there are 306,000,000 hectares of grazing land in Australia. Best practice grazing management can increase soil carbon in any landscape. Complementary work initiated in the region more than a decade ago focuses on managing carbon flows through Carbon Grazing. This approach addresses both short-term and long-term carbon flowing through the grazing system – plants, soils and stock – and optimises carbon flowing through and stored within the grazing system to build system resilience and increase productivity and profitability.[104]
3. Soil carbon supports food production, resilience, profitability and a wide range of positive environmental outcomes.
4. Soil carbon can be measured accurately and cost-effectively using new and developing technology.
5. Unlike emission avoidance projects, which just slow down the damage, soil carbon takes carbon out of the atmosphere, effectively reversing the damage. This makes it a critical element to addressing the risks of climate change.

102. Canadell P and Poulter B. 2014. 'Record Rains Made Australia a Giant Green Global Carbon Sink', in *The Conversation*, 22 May 2014. Available from **http://theconversation.com/record-rains-made-australia-a-giant-green-global-carbon-sink-26646.**

103. Department of the Environment. nd. *Emissions Reduction Fund methods. Australian Government.* Available from **http://www.environment.gov.au/climate-change/emissions-reduction-fund/methods**.

104. Carbon Grazing. nd. *The Carbon Grazing principle*. Available from **http://www.carbongrazing.com.au/default.asp?PageID=6.**

As the success of soil carbon projects is dependent on landholders' ability to manage timing and intensity of grazing pressure, it is imperative that landholders have exclusion fencing. For this reason, South West NRM has organised workshops for Resource Consulting Services (RCS) and Carbon Link to showcase the benefits of soil carbon sequestration to participants in three of the seven CAM groups that South West NRM was instrumental in establishing in this region. RCS has also been showcasing the benefits of exclusion fencing and CAM to landholders in neighbouring regions, as an option for moving forward with this CFI.

Minimising loss of trees and regrowth of trees are other CFI approaches that lend themselves to the semi-arid South West NRM region. However, there can be adverse outcomes if the scale of intervention is not well managed. Some 24% (4.6 million hectares) of the region has non-remnant regional ecosystems that are lawfully able to be cleared (Figure 6). Even within conservative approaches to foregoing the rights to clear or to keep cleared such areas of vegetation to realise carbon sequestration commitments, this represents significant potential financial benefits for landholders in the region. It is therefore critical to understand the consequences of optional changes to land management practices that balance dense mulga and woody thickening against the ability to support perennial pasture and biodiversity and ecological values, before this CFI option is pursued across large tracts of the region's landscape. It is important to note that the two systems (soil and tree carbon sequestration) are often complementary, and actions by land managers to pursue either or both would be included in the many considerations they weigh up in managing the current and future operation of their enterprise.

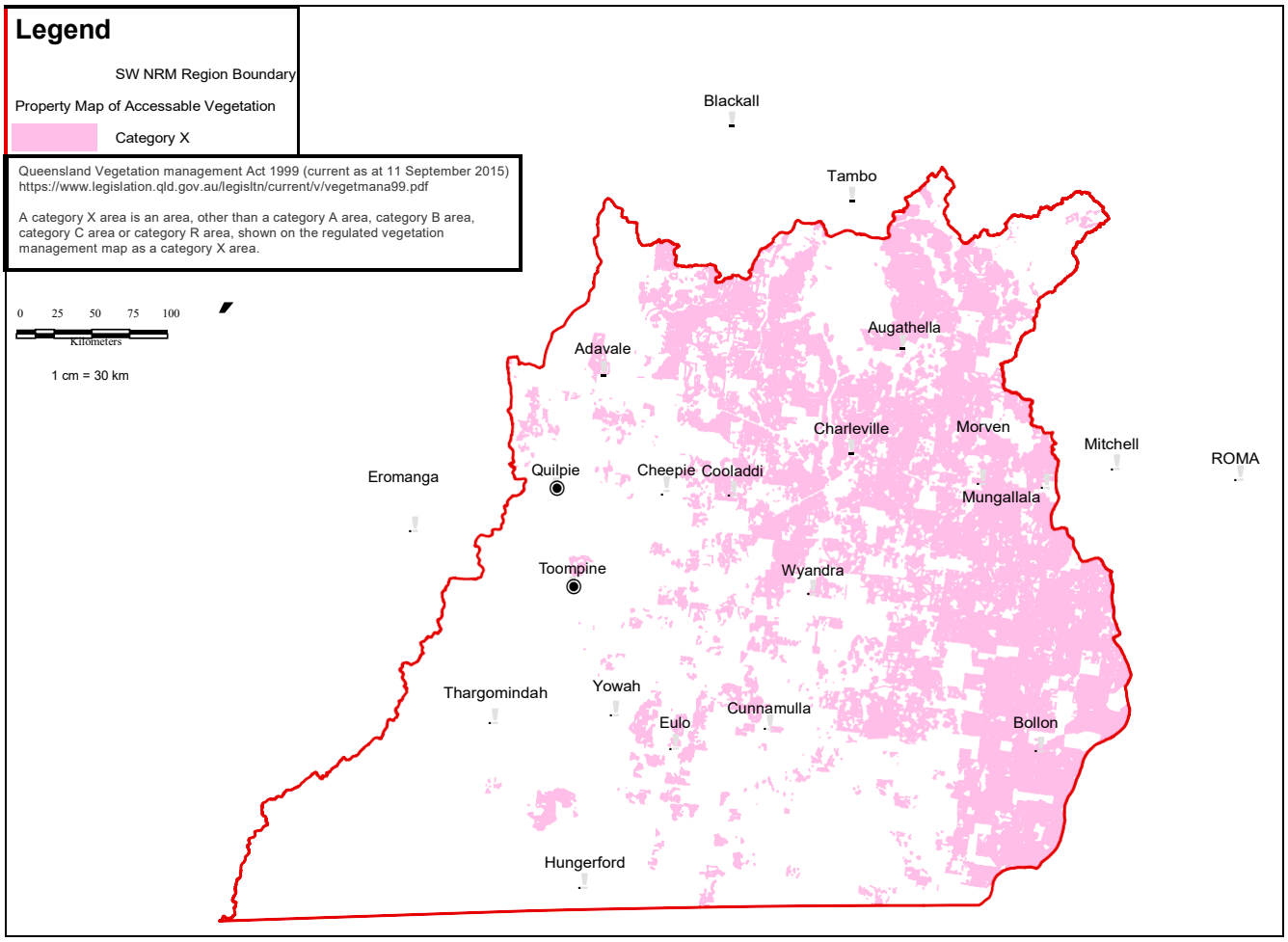

Figure 6: Non-remnant vegetation with carbon sequestration potential in the South West NRM Region

The Carbon Grazing principle[105] and the practices for its implementation had their genesis in the South West NRM grazing industry. Resting pasture for a short period (up to six weeks, depending on the land type and its condition) after rainfall events in excess of 15 mm allows the vigorous new vegetation to capture carbon from the atmosphere and add it to the natural carbon flows that occur in the soil/plant system, building root mass and soil health. Grazing of the leaf material after that time prevents the pasture from becoming moribund and less responsive to further rainfall. This practice is emerging as a key to improving both profitability and grazing system resilience.

Given that grass is 45% carbon and livestock are about 18% carbon, the success of a grazing business relies on the level of carbon that management allows to flow into the paddock following rain. In marginal years, it is even more critical to maximise carbon flows from the little rain that does fall. Carbon Grazing contributes to carbon sequestration both by increasing the amount of short-term organic carbon 'stored' in the carbon flow system (especially in plant roots and soil) and by conversion of about 2% of this organic carbon to the long-term soil carbon pool. Because a little long-term soil carbon keeps oxidising and returning to the atmosphere, the carbon pool balance is influenced by the management of carbon flows in the short period after rain.[106]

Planted edible shrubs, such as old man saltbush, are useful in recovering degraded grazing lands by building soil carbon, and saltbush plantations can provide alternative feed for livestock while pastures are rested after rain to increase the inflow of carbon.

As at August 2015, there are 21 carbon sequestration projects in the region recorded on the national Emissions Reduction Fund project register, eight of which have sold Australian carbon credit units (ACCUs) through the existing carbon market system, under the Native forest from managed regrowth methodology.

There are 18 projects under the Native forest from managed regrowth methodology, one project under the Human-induced regeneration of a permanent even-aged native forest methodology, and two projects under the Sequestering carbon in soils in grazing systems methodology.

105. Carbon Grazing, nd. op. cit.

106. ibid

Outcome 3.1 – Carbon management

By or before 2020, to have assessed the potential for carbon sequestration in the South West NRM Region and identified investment opportunities, and by or before 2020 to have trialled Carbon Grazing for improved productivity and soil system resilience.

Management actions

1. Work with landholders and brokers currently engaged in CFI projects or interested in pursuing CFI opportunities to integrate carbon sequestration projects into their enterprise decision-making.
2. Support emerging carbon sequestration CFI methodologies appropriate for semi-arid regions.
3. Work with agencies and stakeholders to better understand the landscape consequences of carbon sequestration interventions, to avoid or minimise adverse effects on landscape resilience and condition.
4. Work with stakeholders to identify suitable locations for, to plan and to implement trial projects to calibrate the timing and management actions needed to apply the Carbon Grazing principle appropriate to the region's land types.
5. Promote decision-making tools that assist landholders to evaluate opportunities for embarking on soil and tree carbon sequestration projects.

