



# Riverine ecosystems

## Western region

### State Plan target

By 2015 there is an improvement in the condition of riverine ecosystems.

### Background

The Western region is the largest management area in New South Wales, covering some 230,000 km<sup>2</sup>, and includes the Barwon–Darling, Culgoa, Paroo, Warrego, Narran, Bokhara and Birrie river catchments and parts of the lower Bogan and Macquarie river catchments of the Murray–Darling Basin. The region contains the entire Lake Bancannia catchment and portions of the Bulloo catchment as well as portions of the Cooper Creek and Lake Frome catchments of the Lake Eyre Basin (Figure 1). It takes in significant portions of the Bourke, Brewarrina, Central Darling, Cobar and Walgett shires and the Unincorporated Area. The catchment is predominantly leasehold land, administered under the *Western Lands Act 1901* by the NSW Land and Property Management Authority. There are more than 630 pastoral and agricultural holdings in the region. The population of the Western catchment is approximately 18,000 people (excluding the City of Broken Hill).

The Barwon River and the Darling River form the major continuous river system in the region. The Barwon River is some 890 km in length with its headwater tributaries originating in Queensland and NSW, and flows through Mungindi to its confluence with the Darling River. The Darling River begins near Brewarrina at the confluence of the Culgoa and Barwon rivers, with headwater streams rising in the ranges of southern Queensland. The Darling River is around 1570 km in length with the majority of the river occurring in the Western region to north of Menindee. The flow of the Barwon–Darling River is modified by up to 12 weirs located along its length in the Western region.

A detailed technical report describes the methods used to derive the information contained in this report. At the time of publication of the *State of the catchments (SOC) 2010* reports, the technical reports were being prepared for public release. When complete, they will be available on the NOW website: [www.water.nsw.gov.au](http://www.water.nsw.gov.au).

**Note:** All data on natural resource condition, pressures and management activity included in this SOC report, as well as the technical report, was collected up to January 2009.

The Paroo (640 km in length), Warrego (800 km in length) and Culgoa (320 km in length) rivers are the westernmost tributaries of the Darling River and rise in hills lower than the other tributaries of the Darling. The Paroo River is the last remaining free-flowing river in the northern part of the Murray–Darling Basin and has its origin in the gorge country of western Queensland, meandering south and spreading into the vast floodplains of NSW, eventually reaching the Paroo overflow lakes. The Warrego River, considered an ephemeral stream, rises in the Carnarvon Ranges of Queensland. The Culgoa River is a continuation of the Balonne River in southern Queensland and flows south-west to join the Darling River upstream of Bourke.

The Narran River is 300 km in length and rises from near Dirranbandi in Queensland. It is a distributary of the Balonne River that does not rejoin the other major channels in the region. This results in the formation of a terminal wetland system called Narran Lakes, which is a Ramsar-listed wetland.