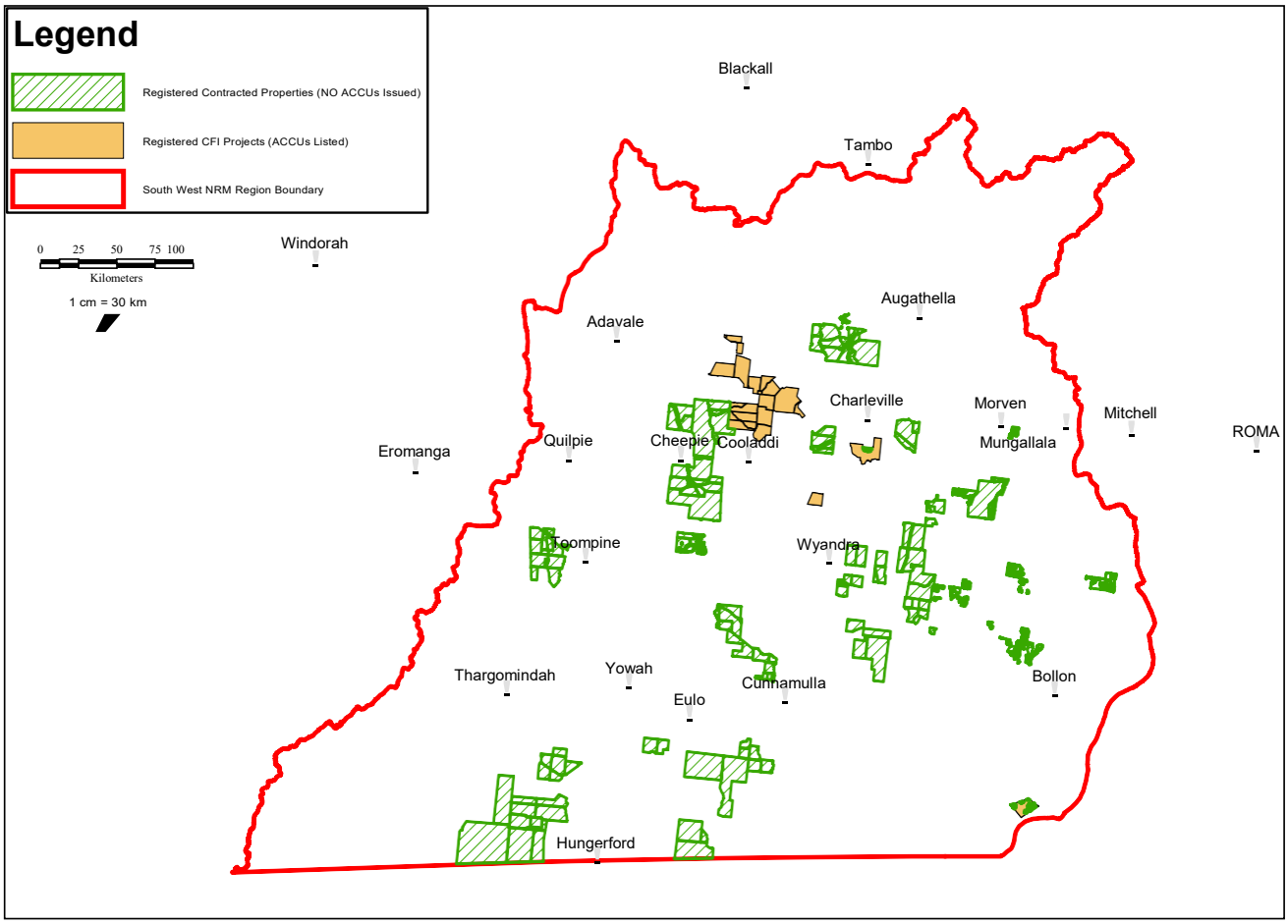

Figure 7: Registered CFI projects in the South West NRM Region

3.2 Waters

Background information

In the semi-arid region of South West NRM, all surface and groundwater is environmentally, culturally and economically valuable.

Key surface water assets in the South West NRM Region are:

- Warrego River, which has the largest catchment in the region, covering an area of approximately 78,000 square kilometres of which 84% lies in Queensland and the remainder in New South Wales.
- Paroo River, which has a total catchment area of 64,800 square kilometres, approximately 50% of which lies in the South West NRM region.
- Bulloo River, which is an internally draining system located between the Lake Eyre and Murray–Darling basins. The catchment covers a total area of some 74,900 square kilometres, of which about 74% is in Queensland.
- Nebine River,[107] the catchment of which incorporates the catchments of Nebine, Mungallala and Wallam creeks and covers a total area of some 38,100 square kilometres, of which only 1% lies in New South Wales.

Surface water flows in the region are highly variable, with portions of many water courses being ephemeral in nature. These flows serve a variety of uses, including household (non-drinking) water, habitat for aquatic plants and animals, water for stock and, to a lesser extent, for irrigation (with infrequent overland flows or seasonal diversions impounded in large stock dams and tanks), some industries, and for recreational activities such as fishing and boating.

Groundwater

Groundwater exists in the region as shallow alluvial and sandstone aquifers and within the deeper confined strata of the Great Artesian Basin (GAB). Shallow aquifers are recharged locally during periods of above-average rainfall, whereas the GAB is recharged from infiltration occurring on the north-west slopes of the Great Dividing Range.

Isotope analysis of the GAB demonstrates an age gradient for water of rainfall origin with an extremely slow permeation, that is, recharge of a couple of metres per year. Depending on regional geology, water quality may vary greatly as a result of dissolved salts and minerals, and it is usually geothermally heated.

Accessibility to groundwater is also highly variable; in some areas, the water is too deep below the surface to be cost-effectively accessed.

Wetlands

Wetlands of national significance are found across much of the lower catchment areas in the region. They may be represented as ephemeral inter-dune playa, mound springs, braided river channels, or effectively permanent shallow lakes. They are the focus of ecological diversity and density and are subject to booms and busts determined by seasonal and sometimes decadal conditions.

107. Department of Natural Resources. 2000. *Overview of water resources and related issues*. op. cit.

Aboriginal cultural heritage and connection to water

Traditional Owners of South West Queensland are known as River People.[108] Other Aboriginal groups strongly identify with deserts (Desert People) and the coast (Coastal People). The entire history of the River People in the recent past (last 200 years) as well as the ancient past (over many millennia) has demonstrated a strong cultural, social and practical connection with the watersheds. The key types of water sites (listed in no particular order) that are important to them are:

- Rivers
- Natural springs
- Water holes
- Lakes
- Wetlands
- Bores and the artesian basin
- Underground rivers
- The flow of surface water
- Native wells
- Native springs
- Gilgais
- Ephemeral claypans.

These water sites remain precious cultural and sacred sites and are integral to ceremonies and stories, as they are imbued with the histories of their ancestors.[109]

Planning

All river systems in the South West NRM Region, with the exception of the Bulloo, form part of the Murray–Darling Basin. The management of all catchments must therefore be coordinated with downstream users and government agencies across several states to achieve responsible economic and environmental outcomes, regardless of seasonal conditions. Collaborative activities currently undertaken include water quality testing and monitoring with the Queensland Department of Environment and Heritage Protection (EHP). South West NRM and EHP have worked in collaboration to develop the Healthy Waters Management Plan for the Warrego, Paroo, Bulloo and Nebine basins in accordance with the Environmental Protection (Water) Policy 2009. This plan will be submitted for accreditation/recognition under the Basin Plan by June 2016. The Healthy Waters Management Plan is a key planning tool for improving the quality of Queensland waters.

Another collaborative effort is with the Australian Government to contribute data and other relevant information to the Bioregional Assessment Programme, to ascertain potential impacts of future coal seam gas operations on regional water assets and dependent ecosystems, production and human lifestyle and culture.

A study conducted in 2012 on water assets and their dependent ecosystems in South West Queensland showed that flow paths are 'crucial to supporting ecological processes for sustaining healthy populations and resilient biota of the dryland rivers and wetlands'. The author explains that 'large ephemeral terminal lakes and floodplain wetlands largely depend on upstream flows and connected flow paths to persist. These connected pathways from riverine systems to floodplain wetlands are critical

108. Far South West Aboriginal Natural Resource Management Group. 2012. *Caring for Water on Country in South West Queensland*. South West NRM Ltd. Available from **http://www.southwestnrm.org.au/sites/default/files/uploads/managed/Caring%20for%20Water%20on%20Country%20Report_from%20workshop%20with%20TOs_final.pdf**.

109.ibid.

linkages in the relatively flat landscape of southwest Queensland catchments'.[110] Water flows connect wetlands and rivers and are crucial for species dispersal and migration:

> Maintaining these flow paths along with protection of their habitats is vital for their continued survival. The Great Artesian Basin springs are recognised globally as containing endemic and threatened flora and fauna species that have evolved to live in these springs. Some springs in the Eulo supergroup threatened ecological community have gone extinct as a result of more than 100 years of continually flowing bores and declining water pressure to these springs. The vulnerability of these spring communities are extreme due to their size, location and reliance on ground water supplies continuing from the GAB aquifers. These water assets are a high priority for maintaining Australia's unique biota and also for terrestrial species as a permanent source of water during dry periods in the largely terrestrial environments of southwest Queensland.[111]

Protection of refugial waterholes is also an extremely high priority as noted in Outcome 3.4, below.

The Basin Plan requires the preparation of Water Quality Management Plans as components of a Commonwealth Water Resource Plan. Commonwealth Water Resource Plans under the Basin Plan are to be submitted to the Murray–Darling Basin Authority for accreditation by the Australian Government Minister responsible for water. In Queensland, Commonwealth Water Resource Plans will comprise a package of existing state instruments, primarily Queensland Water Resource Plans and Resource Operations Plans under Queensland's *Water Act 2000*, as well as Healthy Waters Management Plans under the Environmental Protection (Water) Policy 2009. The Healthy Waters Management Plan for Warrego, Paroo, Bulloo and Nebine basins will be submitted for accreditation/recognition under the Basin Plan by June 2016. The focus for the next ten years will be on implementing the management responses of the Healthy Waters Management Plan to address the following identified risks:

- elevated levels of suspended matter and deposited sediment as very high risk in the Paroo and Bulloo basins and high risk in the Warrego and Nebine basins
- dissolved oxygen outside natural (ambient) ranges as a medium risk in the Paroo and Bulloo basins
- elevated levels of salinity as a medium risk in the St George Alluvium
- aquatic habitat/connectivity within and between water-dependent ecosystems, riparian extent/connectivity/condition as high risk in all four basins
- pest fauna (land) as high risk in all four basins
- pest fauna (aquatic) as high risk in the Warrego, Paroo and Nebine basins and very high risk in Bulloo basin
- pest flora (land) as medium risk and pest flora (aquatic) as high risk in all four basins.

110. Fielder DP. 2012. *A risk assessment of water dependent threatened species and communities and water assets of southwest Queensland from coal seam gas and coal mining*, South West NRM, Charleville, 2012, p. 1. Available from **http://www.southwestnrm.org.au/sites/default/files/uploads/ihub/2012fielder-risk-assessment-threatened-species-and-communities-and-water-assets-southwest-queensland.pdf**.

111. ibid., p. 2.

Photo courtesy CathyZwick

Outcome 3.2 – Waters

By or before 2025, all GABSI target area bores have been capped and piped and guidelines are available for protection of surface waters from stock, weed and pest damage.