### Map of the catchment

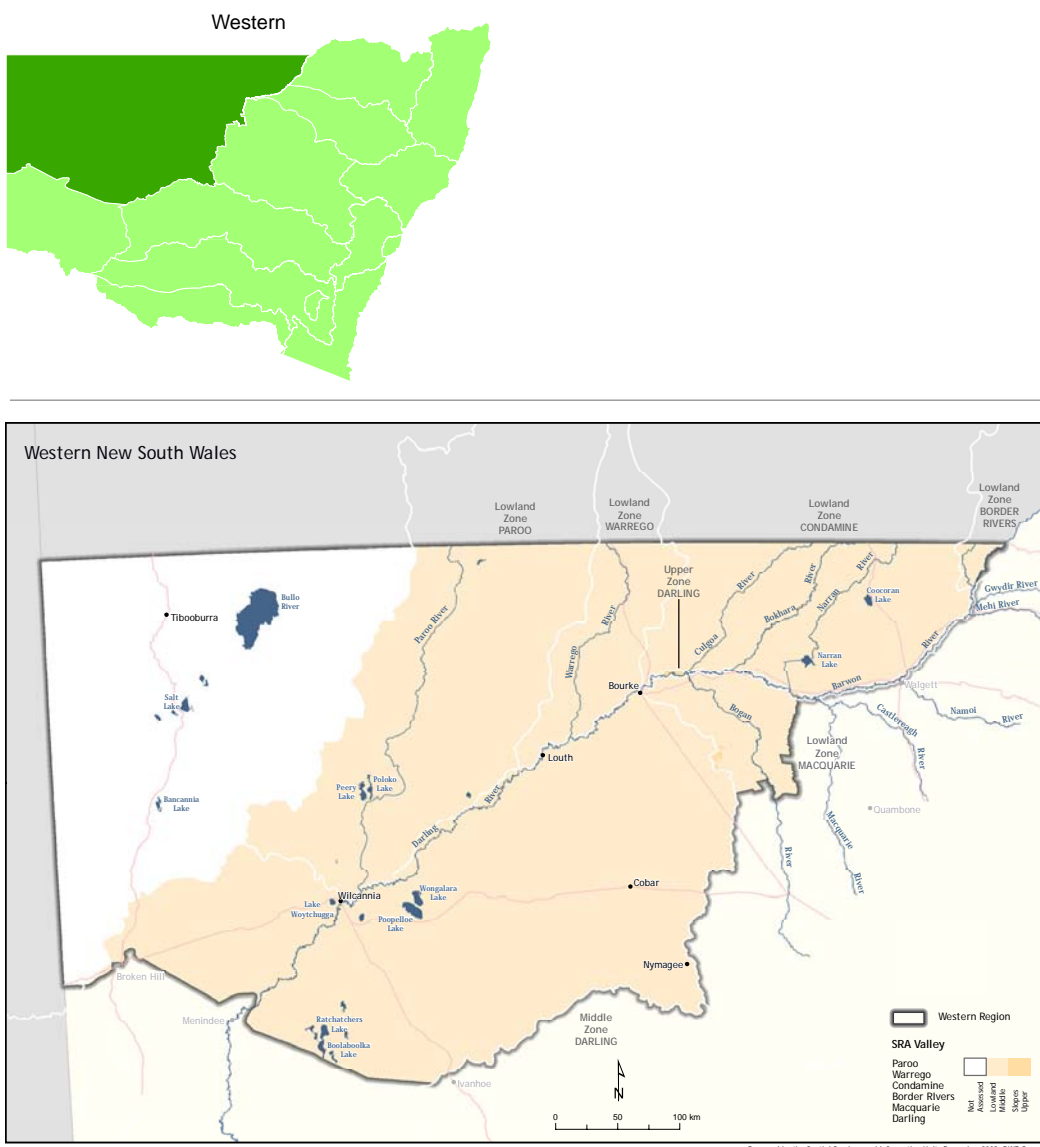


Figure 1 The Western region

## Assessment

Riverine ecosystem condition has been assessed using water quality, macroinvertebrate, fish and hydrology indicators. Water quality condition is described as the percentage of samples exceeding the ANZECC water quality guidelines for turbidity and total phosphorus (ANZECC & ARMCANZ 2000). Condition for macroinvertebrates, fish and hydrology is based on the Sustainable Rivers Audit (SRA) and is described using a five point scale (Davies et al 2008). Trend information is provided for the water quality indicators: electrical conductivity, turbidity and temperature.

For macroinvertebrate, fish and hydrology condition indicators, the overall condition ratings for the region were calculated using the Western Catchment Management Authority (CMA) boundary, incorporating parts of the Paroo, Warrego, Condamine, Border Rivers, Darling and Macquarie SRA valleys, as labelled on the maps. The overall condition for the CMA region as shown on the maps may therefore be slightly different from the overall condition presented for individual valleys in the SRA report (Davies et al 2008). The maps provide information on condition in greater geographical detail based on the SRA within-valley zones. It is important to note that overall regional condition outcomes for most of the attributes listed below do not include details for catchments west of the Paroo and Darling rivers, and are therefore not comprehensive regional condition outcomes.

## Condition

### *Water quality*

Condition was determined for the following indicators of water quality in the Western region:

- **turbidity**, which is a measure of the effect of suspended sediment on water clarity and a potential indicator of sedimentation and erosion
- **total phosphorus (TP)**, which is a measure of all forms of phosphorus, some of which can occur naturally or via inputs from other factors including erosion, sedimentation and grey water (all non-toilet household wastewater). High levels may cause eutrophication, resulting in excessive growth of aquatic plants.

Data was analysed for the period 2005–2008. For turbidity in inland rivers, the upper limit of the guideline was adopted (ie 25 and 50 nephelometric turbidity units [NTU] for upland and lowland rivers respectively). The guidelines for total phosphorus are <0.02 mg/L for upland rivers and <0.05 mg/L for lowland rivers. The classification of sites as belonging to upland or lowland rivers was based on altitude as recommended by the ANZECC guidelines (upland >150 m and lowland <150 m above sea level).

The map (Figure 2) shows the percentage of water quality samples at each site that exceeded the above guidelines. In general terms, the higher the percentage of exceedance, the higher the priority the site (and its catchment) would be for further investigation.

For water quality condition, data confidence bands were applied based on the degree that data met two criteria: first, the completeness of records over the three-year period of sampling, and second, the regularity of sampling intervals. A high confidence rating was given when data satisfied – or nearly satisfied – the ideal situation of a complete three-year sampling period and regular sampling intervals every month. Conversely, a lower rating was given when data departed further from the ideal, with the lowest confidence being for data collected over less than a year and/or with sampling intervals of six months or greater.

Trends (Figure 3) were determined for the following indicators of water quality in the Western region:

- **water temperature**, which is affected by altitude, shading, channel width and depth, flow, water impoundment, groundwater discharge and climate
- **electrical conductivity (EC)**, which measures the ability of water to carry an electrical current. This ability depends on a number of factors including the presence and concentration of salts
- **turbidity**, which is a measure of the effect of suspended sediment on water clarity and a potential indicator of sedimentation and erosion.

The period of record ranges from the mid 1960s and 1980 through to the current day for EC; the late 1960s and early 1970s through to 2005–08 for temperature; and from the mid 1970s and 1980 through to the current day for turbidity.

The NSW discrete water quality data archive (Triton database managed by the NSW Office of Water [NOW]) was evaluated using a long-term trend analysis (30–35 years), which provided a preliminary understanding of the behaviour of EC, temperature and turbidity trends within the study area. This understanding is vital for providing the context for future data collection, analysis and reporting.

To quantify the level of confidence in archival water trend data for each CMA region, a debit point system was used to assess operational issues, excessive data gaps, data collection and archival issues (NOW in prep.). This provided the basis for applying a low, medium or high data confidence ranking.

The percentage of samples that exceeded total phosphorus guidelines was high to very high at all sites across the catchment, with the exception of one site that had a moderate result. The percentage of samples that exceeded turbidity guidelines was high to very high across the region, with the exception of one site that had a moderate result and a site with insufficient data (Figure 2).

Data confidence	Commentary
TP – medium	For TP, sites generally have an average of 12 samples collected over the sample period. Confidence in the degree of representativeness of these data for the period of record is medium.
Turbidity – medium	For turbidity, sites generally have over 12 samples collected over the sample period. Confidence in the degree of representativeness of these data for the period of record is medium. Occasionally, there were periods between samples of longer than three months for both TP and turbidity.