Management actions

1. Collaborate to monitor water quality for comparison with the water quality targets specified in the Healthy Waters Management Plan for Warrego, Paroo, Bulloo and Nebine basins.
2. Collaborate to reduce the intensity of overland flow and address turbidity through improved ground cover and land management.
3. Collaborate to reduce the disruption to ecosystems caused by weed and feral pest fish species. Activities may include:
   - *Continuing electrofishing programs to reduce the numbers of carp, tilapia and other pest fish in South West NRM waterways*
   - *Continuing weed control programs*
   - *Fencing projects*
   - *Relocating stock watering points out of riparian zones*
   - *Reinvestigating opportunities to convert carp fish and other exotic pest fish into organic fertiliser*
   - *Continuing to contribute data and other relevant information about regional surface and groundwater assets to the Australian Government's Bioregional Assessment Programme to assist with ascertaining potential impacts of future coal seam gas operations on regional water assets.*

3.3 Overabundant and invasive native species of flora and fauna

Background information

Macropods

Throughout the various community consultation workshops, a recurrent message from landholders was that periodic increased populations of kangaroos were seen as a major threat to productivity. Although the terms 'macropods' and 'kangaroos' are widely used in relation to overabundant populations of these animals, only a small number of species are actually problematic. Primarily, these species are the eastern grey kangaroo (*Macropus giganteus*), the red kangaroo (*Macropus rufus*) and the wallaroo (*Macropus robustus*). An opportunity that stakeholders offered was a viable wild game harvesting industry and an expansion of markets for kangaroo products (see Strategy 1: Context). The growing interest in China for kangaroo meat, coupled with the periodic population explosion of kangaroo numbers, has prompted Australia's reinvestigation into the kangaroo wild game industry.

The management of macropods and other native species that are periodically over-abundant or are invasive remains a 'wicked problem' that presents ongoing challenges to producers. The implementation of the CAM initiative seeks to assist in managing total grazing pressure while reducing the impacts of invasive and pest species.

Flora

Australia's native flora is widely used in horticulture for a variety of uses, including amenity planting, windbreaks, garden ornamentals and revegetation programs. When used in Australia beyond their natural distribution, however, these plants can thicken and naturalise, causing ecological harm in natural ecosystems and impacts similar to those associated with exotic plants introduced from overseas.[112] With regard to overabundant indigenous plants, it is believed that these thickenings, in some cases, are the result of land degradation.

In South West Queensland, the following plants are recognised as invasive native species:

- Green turkey bush (*Eremophila gilesii*)
- Grey turkey bush (*Eremophila bowmanii*)
- False sandalwood (*Eremophila mitchellii*)
- Narrow leaf hop bush (*Dodonaea viscosa*)
- Turpentine (*Eremophila sturtii*)
- Silver cassia (*Cassia nemophila*)
- Cassia (*Cassia artemisioides*)
- Punty bush (*Senna artemisiodes*), called bean bush mostly in this area.

112. Adair RJ. 2008. Biological control of Australian native plants, in Australia, with an emphasis on acacias. *Muelleria* 26(1), pp. 67–78.

Outcome 3.3 – Overabundant and invasive native species of flora and fauna

By or before 2020, in collaboration with agencies and industry, to have a broader suite of tools to address invasive native species.

Management actions

1. Support research and development of innovative methods to manage invasive native species of flora and fauna. This may include:

   – *Supporting the Australian Government's efforts to reinvestigate the kangaroo wild game industry, with the view to re-establishing it in the South West NRM region.*

2. Collaborate with the Queensland Department of Science, Information Technology and Innovation to access remote sensing imagery and methods to detect and map native woody weed thickening in native pastures.

3. Align funding and NRM programs to further support partnering with landholders to manage invasive native species of flora and fauna.

Photo courtesy CathyZwick.

3.4 Natural system resilience

Background information

In essence, resilience is the capacity of a system to withstand and recover from impacts without losing its core ability to continue to function. Natural system resilience has several dimensions, fundamental among which is the protection of the full suite of functional elements that comprise the landscape. Protection of multiple replicates of all functional elements is important to build redundancy as a buffer to system shocks from loss of functionality in key components.

Connectivity is critical to natural system function, and this may be structural (where areas are physically adjacent allowing continuity of flows of resources) and/or functional (where, even if areas are separated they still support system services–such as separate localities used by migratory birds where one area is needed for breeding and another needed for feeding).

Within the landscape, certain areas provide refuge when the landscape is under environmental stress. Such refugia tend to provide moderation of daily fluctuations or longer term extremes of exposure to moisture and/or temperature. In flood events, these are the higher parts of the landscape that remain above the flood peak. In bushfire events, they are the caves, crevices and protected gullies that fire cannot reach or is starved of available fuel. In drought events, they are the permanent waterholes either too deep to readily evaporate or fed by underground water. Refugia include tree hollows, cracks in drying soils and the voids in broken, rocky features.

The condition of soils and vegetation is a major contributor to natural system resilience, both in their endurance of environmental stress and in their regenerative capability. The persistence of seed banks, the storage of soil carbon and the ability to capture and store moisture are all vital to the resilience of natural systems in South West Queensland.

Under the projected effects of climate change, water scarcity is likely to continue, therefore the focus on identification, management and protection of aquatic refugia is of critical importance to the maintenance and protection of the region's ecosystems and biota that rely on the region's rivers and other wetlands for survival. Under Stream 2 funding, Davis has produced an important guideline document for the recognition, risk assessment and prioritisation of protection of aquatic refugia in the rangelands,[113] and makes the following critical observations:

> The vulnerability of aquatic refugia to climate change is influenced by their source of water (groundwater or surface water). Those waterholes that depend primarily on rainfall (surface water) for their water supply are highly sensitive, and those that depend primarily on discharge from groundwater (either regional or local) systems are the least sensitive, because of the great buffering capacity of groundwater, both hydrologically and thermally. The climate adaption capacity of aquatic species in the rangelands is influenced by their habitat requirements and their dispersal ability. Short-range endemics and relictual species have limited capacity to recolonise waterbodies that dry out and so these species are at the greatest risk of extinction, particularly from the indirect impacts of climate change.
>
> The indirect effects of climate change, particularly an increase in human demands for water (for direct consumption and production of food, fibre and energy) are likely to have greater impacts than direct climatic effects. Excessive groundwater drawdown will destroy spring-based evolutionary refugia, and the construction of surface water impoundments will destroy the aquatic connectivity essential for the persistence of riverine waterholes as ecological refugia. The existing adverse impacts of livestock, feral herbivores, invasive fishes, exotic plants, recreation and tourism must also be managed.

113. Davis J. 2014. *Australian rangelands and climate change – aquatic refugia*. Ninti One Limited and University of Canberra, Alice Springs. Available from **http://www.nintione.com.au/resource/AustralianRangelandsAndClimateChange_AquaticRefugia.pdf**.

The refugial waterholes along the river systems in the South West NRM Region represent the only permanent aquatic habitat during extended periods of low or no flow and are critical components of a functioning 'source and sink' system for aquatic organisms in arid and semi-arid landscapes. The permanent refugial waterholes experience variable patterns of connection and disconnection, which is a fundamental driver of ecological processes in these riverine environments that is vital for dispersal and survival of diverse populations of biota.[114]

As key landscape features, major drainage lines and stock routes serve to indicate likely structural connectivity. Similarly, permanent waters and the elevated or deeply incised topography indicated by close contours provide likely settings for refugia. When the known locations of persistent species and ecological communities of conservation concern are mapped onto a base of these features, it provides a spatial product to guide efforts and investments in protecting connectivity and refugia.

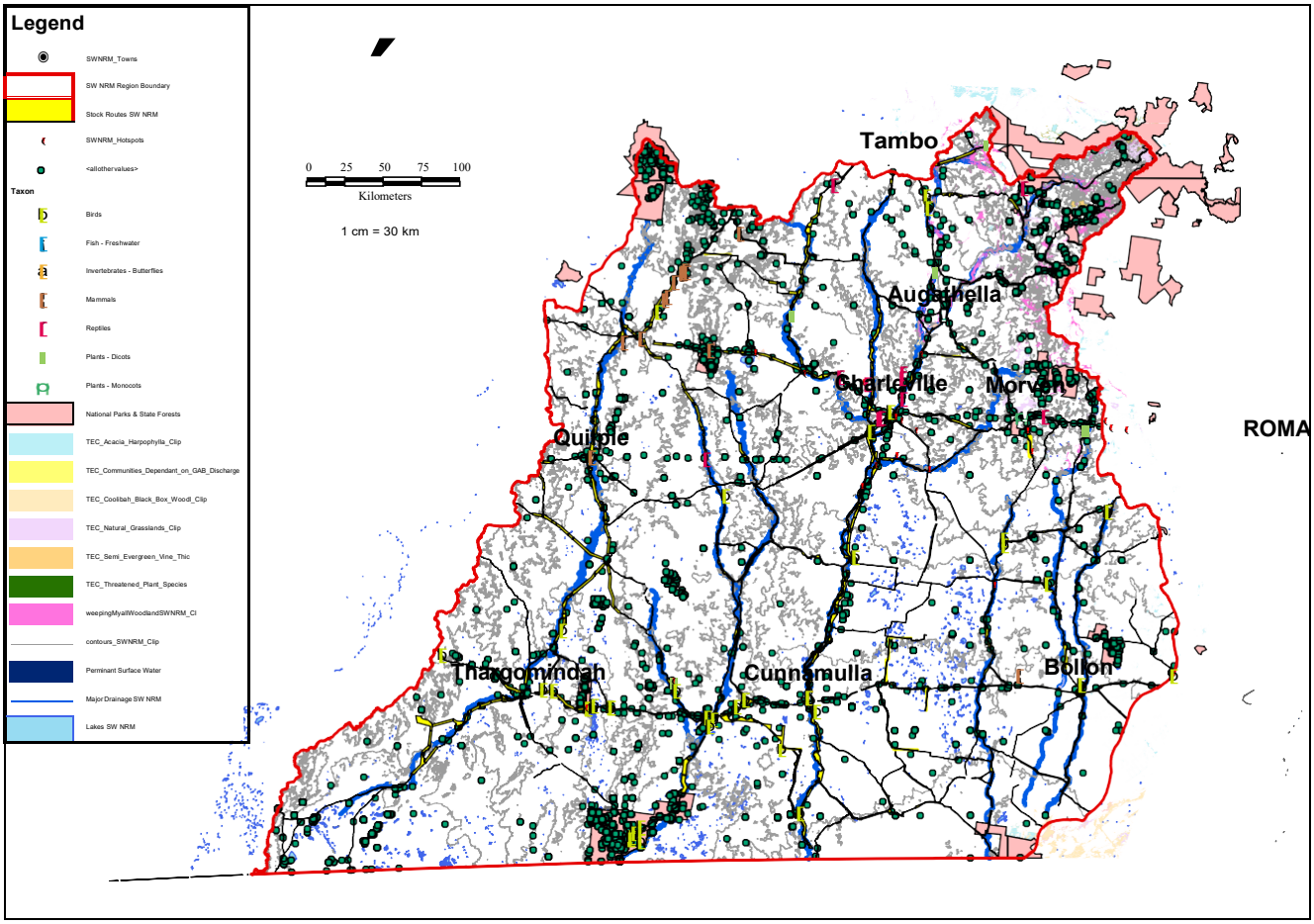

Figure 8: Connectivity and refugia in the South West NRM Region

114. ibid.