### Water quality trend

Almost all the results showed stable trends in water quality (Figure 3). The exceptions were due to substantial gaps in the data record resulting in an unclear result.



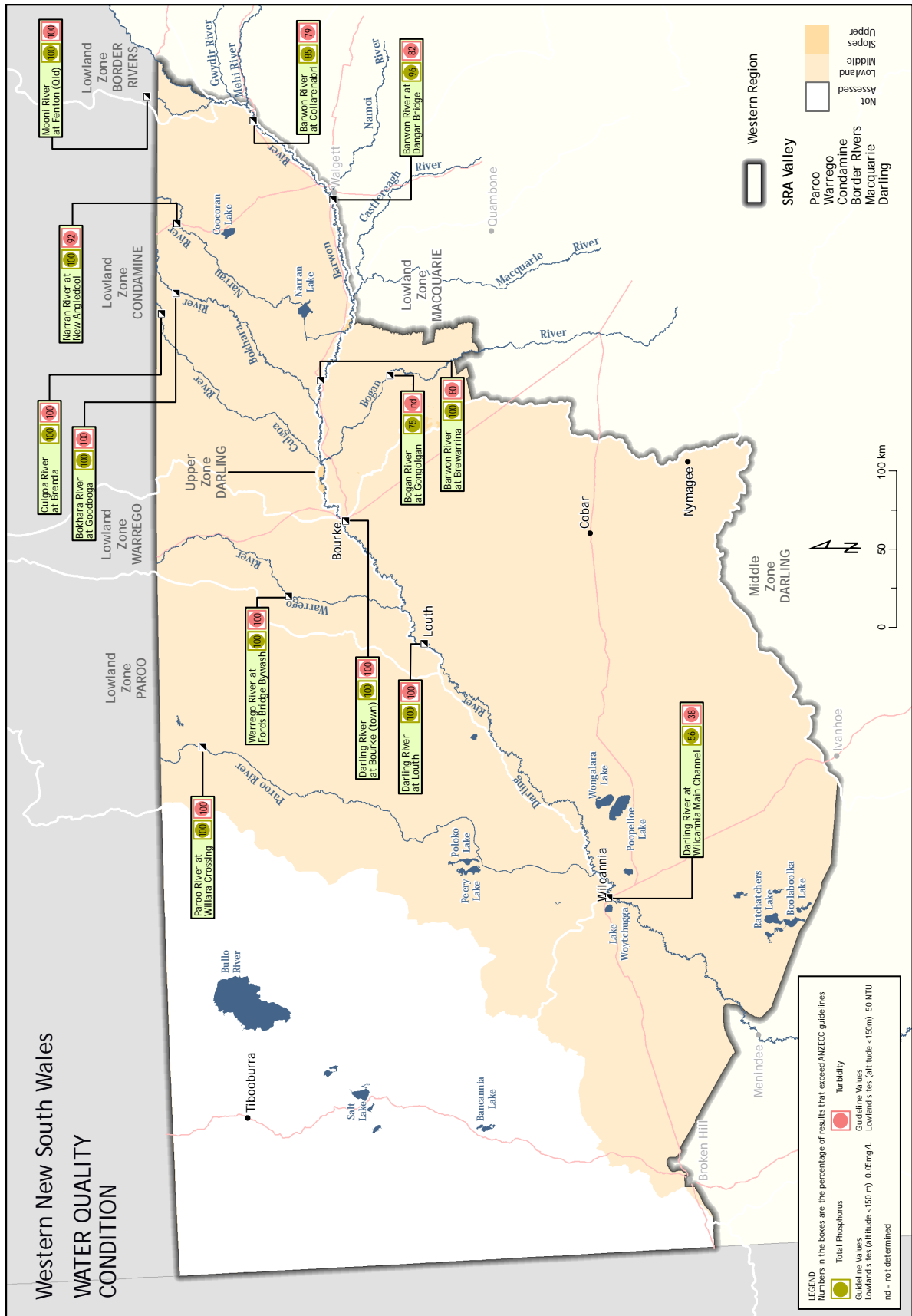
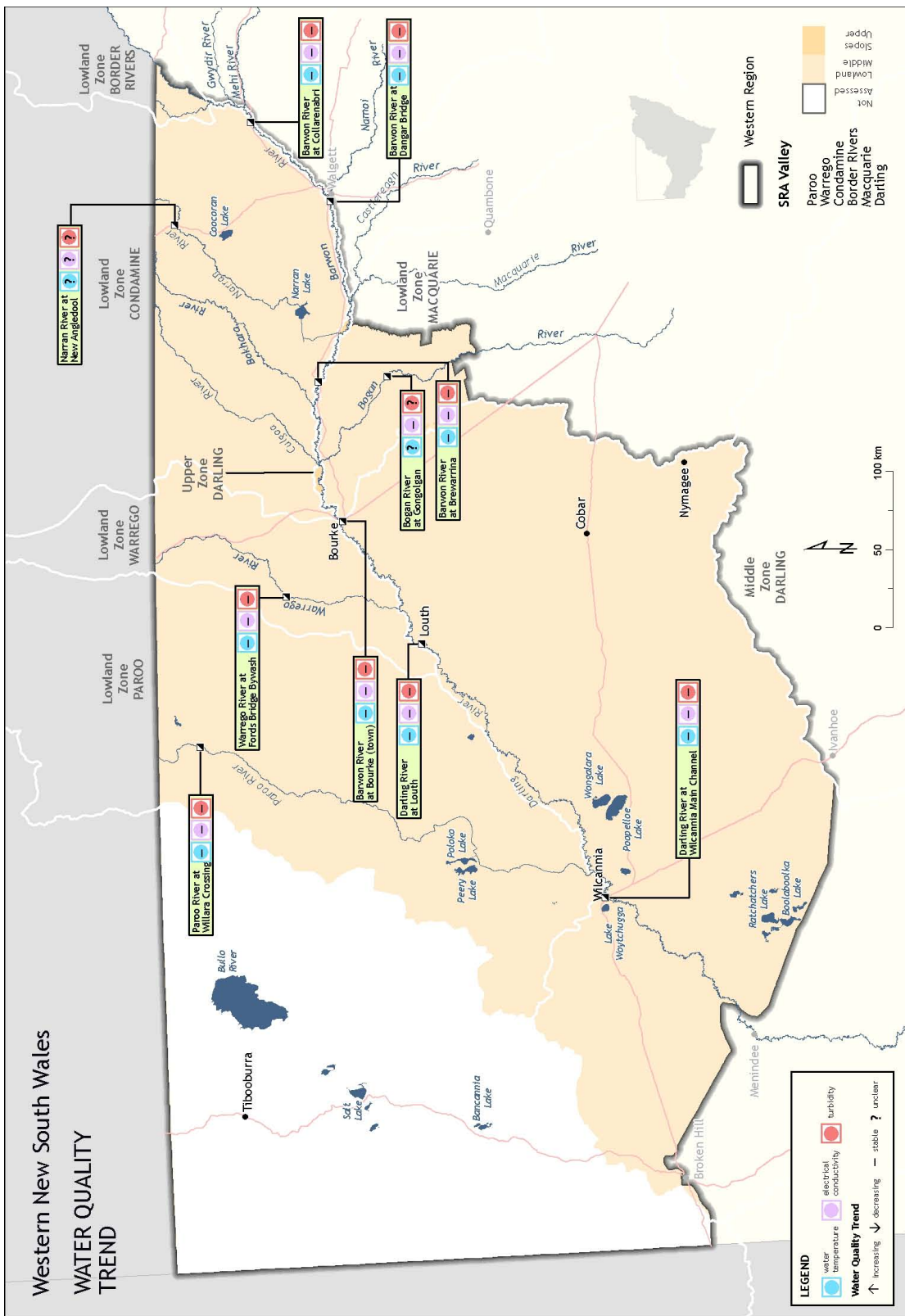