Photo courtesy Cathy Zwick.

As of August 2015, South West NRM has been collaborating with EHP to identify critical areas of the landscape that provide ecological refuge and functional connectivity for ecosystems of the South West NRM region, with a view to mapping Strategic Offset Investment Corridors.[115]

The Australian Government's Threatened Ecological Communities (TEC) program has informed this mapping process, having provided funds for the identification of nodes of biodiversity within the region for future linkages of TECs through corridors where vegetative communities allow. Two other crucial documents that identify local biodiversity and are being fed into this mapping project are *Enhancing Biodiversity Hotspots along Western Queensland Stock Routes*[116] and *Back on track actions for biodiversity: Taking action to achieve species conservation in the South West Queensland Natural Resource Management Region*.[117]

The Queensland Government Department of Science, Information Technology and Innovation report *Monitoring Riparian Forest and Ground Cover Levels in the Queensland Murray-Darling Basin and Bulloo Catchment* will assist the prioritisation of areas for improved groundcover management and connectivity of the riparian zone.[118]

115. From Queensland Government. 2016. *Environmental offsets*. Available from **https://www.qld.gov.au/environment/pollution/management/offsets/**: Strategic Offset Investment Corridors (SOICs) identify some of the best places in the landscape for environmental offsets. They mainly consist of core areas of largely intact remnant vegetation, generally associated with protected areas such as national parks, or areas that provide important links between those core areas. SOICs make offsets easier and cheaper to find. They provide income opportunities for landholders willing to provide offsets on their land. They also provide strategic conservation benefits for important environmental values, such as threatened regional ecosystems and species that have been significantly impacted by development elsewhere.

116. Walsh B and South West NRM. 2009. *Enhancing biodiversity hotspots.* op. cit. This was a collaboratively funded project between the Australian Government, Queensland Government, South West NRM, Southern Gulf, Queensland Murray Darling Committee and Desert Channels.

117. Department of Environment and Resource Management. 2010. *Back on track actions for biodiversity.* op. cit.

118. Clark, A., Healy, A., and Tindall, D. 2015. *Riparian vegetation levels in the Queensland Murray-Darling Basin and Bulloo catchment for 2013*. Department of Science, Information Technology and Innovation. Brisbane

Outcome 3.4 – Natural system resilience

By or before 2025 to have identified, and prepared guidelines for protective management of, the critical areas of the landscape that provide ecological refuge and functional connectivity for the ecosystems of the South West NRM Region.

Management actions

1. Work with community partners and landowners to protect areas of critical landscape connectivity and refugia.
2. Support landholders and custodians to enhance and protect vulnerable ecosystems and wildlife corridors. This may include:
   - *Calling for Expressions of Interest from community and land managers who live and operate in target project areas to reduce grazing pressure on areas supporting vulnerable ecosystems and/or wildlife corridors within and around the Carnarvon National Park and the Lake Bindegolly National Park; monitor and evaluate*
   - *Reducing feral pest predation by pigs, cats, foxes and wild dogs on threatened ground-dwelling and migratory bird species*
   - *Supporting landowners in their efforts to protect Threatened Ecological Communities by assisting them with developing strategies that deliver outcomes that combine benefits to agriculture, cultural heritage and conservation*
   - *Establishing, monitoring and evaluating activities on participatory action learning sites in areas of national and environmental significance to build community skills and knowledge by demonstrating:*
     - *Improved biodiversity values*
     - *Improved water quality*
     - *Increased ground cover (using spatial referencing)*
     - *Strategic and cost effective fencing.*

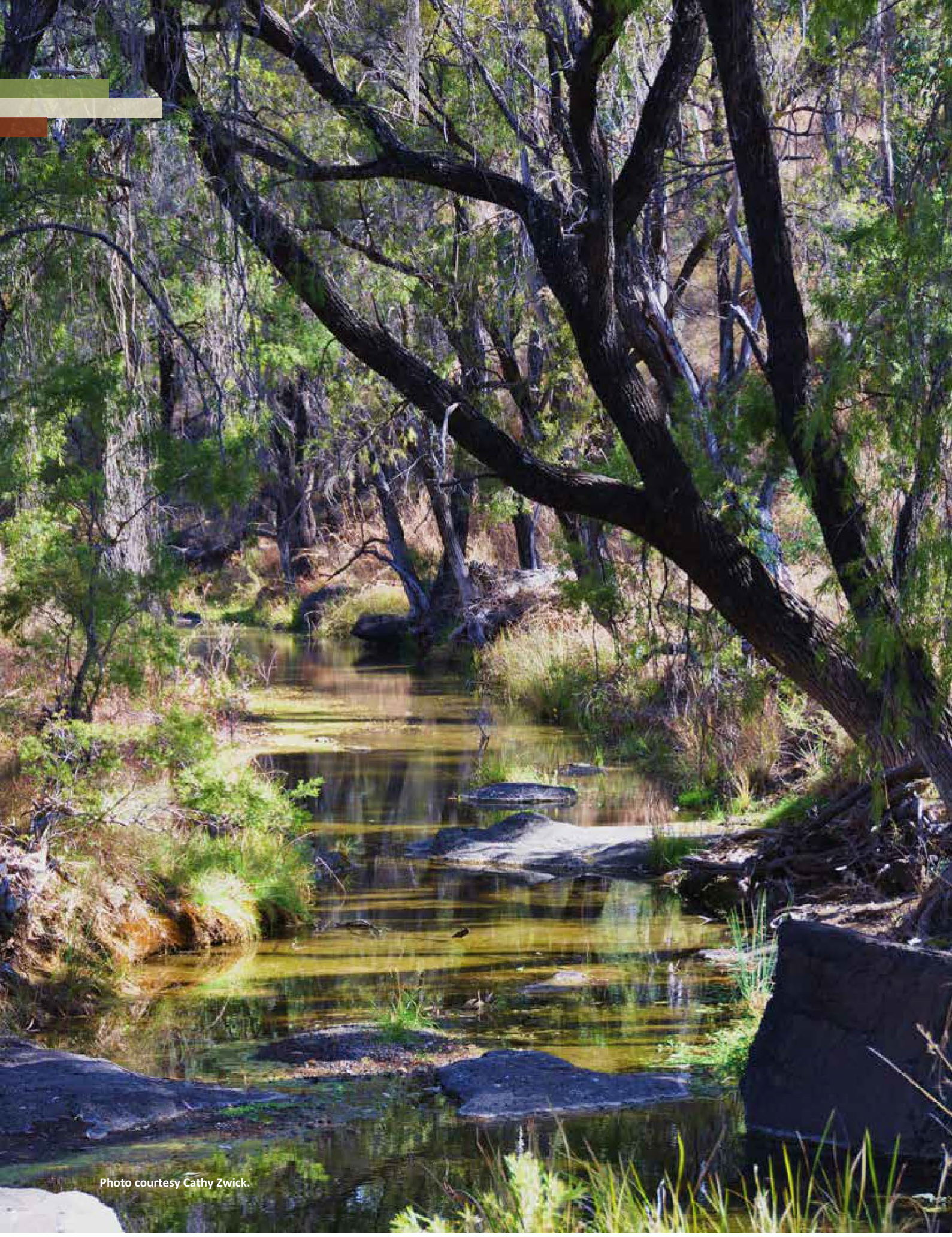

Photo courtesy Cathy Zwick.

Photo courtesy Cathy Zwick.

PART C:

MONITORING, EVALUATION AND ADJUSTMENT

The South West NRM Plan has been developed using the robust, simple first principles of strategy and evaluation that underpin the adaptive management cycle. The **Outcomes** have been designed to support their evaluation, and implementation of the **Actions** is able to be regularly monitored, reported and adjusted. The outcomes reflect the need for clarity of objectives and certainty of outcomes noted in the *AdaptNRM – NRM Adaptation Checklist*[119] developed with funding under Stream 2. The achievement of the Outcomes in this Plan is bound to the successful attraction of investment, particularly from the Queensland and Australian governments. However, the framework this Plan provides supports stakeholders and investors to make decisions as they pursue intentions and aspirations they identified during the consultation and feedback processes that supported the Plan's development.

Implementation of the Plan will be tracked using an annual 'traffic light' report to the South West NRM Board, linked to the reporting processes for project investors. This process will be augmented by a cumulative record of prospective adjustments to support the process of refreshing the Plan on a three-year cycle, consistent with the Australian Government's National Landcare Programme expectations. Such prospective adjustments will explicitly reflect the best emerging science; ongoing stakeholder contributions and perspectives; actual implementation performance; and lessons learned – in the South West, in other NRM regions and elsewhere.

Central to the success of the Plan is the Evaluation of Effectiveness (below) in achieving the Plan's 11 Outcomes across the three Strategy areas of Sustainability, Opportunity and Resilience. Five- and ten-year timeframes have been nominated. However, the three-year Plan updating cycle will take precedence; it will not be a major re-working of the Plan, but instead will set a schedule for periodic assessment of the then current situation for each Outcome. This will provide an appreciation of the extent to which the 2015 baseline situation has moved towards the desired Outcomes and the extent to which those actions that have been implemented are adequate, appropriate, efficient and effective in achieving the Outcomes. This will support decision-making about any adjustments needed.