Figure 2 Water quality condition across the Western region



Prepared by the Spatial Services and Information Unit, December 2008, DWE Orange

Figure 3 Water quality trend across the Western region

Data confidence	Commentary
EC – low	Many sites had a low frequency of samples.  Data confidence for EC was diminished due to data collection issues, excessive data gaps and archival issues across the whole catchment.
Temp – medium	Data confidence for temperature was diminished mostly due to data collection issues and significant data gaps across the catchment.
Turbidity – low	Data confidence for turbidity was very poor, due to data collection issues, data gaps and significant archival issues across the catchment.

### ***Aquatic biota***

The condition of aquatic biota was assessed using the following measures of riverine ecosystem health:

- **macroinvertebrate assemblages**, which consist of larval and adult insects, molluscs, worms and crustaceans and are an important component of river ecosystems
- **fish assemblages**, which consist of native and introduced species.

#### *Macroinvertebrate assemblages*

The Macroinvertebrate Condition Index (Figure 4) integrates indicators of ‘expectedness’ (the proportion of expected families found) and the SIGNAL observed/expected (O/E) score (a score based on the sensitivities of families to pollution or other disturbances). For more details on the method see Davies et al (2008).

#### *Fish assemblages*

The Fish Condition Index (Figure 5) integrates indicators of ‘expectedness’ (the actual presence of native species relative to the species expected under the reference condition) and ‘nativeness’ (proportion of the fish population that is native rather than alien).

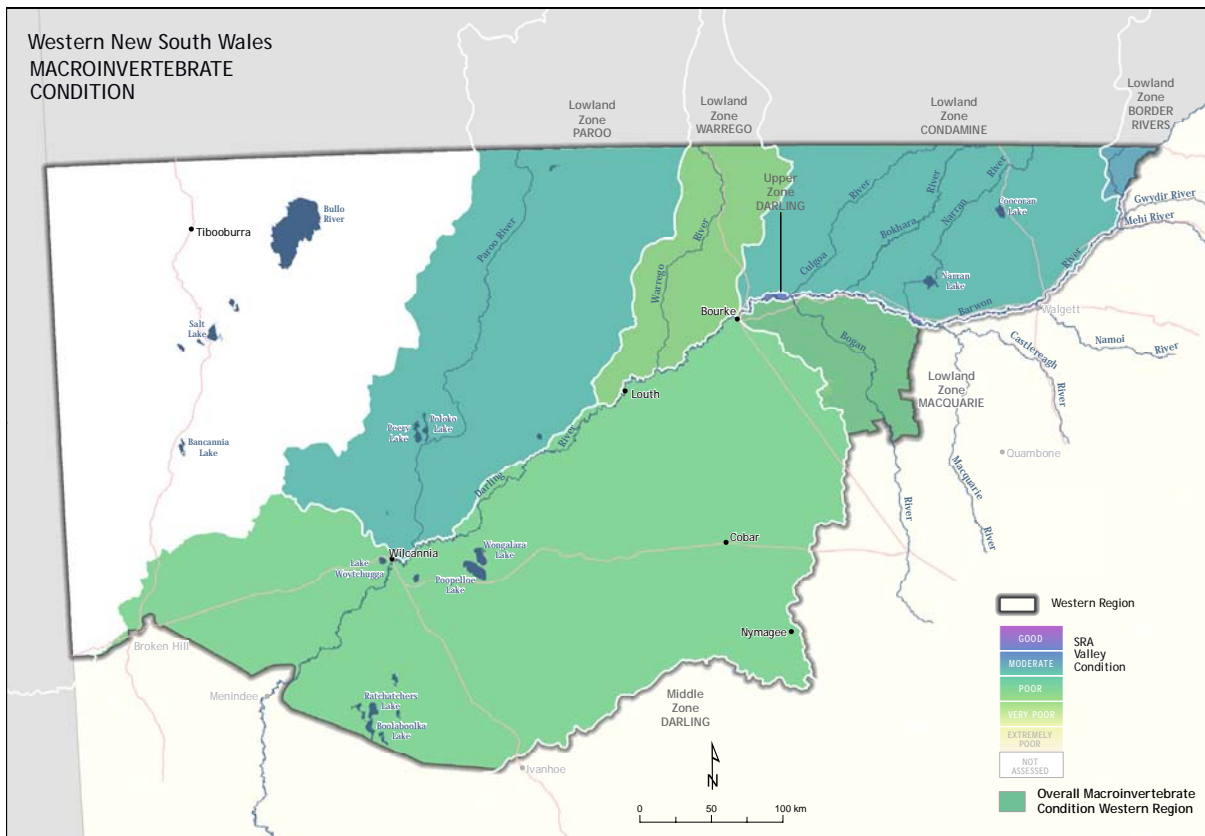
The site selection, sampling and analytical procedure used were largely as described in the SRA report (Davies et al 2008).