119. Rissik D, Boulter S, Doerr V, Marshall N, Hobday A and Lim-Camacho L. 2014. *The NRM Adaptation Checklist: Supporting climate adaptation planning and decision making for Regional NRM.* CSIRO and NCCARF, Australia. Available from **http://adaptnrm.csiro.au/wp-content/uploads/2014/06/AdaptNRM-Adapt-Planning-Tech-Guide1.pdf.**

Evaluation of management effectiveness

Measuring achievement of outcomes

STRATEGY 1 – SUSTAINABILITY IN THE MULGA LANDS		
MANAGEMENT OUTCOMES	**KEY INDICATORS**	**MEASURES | KEY EVALUATION QUESTIONS**
1.1 Collaborative Area Management By or before 2020, to fully enclose seven CAM clusters and by or before 2025 to demonstrate improved productivity linked to South West NRM Plan Outcomes in Strategies 1 and 3 within exclusion fenced areas.	**Presence of feral animals**	**What is the feral species' abundance and distribution?**
	Individual property financial productivity	**What is the annual before-tax (i.e. before deductions) property income (normalised – averaged over 10 years)?**
	Level of participation	**How many property clusters have been established?**
	Grazing pressure control	**What is the total area in which grazing pressure is controlled?**
	Feral animal management and control	**What are the reduction figures of feral animals?**
	NRM Stakeholder Aspirations	**Did South West NRM respond to any of the following Stakeholder Aspirations?** **Community Aspiration 8 – request for: financial assistance to establish more CAMs** *Since this CA was logged in 2013, South West NRM secured a Grant for Innovation from the Queensland Government to continue the trial and data monitoring, expanding from the initial two trial clusters to include a further five. Two rounds of funding saw the establishment of a further two clusters and a final round of funding in February 2015 produced the remaining three clusters. (Note: There are seven CAM clusters in existence, the two completed trial clusters, two further clusters completed and the final three in various stages of construction.)* **Queensland State Government Aspiration 9 – request to:** **(a) collaborate with DAF, Leading Sheep and others to develop and implement strategies to support and grow the sheep industry, particularly through CAMs** *One outcome that the CAM strategy aims to achieve is the ability of landholders to diversify the industry on their individual properties by giving them the option of returning to sheep production. The construction and continued maintenance of the cluster fence is the biggest contributor to the likelihood of growing the sheep industry. Collaboration between landholders is vital if the fence is to be constructed as quickly as possible and mitigation of remaining pests within the cluster is to be undertaken. Monitoring for pest numbers and pasture condition is important to establish the success of the CAM project, and some form of monitoring should be continued for the life of the fence for the most accurate results.* **(b) identify reasons for decline of sheep industry through monitoring and evaluation and facilitate implementation of actions and strategies to address decline** *Within 3–5 years from the completion of the exclusion fences, it is expected that landholders within clusters will see a significant drop in wild dog and other predator numbers and a drop in kangaroo numbers leading to an increase in pasture condition and an increase in carrying capacity. Landholders have indicated that the reason for reducing their sheep production has been an increase in the predation of wild dogs, it is thought that the construction of the exclusion fence will allow landholders to control this issue and return to the sheep industry.*

STRATEGY 1 – SUSTAINABILITY IN THE MULGA LANDS		
MANAGEMENT OUTCOMES	**KEY INDICATORS**	**MEASURES | KEY EVALUATION QUESTIONS**
1.2 Vegetation and soils By or before 2025 at least 50% of the 3-P pastures of the Mulga Lands will be in 'B' (good) condition or better; no more than 50% of the mulga resource will be grazed without a BMP grazing regime; and at least 50% of the Region's soils (area) will be managed using a BMP soils module to minimise soil loss.	**Partnerships and initiatives**	**Has South West NRM developed partnerships with industry and researchers (to enhance grazing BMP uptake)?**
	Grazing BMP and land condition	**Has the grazing BMP been extended into the South West Region?** **Does the grazing BMP include a mulga module?** **What percentages of the region's vegetation and soils are in this condition or are being managed as specified in this Outcome?**
	Engagement	**By what percentage did land managers engaged in grazing BMP increase?** **Did South West NRM respond to any of the following Stakeholder Aspirations?** • Community Aspiration 11: access to on-farm and off-farm laboratory research and development • Community Aspirations 1, 3, 6a and 6b: to include coverage of the following topics in South West NRM–organised workshops/ information/demonstration field days: i. Increasing ground cover ii. Latest research on more suitable pasture species iii. Water-harvesting methods iv. Dam design v. Water-capture and -ponding techniques (including contouring and keyline systems) vi. Soil-retention techniques (including blade-ploughing and ripping) vii. Access to financial support to sink communal bores • Queensland Government Stakeholder Aspiration 1: viii. Allow time at 'Caravan of Collaboration' to update landholders and managers about legislative changes.
1.3 Declared weeds and pests By or before 2025, to have all agencies and all properties that are identified as critical in a weeds and pests operational program engaged in strategic management of weeds and feral animals.	**Weeds of National Significance**	**Were Weeds of National Significance across the South West NRM region mapped?**
	Collaborative regional management	**Were any collaborative regional weed and pest management plans implemented?**
	Weed and pest mitigation programs	**What weed and pest mitigation programs did South West NRM facilitate?**
	Weed and pest infestations	**What on-ground activities (for management of weed and pest infestations) did South West NRM promote?**
	Engagement	**Did South West NRM respond to any of the following Stakeholder Aspirations?** • Queensland Government Aspiration 5: Collaborate with Biosecurity Qld and other stakeholders to monitor, evaluate and add emerging pest species to pest management plans • Queensland Government Aspiration 7: Collaborate with Biosecurity Qld and other stakeholders to increase surveillance opportunities through the use of South West NRM's Indigenous Cactus Control Team; investigate the use of biological control opportunities; use drones for spotting and spraying; and education in schools. • Community Aspiration 7: Investigate installation of wash-down bays on main roads to curb weed spread.

STRATEGY 2 – OPPORTUNITY: EXPANDING OUTBACK HORIZONS		
MANAGEMENT OUTCOMES	**KEY INDICATORS**	**MEASURES | KEY EVALUATION QUESTIONS**
2.1 Outback Experience: Sharing our natural and cultural assets By or before 2020, to have the average visitor stay duration at five nights and the average visitor spend at $200.	**Natural resources enhancing the tourist experience**	**How many and what type of activities conducted by tourism groups, agencies and community stakeholders did South West NRM support?**
	Targeted funding applications	**How many funding applications for research into natural sciences in the region did South West NRM support?**
	Meaningful collaborations	**How many tourist bureaux did South West NRM collaborate with to add value to the tourist experience?**
2.2 Remote Area Technologies By or before 2025 to have South West Queensland recognised by government, industry and regional communities as a key locality for innovation in remote area technologies.	**Recycling programs and renewable energy opportunities**	**What shire councils and other stakeholders did South West NRM collaborate with to investigate recycling programs and renewable energy opportunities?** **What recycling programs and/or renewable energy opportunities were identified?** **How many of these recycling programs and/or renewable energy opportunities were initiated?** **How many interagency workshops/information sharing sessions on recycling and/or renewable energy opportunities did South West NRM facilitate?** **What agencies were engaged and participated in these workshops and/or information-sharing sessions?** **What recycling and/or renewable energy opportunities were discussed?** **How many of these opportunities have been initiated?**
	Agricultural technologies	**What emerging technologies to assist the agricultural sector did South West NRM promote?** **What agencies/local governments/industry stakeholders were engaged and participated in promoting emerging technologies?**
	Early Warning Floodwatch System	**Has maintenance on the Early Warning Floodwatch System continued?** **If so, how has value been added to the Early Warning Floodwatch System?**
2.3 Belonging to land in Aboriginal Australia By or before 2025, to be clearly demonstrating Aboriginal engagement in managing sites, landscapes and NRM activities within the region.	**Traditional Owner culture, history and on-country knowledge enshrined into local education and tourism**	**How many, and what schools has South West NRM worked with to engage Traditional Owners in storytelling (to enshrine culture, history and 'on country' knowledge into local education and tourist opportunities)?**
	Engagement with Traditional Owners	**Has South West NRM engaged with Traditional Owners' incorporated as well as unincorporated bodies about South West NRM projects?** **If so, how did this grow Traditional Owner capacity and self-determination?** **Has this resulted in the establishment of an Indigenous Ranger Program?** **What staff resources has South West NRM committed to engagement with Traditional Owners?**
	Educating about NRM	**What has South West NRM done to support and facilitate education and communication about NRM?** **How many projects involved at least one stakeholder whose purpose was to spread the lessons and benefits of the project elsewhere?**
2.4 Promoting NRM in the South West By or before 2025, in at least 50% of the projects being implemented under the South West NRM Plan, to have at least one party engaged to take the lessons and benefits elsewhere.	**Community and project engagement**	**What public events and opportunities has South West NRM used to facilitate engagement on NRM programs and activities?** **What were the NRM topics that were addressed through these public events and opportunities?**
	South West NRM Communication Strategy	**What has South West NRM done to improve its Communication Strategy?**