Although the same analytical procedure was used, there are some slight variations between the results presented here for Murray–Darling Basin catchments and the results presented in Davies et al (2008). There are several possible reasons for this:

- the use of the most recent data (some of which has not yet been reported by the SRA program)
- the exclusion of data collected from neighbouring states for cross-border valleys, unless fewer than four data points occurred in the NSW section of each zone

in many cases, more data was available for this reporting than was used for SRA analysis; the extra samples resulted in slightly different median metrics from those reported by the SRA

a state-wide stream network (5 ML day Stein stream network version 2.92: Fenner School of Environment and Society, Australian National University, unpublished) was used to weight zone data when calculating valley and regional statistics. This varies slightly from the stream network used for the SRA.



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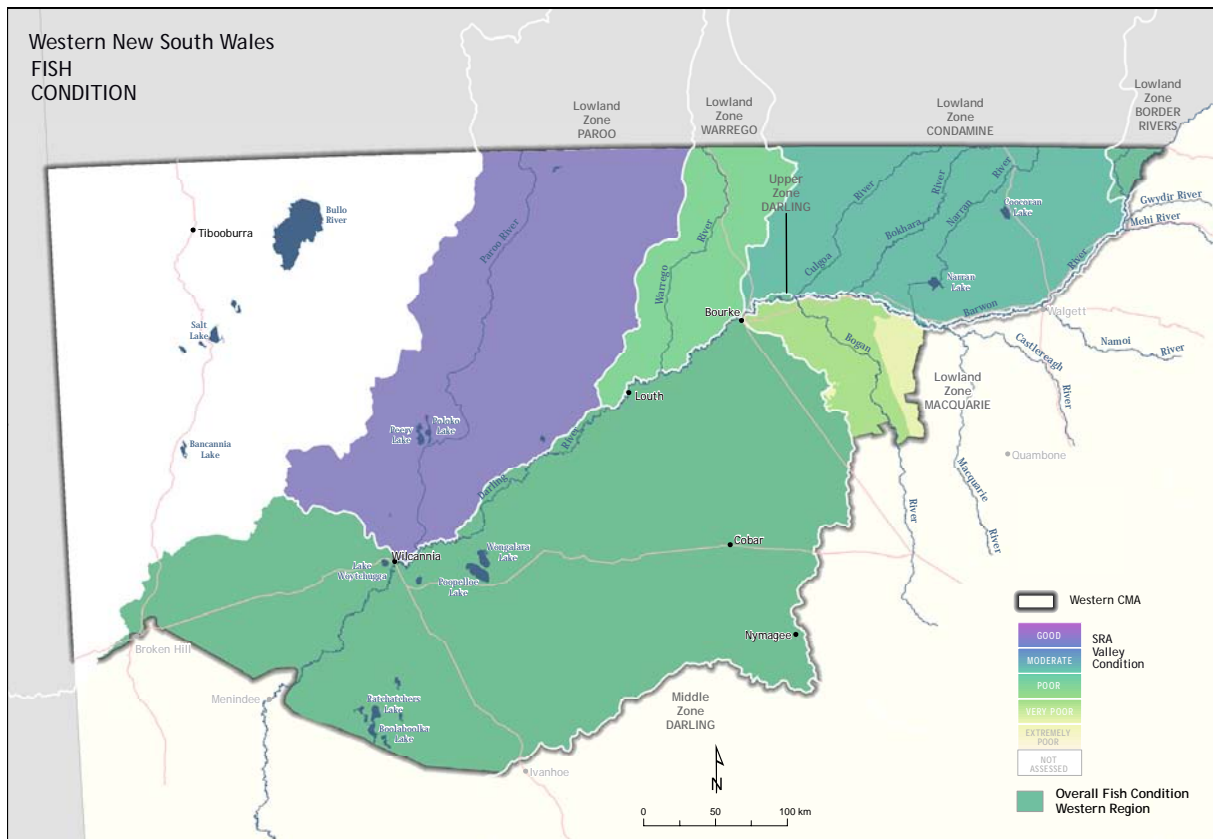
**Figure 4 Macroinvertebrate condition across the Western region**

Data confidence	Commentary
Not assessed	Condition data derived from the Sustainable Rivers Audit (see <a href="http://www.mdbc.gov.au/SRA/river_health_check_-_sra_report_one">www.mdbc.gov.au/SRA/river_health_check_-_sra_report_one</a> ).

**Fish condition**

The overall fish condition across the whole region was poor, with nativeness (the proportion of the fish assemblage that is native versus introduced fish) being poor and expectedness (the proportion of species collected during sampling that were expected to have occurred in each basin zone before European colonisation) being very poor. However, no data has been collected from the non Murray–Darling Basin catchments within the region. Of the individual catchments, the Paroo catchment was the only one where fish communities were in good condition. The Barwon River and the Culgoa-Narran and Moonie catchments were in moderate condition. The Darling River and Warrego were in poor condition and the Lower Bogan and Lower Macquarie catchments were in very poor and extremely poor condition respectively. Expectedness was poor in the Paroo, poor in the Darling, Barwon, Moonie, lower Bogan and Culgoa-Narran, very poor in the lower Macquarie and extremely poor in the Warrego. Nativeness was good in the Paroo, moderate in the Darling, Barwon, Culgoa-Narran and Warrego, poor in the Moonie, lower Bogan and extremely poor in the lower Macquarie.





Prepared by the Spatial Services and Information Unit, December 2008, DWE Orange

**Figure 5 Fish condition across the Western region**

Data confidence	Commentary
Low to high	<p>All data was collected within the three year period between 1 January 2006 and 31 December 2008.</p> <p>Data confidence within individual basins varies from high to low depending on the number of sites sampled within each, with higher confidence in basins with more sites and medium or low confidence in basins supported by less data.</p> <p>Data from the four non Murray–Darling Basin catchments was not due to be collected until spring 2009; therefore no overall region condition score is available. The overall condition score should be treated with caution as it does not represent the entire region.</p>

## Hydrology

Hydrologic condition (Figure 6) measures the ecologically significant aspects of the flow regime including volume, variability, extreme flow events and seasonality. Changes to flow regimes have significant potential to influence riverine ecosystems.

‘The Paroo Valley was in good hydrological condition throughout. Very high values of both the index and all hydrology indicators reveal that hydrology in the Paroo is little changed from its natural flow regime’ (MDBC 2008).

'The Warrego Valley was in good hydrological condition. The values suggest that the flow regime in the Warrego is only slightly changed from the natural regime, though changes in the lower reaches are of ecological significance' (MDBC 2008).

The Upper and Middle zones in the Darling River are in moderate hydrologic condition.

'Overall, the flow regime had fewer high flows, and reduced annual volumes and variability, with little change to low and zero flows and flow seasonality. This pattern reflects the diversion of a significant volume of water from the system and the effect of differentially harvesting high flows' (MDBC 2008).

The Lowlands zone in the Macquarie Valley was in moderate hydrologic condition.

The Lowlands zone of the Condamine Valley was in moderate hydrologic condition.

'The Valley flow regime was characterised by reduced high flows and annual volumes, and minor changes in variability and seasonality' (MDBC 2008).

### Hydrology condition

Data confidence	Commentary
Altitude zone condition – medium	Condition data derived from the Sustainable Rivers Audit (see <a href="http://www.mdbc.gov.au/SRA/river_health_check_-_sra_report_one">www.mdbc.gov.au/SRA/river_health_check_-_sra_report_one</a> ).
Overall region condition – medium	Condition data interpreted from the Sustainable Rivers Audit by combining the conditions of the Paroo, Warrego, Condamine, Border Rivers, Darling and Macquarie SRA Valleys.