STRATEGY 3 – RESILIENCE		
MANAGEMENT OUTCOMES	**KEY INDICATORS**	**MEASURES | KEY EVALUATION QUESTIONS**
3.1 Carbon management By or before 2020, to have assessed the potential for carbon sequestration in the South West NRM Region and identified investment opportunities, and by or before 2015 to have trialled Carbon Grazing for improved productivity and soil system resilience.	**CFI opportunities**	**How did South West NRM support emerging Soil Carbon Sequestration methodologies that would be appropriate for CFI projects in semi-arid regions?** *South West NRM initiated and CEO attended a meeting that was conducted with Director of RCS, CEO of Regional Groups Collective, representative of the Rangelands Alliance and policy advisors to the Federal Minister for the Environment to showcase the soil carbon sequestration methodologies developed by RCS for larger sized properties in semi-arid regions.* **How many projects covering what areas are actively brought to market and under what methodologies?** *Opportunities and current methodologies relating to Mulga Lands bioregion in South West Queensland increasing over time.*
	Carbon Grazing	**To what extent were Carbon Grazing trial areas established and monitored?**
	Decision-making tools (information, spatial mapping, etc.) for CFI projects	**What decision-making tools were identified and made available to assist landholders to evaluate opportunities for embarking on carbon sequestration projects?**
3.2 Waters By or before 2025, all GABSI target area bores have been capped and piped, and guidelines are available for protection of surface waters from stock, weed and pest damage.	**Better spatial and temporal data for the Bulloo, Paroo, Warrego, Nebine/ Mungallala/Wallum basins**	**Did South West NRM collaborate with EHP to continue water quality monitoring in the South West NRM region?**
	Compare monitoring results to water quality targets	**What gaps have been identified and addressed in managing water quality?**
	GABSI bores	**How many of the GABSI target area bores have been capped and piped?**
	Guidelines	**How useful are the available guidelines for the protection of surface waters from damage by stock, weeds and pests?**
	Reduced intensity of overland flow from improving groundcover and land use management	**What organisations/groups/government departments has South West NRM collaborated with to reduce intensity of overland flow?**
3.3 Overabundant and invasive native species of flora and fauna By or before 2020, in collaboration with agencies and industry, to have a broader suite of tools to address Invasive native species.	**Innovative methods to manage invasive native species of flora and fauna.**	**What research and developments into innovative methods to manage invasive native flora and fauna has South West NRM supported?**
	Mapping of native woody weed thickenings in native pastures	**Has South West NRM collaborated with the Queensland Government Department of Science, Information Technology and Innovation (to access remote sensing imagery and methods) to map native woody weed thickening in native pastures?**
	Improved management of invasive native species of flora and fauna	**How has South West NRM aligned funding and programs to further support partnering with landholders to manage invasive native flora and fauna?**
3.4 Natural system resilience By or before 2025 to have identified, and prepared guidelines for protective management of, the critical areas of the landscape that provide ecological refuge and functional connectivity for the ecosystems of the South West NRM Region.	**Prioritise critical connectivity and refugia for protection**	**What organisations/groups/government departments has South West NRM collaborated with to protect connectivity and critical refugia?**
	On-ground works to protect areas of critical connectivity and refugia	**What community partners has South West NRM engaged to protect areas of critical connectivity and refugia?** **What on-ground works have been undertaken to protect critical connectivity and refugia?**
	Enhancement of vulnerable ecosystems	**Has South West NRM supported landholders and custodians to enhance and protect vulnerable ecosystems?**

Appendix 1: South West NRM Region Climate Change Risk and Vulnerability Assessment

Table A1.1. RISK IDENTIFICATION with RISK and VULNERABILITY RATINGS

Formulas as follows: P x H = R means probability x harm = risk, where possible values of: P are U (unlikely), E (as likely as not), L (likely) and C (almost certain) so P(L) means that the probability is likely (from Table A1.2), H are M (dismissible), A (damaging), R (disruptive), S (destructive) and D (disastrous), so that H(A) means that harm level is damaging (from Table A1.2), R are ER (established response: green cells), OC (operationally critical: yellow cells) and EC (enterprise critical: red cells), so that R(OC) means the risk is operationally critical) (from Table A1.2). Vulnerability (V) values as follows: Vulnerability (V) of an asset = Exposure (E) of the asset to a hazard plus (+) Sensitivity (S) of the asset to harm from the hazard minus (-) the Adaptive Capacity (AC) of the asset (from Tables A1.3 and A1.4).

HAZARDS		ASSETS																													
		HUMAN						SOCIAL								NATURAL															
		Field workers	V	Staff and support workers	V	Families	V	Formal networks and organisations	V	Informal networks	V	Events	V	Pastures	V	Waters	V	Soils	V	Groundcover	V	Biodiversity	V	Sheep, cattle and goats	V						
	More hot days, hotter hot days and longer warm spells	Heat stress P(L)xH(A) = R(OC))	1	Heat stress P(E)xH(A) = R(ER)		Leave region P(E)xH(R) = R(OC)	-1	Increasing cost P(L)xH(M) = R(ER)				Postponement or cancellation P(E)xH(A) = R(ER)		Reduced productivity of natural pastures P(L)xH(R) = R(OC)	4	Increased draw on groundwater P(L)xH(A) =R(OC)	1			Reduced grass/herb plant material P:ExH:A*R=ER	2	Wildlife mortality events P:ExH:A*R=ER		Heat stress P:LxH:R*R=OC	3						
		Reduced productivity P(L)xH(M) = R(ER)		Reduced productivity P(L)xH(M) =R(ER)				Reduced productivity P(E)xH(M) = R(ER)						Reduced productivity of improved pastures P(L)xH(R) = R(OC)	3	Reduced availability of surface waters P(L)xH(A) = R(OC)	4					Reduction in wetlands P:ExH:A*R=ER		Reduced productivity P:LxH:A*R=OC	3						
														Increased woody weeds P(L)xH(R) = R(OC)	1							Increased cacti P:LxH:R*R=OC	5	Increased wild dogs P:LxH:R*R=OC	2						
Regional climate regime shift														Increased cacti P(L)xH(R) = R(OC)	3																
														Increased macropod grazing pressure P(L)xH(R) = R(OC)	1							Increased feral cats P:LxH:R*R=OC	5							
	More evaporation													Reduced productivity of natural pastures P(L)xH(R) = R(OC)	4	Increased draw on groundwater P(L)xH(A) =R(OC)	1					Reduction in wetlands P:ExH:A*R=ER								
														Reduced productivity of improved pastures P(L)xH(R) = R(OC)	3	Reduced availability of surface waters P(L)xH(A) = R(OC)	4														
	Harsher fire weather	Exertion and fatigue P(E)xH(A) = R(ER)		Exertion and fatigue P(E)xH(A)=R(ER)		Exertion and fatigue P(E)xH(A) = R(ER)		Increased demand for fire disaster management response P(L)xH(R) = R(OC)	-4					Loss of stockfeed P(E)xH(S)=R(OC)	1					Loss of burnable groundcover P(E)xH(A)=R(ER)	2										
Extreme weather events	Storm rainfall more intense					Risk to life P(U)xH(S) = R(OC)	-2	Increased demand for flood disaster management response P(L)xH(R) = R(OC)	-4																										
																		Increased erosion and water turbidity P(E)xH(S) = R(OC)	1.5										

RISK IDENTIFICATION with RISK and VULNERABILITY RATINGS

HAZARDS		BUILT								FINANCIAL					
		Houses and sheds	V	Bores, pipes and troughs	V	Fences and gates	V	Roads	V	Property equity	V	Loans and borrowing capacity	V	Operating capital and cash-flow	V
				Increased stock and macropod demand/ damage on bores P(L)xH(R) = R(OC)	2					Reduced equity in natural pasture-based enterprises P(E)xH(R) = R(OC)	0	Reduced borrowing capacity of natural pasture-based enterprises P(E)xH(R) = R(OC)	0	Reduced profitability of natural pasture-based enterprises P(E)xH(R) = R(OC)	0
	More hot days, hotter hot days and longer warm spells									Reduced equity in improved pasture-based enterprises P(E)xH(S) = R(OC)	1	Reduced borrowing capacity of improved pasture-based enterprises P(E)xH(S) = R(OC)	1	Reduced profitability of improved pasture-based enterprises P(E)xH(S) = R(OC)	1
Regional climate regime shift	**More evaporation**														
	Harsher fire weather	Loss of property (fire) P(U)xH(S) = R(OC)	-1	Loss of property (fire) P(E)xH(S) = R(OC)	2	Loss of property (fire) P(E)xH(S) = R(OC)	2			Uninsured losses P(E)xH(R) = R(OC)	2	Increased need for recovery funds P(E)xH(R) = R(OC)	0	Reduced pool of resources P(E)xH(R) = R(OC)	0
Extreme weather events	**Storm rainfall more intense**	Loss of property (flood) P(U)xH(S) = R(OC)	-1	Loss of property (flood) P(E)xH(S) = R(OC)	2	Loss of property (flood) P(E)xH(S) = R(OC)	2	Loss of property (flood) P(E)xH(S) = R(OC)	2	Uninsured losses P(E)xH(R) = R(OC)	2	Increased need for recovery funds P(E)xH(R) = R(OC)	0	Reduced pool of resources P(E)xH(R) = R(OC)	0

Table A1.2. RISK RATING MATRIX

		PROBABILITY or LIKELIHOOD			
		UNLIKELY	**AS LIKELY AS NOT**	**LIKELY**	**ALMOST CERTAIN**
SEVERITY of HARM	*DISMISSABLE*	Established response	Established response	Established response	Established response
	DAMAGING	Established response	Established response	Operationally critical	Operationally critical
	DISRUPTIVE	Established response	Operationally critical	Operationally critical	Operationally critical
	DESTRUCTIVE	Operationally critical	Operationally critical	Enterprise critical	Enterprise critical
	DISASTROUS	Enterprise critical	Enterprise critical	Enterprise critical	Enterprise critical

CALIBRATION

PROBABILITY or LIKELIHOOD	
UNLIKELY	There is no reasonable expectation of risk to this asset from this hazard
AS LIKELY AS NOT	This asset can reasonably be expected to be harmed by this hazard at least once/intermittently over a ten-year period
LIKELY	This asset can reasonably be expected to be harmed by this hazard more than once/periodically over a five-year period
ALMOST CERTAIN	This asset can reasonably be expected to be harmed by this hazard periodically/frequently from now onwards

SEVERITY of HARM	
DISMISSABLE	The level of harm is within the routine range of operational setbacks
DAMAGING	The level of harm causes a significant operational setback without interrupting the enterprise
DISRUPTIVE	The level of harm causes a major operational setback without threatening the enterprise
DESTRUCTIVE	The level of harm causes a major operational setback potentially threatening the enterprise
DISASTROUS	The level of harm causes a major operational setback significantly threatening the enterprise

Table A1.3. VULNERABILITY

Vulnerability is a function of ***Exposure*** of the asset to the Hazard combined with the ***Sensitivity*** of the asset to harm from that hazard offset by the ***Adaptive Capacity*** of the asset

V = E + S - AC

CALIBRATION

Exposure score

0	No exposure to harm from this hazard
1	Minimal exposure to harm from this hazard
3	Periodic or partial exposure
5	Fully exposed

Sensitivity score

0	No sensitivity to harm from this hazard
1	Minimal sensitivity to harm from this hazard
3	Sustains temporary damage and capable of recovery
5	Destroyed or permanent loss of core functionality

Adaptive capacity score

0	No adaptive capacity to harm from this hazard
1	Minimal adaptive capacity to harm from this hazard
5	Adaptive capacity allows adjustment to repeated exposure to this hazard, with diminished functionality
10	Adaptive capacity allows adjustment to repeated exposure to this hazard, with full functionality

Vulnerability score

-10 to -4	Adaptive capacity of asset strongly reduces harm from this hazard
-3 to 3	Adaptive capacity of asset substantially reduces harm from this hazard
4 to 10	Adaptive capacity of asset inadequately reduces harm from this hazard

Photo courtesy CathyZwick.