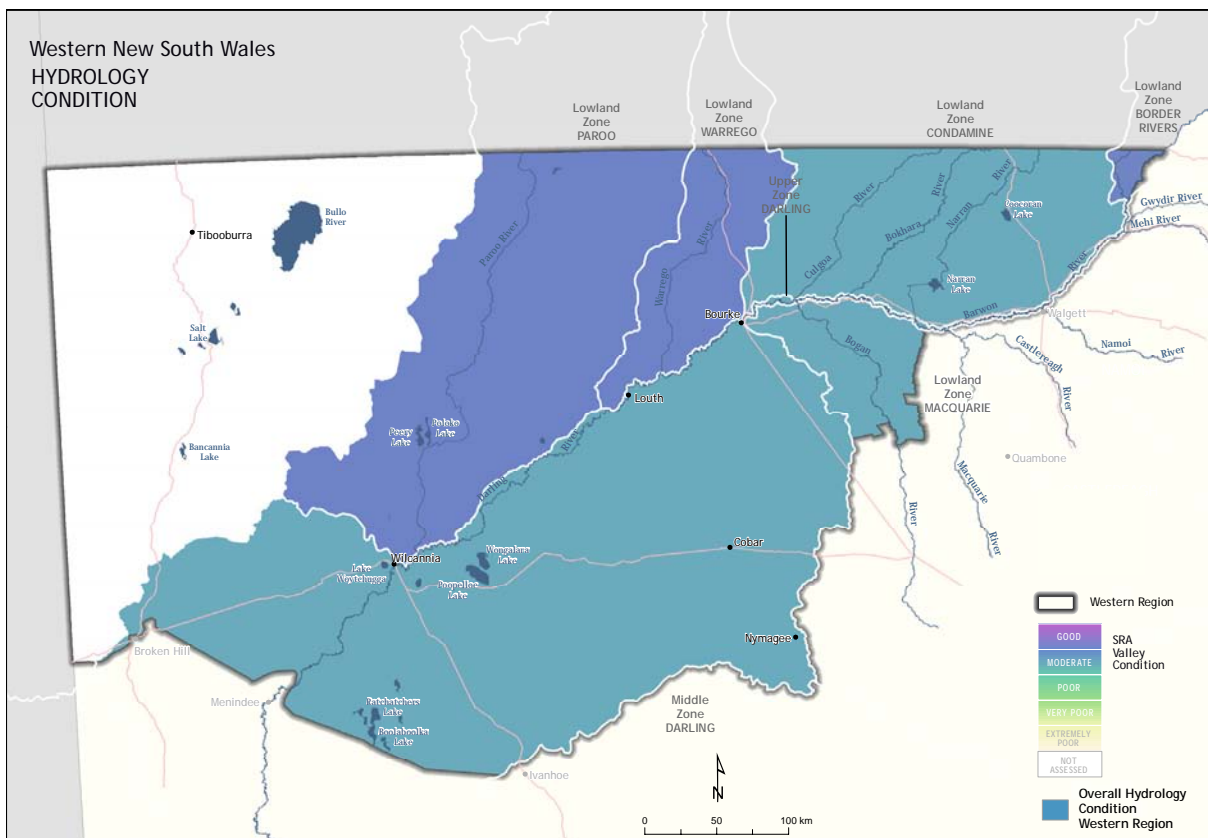


Figure 6 Hydrologic condition across the Western region

## Pressures

### *Introduction of pest species*

#### *Alien fish species*

Alien fish apply pressure to native fish species, populations and communities as they compete for available resources (habitat and food). Some alien fish also prey on native fish.

Alien fish species assessment is derived using the nativeness indicator output from SRA models (Davies et al 2008). Nativeness comprises three metrics:

- proportion of total biomass of native species
- proportion of individuals that are native
- proportion of species that are native.

Rankings range from 0 to 100; the lower the number, the greater the pressure from alien fish. The nativeness ranking is the average score of sites within each zone.

Valley name	Altitude zone	Nativeness ranking
Middle Darling	Lowlands	65
Barwon	Lowlands	72
Moonie	Lowlands	57
Culgoa-Narran	Lowlands	76
Warrego	Lowlands	79
Paroo	Lowlands	99
Western CMA Bogan	Lowlands	46
Western CMA Macquarie	Lowlands	No data
Bulloo	Lowlands	No data
Lake Bancannia	Lowlands	No data
Lake Frome	Lowlands	No data
Cooper Creek	Lowlands	No data

### *Water management*

#### *Alteration of natural temperature patterns*

There are no dams identified as causing cold water pollution in the Western region.

#### *Artificial barriers to fish passage*

Many fish species migrate up and down rivers to breed or to find alternative habitat during extreme events such as drought. Construction of weirs, dams and road crossings can limit or prevent

migration, resulting in loss or depletion of certain fish species upstream of such barriers.

In 2006, Industry & Investment NSW (I&I) undertook a detailed review of weir barriers to fish passage for each CMA. Primary objectives included identification of high priority barriers that have major impact on fish passage and aquatic habitat condition, priority ranking for remediation, and recommendations for appropriate remediation action. Below is a summary of the findings, which were updated by I&I in December 2008. It lists the priority ranking, and the increase in habitat area available to migratory fish, should the barrier be remediated.

Rank	Barrier name	Watercourse	Potential increase in habitat area (km)
1	Wilcannia Weir	Darling River	501
2	Bourke Weir	Darling River	250
3	Darling River Weir (20A)	Darling River	165
4	Collarenebri Weir (5)	Barwon River	82
5	Louth Weir (21)	Darling River	185
6	Tilpa Weir (24)	Darling River	378
7	Darling River Weir (19A)	Darling Weir	149

Other pressures with the potential to impact on riverine ecosystem condition are listed below.

### ***Agricultural and urban development***

- Polluted runoff from agricultural, industrial and domestic sources
- Livestock grazing.

### ***Loss of native vegetation***

- Clearing of riparian vegetation
- Clearing of catchment vegetation
- De-snagging of instream channels
- Decline in natural replenishment of instream wood.

### ***Introduction of pest species***

- Aquatic and riparian weeds.

### ***Water management***

- Alteration of natural temperature patterns
- Artificial barriers to fish passage.

### ***Climate change***

- Ability for biota to adjust to environmental changes
- Possible alterations to life cycle cues
- Unknown environmental tolerances of biota.

## Management activity

### State level

The State Plan natural resource management targets are being addressed through state, regional and local partnerships. The catchment action plans (CAPs) and the investment programs that support them are the key documents that coordinate and drive the effort to improve natural resources across NSW. The CAPs describe the whole-of-Government approach to addressing each of the state-wide targets at the regional level. The Western CAP can be found at [www.western.cma.nsw.gov.au/Pages/Tenyearcatchmentplan.html](http://www.western.cma.nsw.gov.au/Pages/Tenyearcatchmentplan.html).

The riverine condition attributes have been grouped against management activities that are being applied to address associated pressures. Associating the management activities in this way identifies the actions being undertaken to address the specific pressures impacting on riverine condition.

At times, it is difficult to isolate the influence of individual and multiple pressures on some riverine condition attributes. Improvement of many condition attributes can also be derived from a single management activity. For example, riparian vegetation rehabilitation can influence the condition of water quality and the habitat for macroinvertebrates and fish. Managing altered river flow through water sharing plans (WSPs) can also improve water quality and then improve habitat for aquatic biota. Hence, the benefits from some of the listed management activities should not be considered in isolation. Where management activities clearly address a broad range of condition/pressure outcomes, these are listed against ‘multiple condition/pressure actions’.