Table A1.4. Asset Vulnerability table – Operationally Critical and Enterprise Critical risks

Asset	Risks		Exposure	+	Sensitivity	-	Adaptive Capacity	=	Vulnerability
Field workers		Heat stress P(L)xH(A) = R(OC)	4	+	3	-	6	=	1
Families		Leave region P(E)xH(R) = R(OC)	3	+	3	-	7	=	-1
		Risk to life P(U)xH(S) = R(OC)	1	+	5	-	8	=	-2
Formal networks and organisations		Increased demand for fire disaster management response P(L)xH(R) = R(OC)	2	+	2	-	8	=	-4
		Increased demand for flood disaster management response P(L)xH(R) = R(OC)	2	+	2	-	8	=	-4
Pastures	**Increased heat**	Reduced productivity of natural pastures P(L)xH(R) = R(OC)	4	+	4	-	4	=	4
		Reduced productivity of improved pastures P(L)xH(R) = R(OC)	4	+	3	-	4	=	3
		Increased woody weeds P(L)xH(R) = R(OC)	4	+	3	-	6	=	1
		Increased cacti P(L)xH(R) = R(OC)	4	+	4	-	5		3
		Increased macropod grazing pressure P(L)xH(R) = R(OC)	4	+	3	-	6	=	1
	Increased evaporation	Reduced productivity of natural pastures P(L)xH(R) = R(OC)	4	+	4	-	4	=	4
		Reduced productivity of improved pastures P(L)xH(R) = R(OC)	4	+	3	-	4	=	3
		Loss of stockfeed P(E)xH(S) = R(OC)	2	+	5	-	6	=	1
Waters	**Increased heat**	Increased draw on groundwater P(L)xH(A) = R(OC)	3	+	3	-	5	=	1
		Reduced availability of surface waters P(L)xH(A) = R(OC)	4	+	4	-	4	=	4
	Increased evaporation	Increased draw on groundwater P(L)xH(A) = R(OC)	3	+	3	-	5	=	1
		Reduced availability of surface waters P(L)xH(A) = R(OC)	4	+	4	-	4	=	4
Soil	**Intense rainfall**	Increased erosion and water turbidity (missing formula here?)	3.5	+	3	-	5	=	1.5
Groundcover	**Increased heat**	Reduced grass/herb plant material P(E)xH(A) = R(ER)	4	+	3	-	5	=	2
	Fire	Loss of burnable groundcover P(E)xH(A) = R(ER)	3	+	4	-	5	=	2
Biodiversity		Increased cacti P(L)xH(R) = R(OC)	4	+	4	-	3	=	5
		Increased macropod grazing pressure P(L)xH(R) = R(OC)	5	+	4	-	3	=	6

Asset	Risks		Exposure	+	Sensitivity	-	Adaptive Capacity	=	Vulnerability
Sheep, cattle and goats		Heat stress P(L)xH(R) = R(OC)	4	+	4	-	5	=	3
		Reduced productivity P(L)xH(A) = R(OC)	4	+	4	-	5	=	3
		Increased wild dogs P(L)xH(R) = R(OC)	4	+	4	-	6	=	2
Houses and sheds		Loss of property (fire) P(U)xH(S) =R(OC)	2	+	5	-	8	=	-1
		Loss of property (flood) P(U)xH(S) =R(OC)	2	+	5	-	8	=	-1
Bores, pipes and troughs		Increased stock and macropod demand/damage on bores P(L)xH(R) = R(OC)	4	+	4	-	6	=	2
		Loss of property (fire) P(E)xH(S) = R(OC)	2	+	5	-	5	=	2
		Loss of property (flood) P(E)xH(S) = R(OC)	2	+	5	-	5	=	2
Fences and gates		Loss of property (fire) P(E)xH(S) = R(OC)	2	+	5	-	5	=	2
		Loss of property (flood) P(E)xH(S) = R(OC)	2	+	5	-	5	=	2
Roads		Loss of property (flood) P(E)xH(S) = R(OC)	2	+	5	-	5	=	2
Property equity	**Increased heat**	Reduced equity in natural pasture-based enterprises P(E)xH(R) = R(OC)	2	+	3	-	5	=	0
		Reduced equity in improved pasture-based enterprises P(E)xH(S) = R(OC)	3	+	3	-	5	=	1
	Fire and flood	Uninsured losses P(E)xH(R) = R(OC)	2	+	5	-	5	=	2
Loans and borrowing capacity	**Increased heat**	Reduced borrowing capacity of natural pasture-based enterprises P(E)xH(R) = R(OC)	2	+	3	-	5	=	0
		Reduced borrowing capacity of improved pasture-based enterprises P(E)xH(S) = R(OC)	3	+	3	-	5	=	1
	Fire and flood	Increased need for recovery funds P(E)xH(R) = R(OC)	2	+	3	-	5	=	0
Operating capital and cash-flow	**Increased heat**	Reduced profitability of natural pasture-based enterprises P(E)xH(R) = R(OC)	2	+	3	-	5	=	0
		Reduced profitability of improved pasture-based enterprises P(E)xH(S) = R(OC)	3	+	3	-	5	=	1
	Fire and flood	Reduced pool of resources P(E)xH(R) = R(OC)	2	+	3	-	5	=	0

Appendix 2: Risk & Resilience in NRM Planning: meeting notes from meeting held Monday 16 June, 2014

The following information is a summary of the outcomes of the State and Local Government stakeholder meeting on Risk and Resilience in NRM Planning.

Risk and Resilience in NRM Planning:

Addressing the drivers of change including the likely consequences of climate and seasonal variability

Monday 16 June 2014, 2:00-4:30pm
Attendees:
Special guest:

- Bob Speirs, NRM Regional Groups Collective – Critical Friend

State and Local Government stakeholders:

- Alex Stirton, Extension Officer, DAFF Charleville (also representing Leading Sheep)
- Greg Field, Manager DNRM
- Toni Willmott, Principal Biosecurity Officer
- Dan McCudden, Biosecurity Officer
- Richard Ranson, Director of Environment and Health Services, Murweh Shire Coucnil

South West NRM Board participants present:

- Mark O'Brien, Chair
- Karen Tully, Conservation Sector Director

South West NRM staff:

- Bernard Holland, CEO
- Craig Alison, Program Manager
- Leanne Day, NRM Planner

Jane Morgan, Cosmos Centre Manager/Murweh Tourist Manager, was unavailable for this meeting but has organised an alternative time to meet with SWNRM CEO Bernard Holland.

Agenda:

- Regional NRM stakeholders welcomed by Independent Chair of the Board, Mark O'Brien.
- Presentation of the progress of the South West NRM Planning Project provided by Senior Project Officer.
- Orientation of the scope and scale of South West NRM's activity in the region provided by CEO, Bernard Holland.
- Presentation about NRM Planning in the South West provided by NRM Regional Groups Collective Critical Friend, Bob Speirs.

Afternoon tea break

- Facilitated group discussion seeking alignment of South West NRM with NRM stakeholders. Discussion focused around:

    1) What the **big directions/drivers** of each stakeholder organisation's effort over the next few years?]

    1) What are the **big risks/barriers** to each stakeholder organisation's success over the new few years?

    2) What are the few things that would make a big difference?

Actions captured in the following discussion to be fed into the South West NRM Plan.

DRNM

Issue: Significant changes in Natural Resource Management Legislation

- Major legislative changes particularly relating to the Vegetation Management Act 1999; The Land Act 1994; Land Protection (Pest and Stock Route Management) Act 2002; Water Act 2000. Educational assistance needed.

Queensland Government Aspiration 1: South West NRM to provide time at its Caravan of Collaboration workshops for DNRM staff to provide educational assistance to landholders by discussing legislative changes.

Issue: Groundwater management: GABSI loses Federal funding after June 30, 2014 which will significantly reduce DNRM's ability to continue to deliver services and resources that sustain/improve the GAB. Finishing GABSI would cost less to maintain the program, than to reinvigorate at a later date.

Queensland Government Aspiration 2: South West NRM to support the continuation of the GABSI through its advocacy role

Issue: Macropod management

Queensland Government Aspiration 3: South West NRM to support the management of excessive macropod numbers through its advocacy role to reinvigorate the Macropod industry and increase the percentage of harvest quota.

Biosecurity

Issue: Connectivity between refugia

- Very little hard data available about connectivity between refugia in south west Queensland

Queensland Government Aspiration 4: South West NRM to continue its mapping of connectivity between refugia through its funded programs.

Issue: Emerging species (not declared) becoming naturalized

Queensland Government Aspiration 5: South West NRM to collaborate with Biosecurity to monitor, evaluate and add emerging pest species to pest management plans.

Issue: The new Biosecurity Act 2014 places onus on landholders to prohibit and restrict movement of pest species.

Queensland Government Aspiration 6: South West NRM to collaborate with Biosecurity and other stakeholders to increase educational opportunities to inform about new legislative requirements and assist with the necessary tools to do so.

Issue: Lengthy delays between when pest species are first located and when Biosecurity is alerted about them.

Queensland Government Aspiration 7: South West NRM to collaborate with Biosecurity and other stakeholders to increase surveillance opportunities through: use of SWNRM's Cactus Control Team; investigating the use of biological control opportunities; use of drones for spotting and spraying; and education in schools.

Issue: little understanding about indigenous native species and their contribution to eco-functionality.

Queensland Government Aspiration 8: South West NRM to collaborate with Biosecurity and schools to facilitate the development of a school program in which students learn the names, and about native plant species.

DAFF and 'Leading Sheep'
Issue: Sheep industry heading further into decline

Queensland Government Aspiration 9: South West NRM to collaborate with DAFF, Leading Sheep and other stakeholders to develop and implement strategies to support and grow the sheep industry, particularly through Collaborative Area Management.

a. identify reasons for decline through monitoring and evaluation; and

b. develop and facilitate implementation actions and strategies to address decline.

Issue: Overseas investment in agricultural industry is not controlled by government to keep benefits in domestic market.

Queensland Government Aspiration 10: Support government control of overseas investment in agricultural industry through its advocacy role, to keep benefits in domestic market.

Murweh Shire Council

Issue: Constraints of working with old technology and lack of funding

Opportunities: Remote area technologies

– currently reviewing hard waste and sewerage systems with a view to creating artificial wetlands and other opportunities such as recycling paper and cardboard.

Local Government Aspiration 1: South West NRM to collaborate with Murweh Shire Council and other stakeholders to investigate programs for recycling paper and cardboard.