### Hydrology

The riverine ecosystems target is being addressed at the state level largely through improved water sharing between users and the environment via WSPs and water purchase for the environment.

WSPs have been the key mechanisms in NSW for balancing competing interests in water management. The WSPs:

- share water between users, and between users and the environment
- increase allocations for the environment and other public purposes
- provide longer term, more secure, and tradeable property rights to facilitate investment and increase business returns from the water used.

WSPs have resulted in notable improvements in the management of NSW water resources by limiting use in the regulated rivers to 200 GL below the Murray–Darling Basin cap, and by providing flow patterns that are more like natural flow regimes. The recovery of additional environmental water through programs such as RiverBank and The Living Murray Initiative has also helped to sustain or improve NSW wetlands.

However, many riverine ecosystems are still under stress from altered flow regimes, and from land-use practices that adversely affect water quality and aquatic habitat. The key initiatives being undertaken to meet this challenge at the state level are:

- completing the remaining WSPs in the Murray–Darling Basin by 2011 and elsewhere before 2013
- progressing the recovery of water for the environment in the short term through RiverBank and Living Murray, and in the longer term in cooperation with the Australian Government through the Water for the Future initiative

- adjusting future WSPs to account for climate change impacts and the Murray–Darling Basin Plan currently being prepared by the Murray–Darling Basin Authority.

### **Water quality**

The following actions are being undertaken to address water quality issues:

- the Drinking Water Catchments Regional Environmental Plan No 1 (2006) aims to achieve water quality management goals while encouraging improved land-use practices for sustainable development, land managers and decision makers
- the Department of Planning is working with relevant government agencies and organisations to progress natural resource model clauses, including stormwater, for inclusion in the standard local environmental plan (LEP) instrument and to provide guidance on how local councils may incorporate these provisions into their new LEPs
- progressing strategies to maintain valued ecological processes such as the Cold Water Pollution Mitigation Strategy, protecting riparian zones in urban areas and the NSW Wetlands Policy
- maintaining water quality that is 'fit-for-purpose' through the NSW Diffuse Source Water Pollution Strategy, stormwater management and regulation of point source pollution
- effectively implementing the monitoring, evaluation and reporting strategy
- providing a framework for councils to develop stormwater management objectives
- providing decision support tools and information to land managers
- developing regional water quality guidelines.

### **Monitoring, evaluation and reporting**

The NSW Integrated Monitoring of Environmental Flows is measuring changes and testing relationships over time in relation to environmental flows and ecosystem responses to provide improved information to decision makers.

### **Regional level**

At the regional level the Western CMA is undertaking the following activities in relation to the riverine ecosystems theme.

#### **Multiple condition/pressure actions**

- A research project has been undertaken to assess riparian condition along the Barwon-Darling rivers and the intersecting streams. River reaches were prioritised for future management based on overall habitat value and potential threat.
- An incentive program has been implemented to provide landholders with funding to fence off sections of river and to install alternative stock watering points. By this 2008 reporting date, 604 km of riparian fencing have been installed.
- A brochure has been developed to assist landholders in the design and installation of alternative stock watering points.
- A sequence of aerial photography has been taken of the Darling River below Bourke to identify remnant pools and potential areas of natural saline inflow.
- The Western CMA has funded a pilot program to test the ability to track water loss on irrigation farms in an attempt to inform improved water use efficiency.

- A framework has been developed to assist the Western CMA in identifying and prioritising wetlands for future management.
- Eleven wetland management plans (WMPs) have been developed in collaboration with I&I for wetlands on private property that has been identified as a high priority. A further 10 WMPs will be developed over the 12 months subsequent to this reporting date.
- Research projects have been undertaken to determine the current condition of rivers and floodplains in the Lower Balonne and Warrego river systems.

### **Water quality**

- The CMA has been working with local councils to review their stormwater management plans and is now providing councils with funding to install 22 gross pollutant traps.
- Education programs have been established in schools in relation to stormwater management.
- A Waterwatch coordinator has been employed to undertake water related capacity building activities within the community.
- Aquatic habitat is being rehabilitated on the Barwon-Darling rivers between Brewarrina and Bourke in a collaborative project with I&I. This has included reintroducing 204 snags to the river, along with fencing the riparian zone, riparian gully stabilisation and carp control. The development of a modified fishway for the Brewarrina Weir is in the final stages of approval.
- A management plan has been developed by I&I for the Darling River between Murtee and Ten Mile Rocks to identify priorities for aquatic habitat rehabilitation.

### **Hydrology**

- The Central Darling Shire has been funded by the Western CMA to improve flows between Lake Wotychugga and the Darling River through the modification of existing road culverts, which currently impede flood flows.

## Further reading

ANZECC & ARMCANZ 2000, *Australian and New Zealand guidelines for fresh and marine water quality*. National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra, [[www.mincos.gov.au/publications/australian\\_and\\_new\\_zealand\\_guidelines\\_for\\_fresh\\_and\\_marine\\_water\\_quality](http://www.mincos.gov.au/publications/australian_and_new_zealand_guidelines_for_fresh_and_marine_water_quality)].

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NSW Office of Water, Triton Water Quality Database, Parramatta, Sydney, NSW.

Published by: Department of Environment, Climate Change and Water NSW, 59–61 Goulburn Street, PO Box A290, Sydney South 1232.

Ph: (02) 9995 5000 (switchboard). Ph: 131 555 (environment information and publications requests).

Ph: 1300 361 967 (national parks, climate change and energy efficiency information and publications requests).

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DECCW 2010/328 ISBN 978 1 74232 641 2 November 2010

Cover photo: DECCW – 'kingfisher'