Local Government Aspiration 2: South West NRM to collaborate with Murweh Shire Council and other stakeholders to promote renewable energy technologies.

South West NRM Board:

Issue: Advancement of the south west region depends on increasing local prosperity and opportunities.

South West NRM Board Aspiration 1: South West NRM to create a comprehensive, themed, presentation of the Earth science and ecological assets of south west Queensland as a basis for visitor appreciation and scientific enquiry (to include dinosaur and megafauna) in collaboration with relevant stakeholders and agencies.

South West NRM Board Aspiration 2: South West NRM to collaborate with stakeholders to explore and promote additional tour itineraries for visitors to the region.

Desirable Outcomes:

- Keeping young people in the region.
- Restore profitability through reducing grazing pressure and leakage from productivity.
- Build effective NRM networks and alternative contacts.
- Work together to share and build skills – emphasis on cooperation not competition.
- Seek new investment from outside.
- Investigate new ways of doing things to increase business effectiveness, including use of remote technology.

Meeting conducted between Jane Morgan, Cosmos Centre Manager (Murweh Tourist Manager) met with South West NRM CEO, Bernard Holland and Senior Project Officer – Planning, Leanne Day at 1pm 29 July 2014.

Issue: Cosmos Centre needing to expand its promotional activities into providing guided tours to capture more of the tourist market.

Action: South West NRM to collaborate with Cosmos Centre to scope and develop guided tours that combine Tourism and Education and include Aboriginal stakeholders to tell their cultural stories (with the aim to improving tourist opportunities and instill pride in Aboriginal peoples' cultural storytelling). Projects could include: Aboriginal Night Sky and River walks. South West NRM to initiate conversation with South West Regional Development Association (South West RED) and inform them of potential projects.

Issue: Loss of momentum on previously initiated projects:

Action: South West NRM to reinvigorate "cold-case" project, 'Charleville Botanic Reserve' (in Percival Road), which began as a collaboration between Cosmos Centre, Murweh Shire Council and South West NRM to install signage for the various native trees and vegetation on that reserve.

Action: South West NRM to collaborate with Cosmos Tourist Centre to install QR codes on regional landmarks and indigenous trees. (Discussion to continue; Jane to provide research items selected for QR codes).

Appendix 3: Linkages and alignment of the South West NRM Plan with other Plans, policies and legislation

Name	Owner	Relevance to South West NRM Plan	How this source will be used
Caring for Our Country, South West NRM Regional Investment Programme 2013–2018	South West NRM/Australian Government	Outlines South West NRM's five-year strategies for delivering Caring for Our Country priorities	Capture CfOC KPIs, themes, priorities and activities in an NRM Plan
South West Regional Plan: planning for a stronger, more liveable and sustainable community (2009)	Queensland Government	Provides a framework that is a key mechanism for integrating federal, state and local government planning agendas	Informs framework of South West NRM Plan
South West NRM Plan 2008–2013	South West NRM	Identifies South West NRM's contemporary priorities and responses	Carry forward relevant information to ensure continuity between previous and current plans
Neighbouring Regions' NRM Plans	• Territory NRM • South Australian Arid Lands • Desert Channels Qld • Western Local Land Services	Neighbouring NRM groups; overlap between NRM regions in farming systems and land types	Ensures cross-boundary collaboration on relevant projects and issues
The Australian Rangelands Initiative – Rangelands 2028	Rangelands NRM Alliance	Information sharing network across Australia's rangelands. Raises the profile of issues and opportunities across the rangelands.	
Don't Camp in the Creek Bed: Planning for Climate Variability in South West Queensland (2014)	South West NRM	Captures community and Traditional Owner aspirational responses to climate change impacts on stakeholder business enterprises, lifestyle and culture	Respond to Community Aspirations in Part B 'Management Actions'
Risk & Resilience in NRM Planning: addressing the drivers of change including the likely consequences of seasonal variability (2014) (Appendix 2, this document)	South West NRM	Captures state government, local government and South West NRM Board stakeholder aspirations	Respond to Aspirations in Part B 'Management Actions'
Queensland Regional NRM Planning Guidelines (2012)	Queensland Regional NRM Groups Collective	Best practice planning and review guidelines for NRM planners	Provides guidelines for best practice NRM planning, ensuring a common set of attributes to apply to the planning process as well as plan content. Also provides a set of best practice approaches for use in the three-year reviewing process

Name	Owner	Relevance to South West NRM Plan	How this source will be used
Caring for Country, Culture and People: the South West Queensland Traditional Owner NRM and Cultural Heritage Plan	South West NRM	Provides Aboriginal perspectives as the focus in advancing Aboriginal involvement in natural resource and cultural heritage management in this region	Inform NRM and cultural planning
Back on track actions for biodiversity: Taking action to achieve species conservation in the South West Queensland Natural Resource Management Region (2010)	Queensland government and South West NRM	Identifies threat abatement and risks to vulnerable and protected species	Informs species conservation and recovery plans for specific threatened identified species
National Water Initiative	Australian Government	Is Australia's blueprint for water reform to increase the efficiency of Australia's water use, leading to greater certainty for investment and productivity for rural and urban communities and for the environment	Informs NRM planning with respect to innovative landscape resilience strategies and projects appropriate for South West Queensland
A risk assessment of water dependent threatened species and communities and water assets of southwest Queensland from coal seam gas and coal mining (2012)	South West NRM	Summarises relevant datasets and research; identifies relative vulnerabilities and level of risk to ecological assets of coal seam gas and mining developments; identifies landscape linkages that sustain ecosystem function and species resilience; outlines management-focused recommendations.	Informs protection strategies and programs for ecological assets from threats (i.e. weeds, pests and reduction of plant- and animal-available water)
Land Protection (Pest and Stock Route Management) Act 2002	Queensland Government	Legislative requirements for mitigation of pests and weeds on public lands and class one and two pests and weeds on private land	Highlights potential areas for collaboration with local councils and Biosecurity Queensland to address weed incursions
Local council pest and weed management plans for the seven shires in the South West NRM Region	Local and Queensland governments	Provides guidelines for mitigation of pests and weeds on public lands and Class I and II pests and weeds on private land based on each council's local priorities	Informs collaborative planning and roll-out of activities relating to pest and weed control
Water Act 2007	Australian Government	Water quality guidelines	Informs NRM planning strategies relating to water quality
[Queensland Murray Darling] *Basin Plan*	Australian Government	Water quality guidelines	Informs planning to improve soil remediation in riparian and flood-out areas
Environmental Protection Act 1994	Queensland Government	Legislative requirements for environmental protection activities	Informs plans relating to innovative landscape resilience strategies relevant to South West Queensland

Name	Owner	Relevance to South West NRM Plan	How this source will be used
Nature Conservation Act 1992	Queensland Government	Provides legislative requirements for conservation of nature through an integrated and comprehensive conservation strategy for the whole of Queensland	Informs planning for conservation on-ground works and community engagement
Queensland Wildlife Trade Management Plan for Export – Commercially Harvested Macropods (2013–2017)	Queensland Government	Provides guidelines for managing and administering commercial operation in accordance with the Environmental Protection and Biodiversity Conservation Act 1999	Informs planning with respect to reinvigorating the kangaroo industry in the region
Biosecurity Act 2014	Queensland Government	The terminology used under the Land Protection (Pest and Stock Route Management) Act 2002 and the obligations imposed by that legislation will change on the commencement of the Biosecurity Act 2014, expected to commence no later than 1 July 2016	Informs strategies for managing declared pests
Queensland Biosecurity Strategy 2009-14	Queensland Government	Threats from pests and weeds (including new and sleeper weeds) as well as biosecurity risks	Informs planning with respect to on-ground works and containment of pest and weed threats
Fisheries Act 1994	Queensland Government	Regulates management of carp	Informs management strategy for carp
Sustainable Planning Act 2009	Queensland Government	Provides the overarching framework for planning and development in Queensland. It manages the process by which development takes place, manages the effects of development upon the environment and coordinates and integrates planning at local, regional and state levels	Informs planning with respect to strategies for management of water assets in region
National Climate Change Adaptation Framework (2013)	Australian Government	Adaptation responses to climate change threats	Informs planning for innovative landscape resilience strategies relevant to South West Queensland
Carbon Credits (Carbon Farming Initiative) Regulations 2011	Australian Government	Contains, Methodology determinations and other information about the Carbon Farming Initiative	Reference tool for understanding and informing planning relating to the CFI
Department of the Environment (website)	Australian Government	Published discussion about the CFI and the Positive and Negative Lists by the Domestic Offsets Integrity Committee	Awareness tool for ascertaining most relevant CFIs for South West Queensland
Climate Change and Greenhouse Gas Reduction Act 2010	Australian Government	Legislative requirements of entities wishing to reduce greenhouse gas emissions and/or increase use of renewable energy sources	Informs planning with respect to CFI opportunities

Name	Owner	Relevance to South West NRM Plan	How this source will be used
Australian Pest Animals Strategy (2007)	Australian Government	Threats from pests and weeds (including new and sleeper weeds) as well as biosecurity risks	Informs planning strategies for on-ground works and containment of pest and weed threats
Australian Weeds Strategy (2007)	Australian Government	Threats from pests and weeds (including new and sleeper weeds) as well as biosecurity risks	Informs plans for on-ground works and containment of weed threats
National Principles and Guidelines for Rangeland Management (2010)	Australian Government	Resilience strategies, principles and guidelines for managing rangeland environments	Informs planning strategies for innovative landscape resilience strategies that are relevant to South West Queensland
Environment Protection and Biodiversity Conservation Act 1999	Australian Government	Legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places	Informs planning strategies for on-ground works to enhance biodiversity
Australia's National Framework for Environmental Management Systems in Agriculture: Natural Resource Management Ministerial Council (2002)	Australian Government	Sustainable enterprise management	Informs planning strategies for innovative landscape resilience strategies relevant to South West Queensland
Australia's Biodiversity Conservation Strategy 2010–2030	Australian Government	Legislatively responsible action that enhances biodiversity and reduces the threats posed to protection of these locations	Informs planning strategies for biodiversity conservation
Closing the Gap on Indigenous Disadvantage: the Challenge for Australia (2009)	Australian Government	Addressing the gap between the life opportunities enjoyed by non-Indigenous and Indigenous Australians to build a fairer Australia	Informs planning strategies for engaging Indigenous peoples in NRM programs

South West NRM

Achieving sustainable landscapes for rural communities

Photo courtesy Cathy Zwick.

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