NSW GOVERNMENT

State of the catchments 2010

Riverine ecosystems

Central West region

State Plan target

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

Background

The Central West region includes the Castlereagh, Bogan and Macquarie River valleys. It covers an area of approximately 92,000 km^2 and is home to 240,000 people. The Central West Catchment Management Authority (CMA) region is located in central western New South Wales, flanked by the Barwon and Darling catchments to the north and west, Lachlan catchment to the south and the Hunter/Hawkesbury-Nepean Basin to the east (Figure 1). Major townships include Orange, Bathurst, Dubbo, Mudgee and Nyngan.

The Castlereagh River is some 541 km in length and rises in rugged broken country in the Warrumbungle Range at an elevation of approximately 850 m. The Castlereagh River flows through Timor Dam and then into the Broadsheet Lagoon on its way to joining the Macquarie River.

The Macquarie River is some 626 km in length and is formed by the joining of the Campbells and Fish rivers, which drain a high plateau area centred near Oberon with a general elevation above sea level of 900 to 1000 m. The river flows northward through steep gorge areas in the Hill End area and is impounded by Burrendong Dam upstream of Wellington. The Cudgegong River rises in the sandstone tableland country east of Rylstone, is impounded by Windamere Dam upstream of Mudgee, and then flows through Mudgee and Gulgong before flowing into Lake Burrendong.

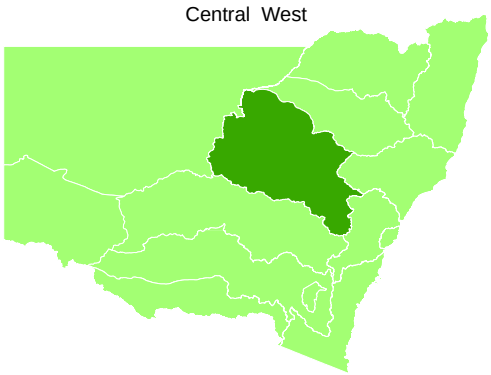
A detailed technical report describes the methods used to derive the information contained in this report. At the time of publication of the *State of the catchments (SOC) 2010* reports, the technical reports were being prepared for public release. When complete, they will be available on the NOW website: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

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.

Downstream of Burrendong Dam, the Macquarie River continues to flow in a north-west direction through Wellington and Dubbo and is joined by several major tributaries from the east and western parts of the catchment. At Narromine the river takes a dramatic turn to the north and commences a complex system of anabranches and effluent creeks that connect the Macquarie, Darling and Bogan rivers. The Macquarie Marshes are located toward the end of the catchment, although the Macquarie River does emerge from the wetlands before being joined by the Castlereagh River and then flowing into the Barwon River near Brewarrina.

The Bogan River is some 617 km in length and rises in the Harvey Ranges between Parkes and Peak Hill. It flows north-west through a broad, flat landscape through Nyngan to join the Darling River near Bourke.

Map of the catchment



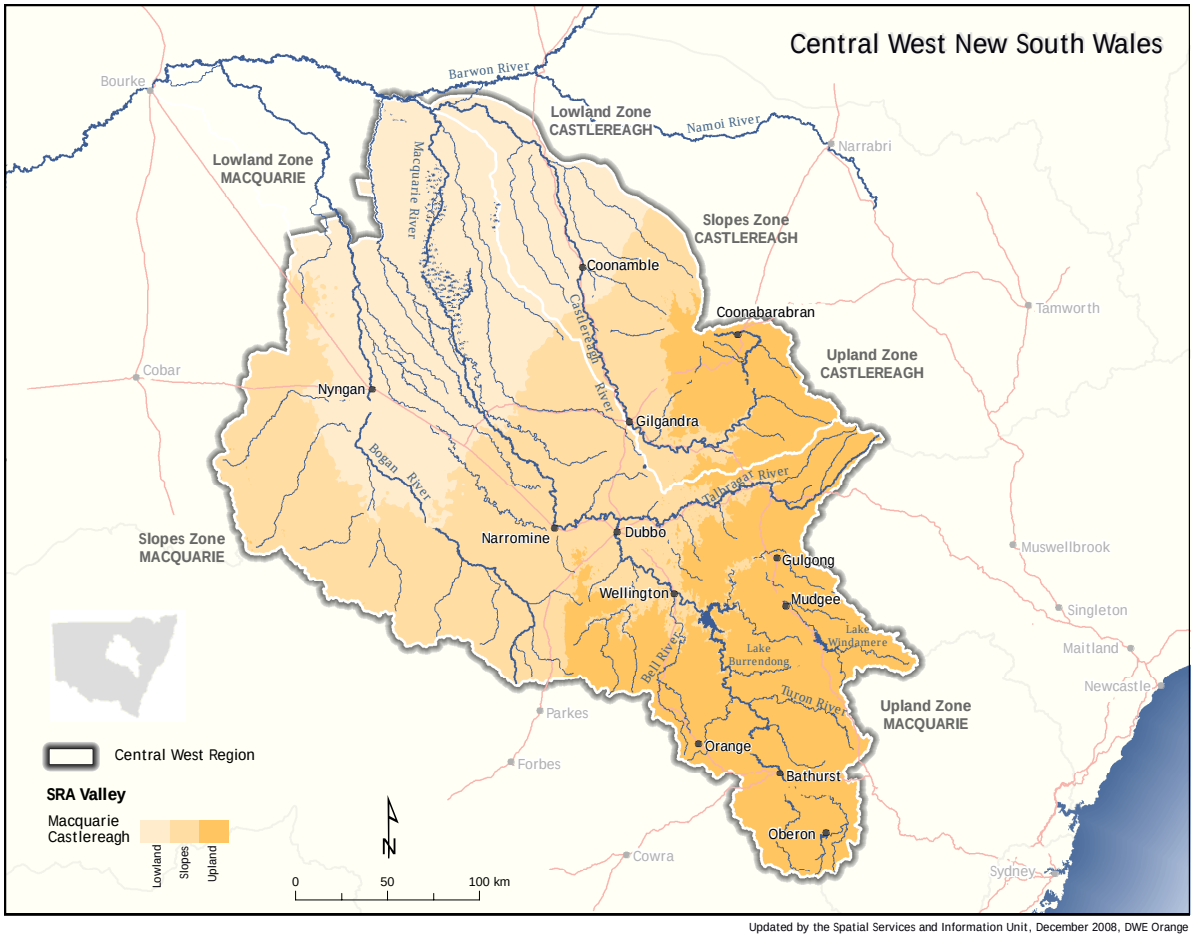


Figure 1 The Central West region

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 for the Central West CMA boundary, combining the Castlereagh River and Macquarie River catchments. The overall condition for the 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.

Condition

Water quality

Condition was determined for the following indicators of water quality in the Central West 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 2007–2008. 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: firstly, the completeness of records over the three-year period of sampling and secondly, 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 Central West 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 for EC ranges from 1967 through to 2008; for temperature from 1970 to 2007 for one site and early to mid 1970s to early to mid 2000s for remaining sites; and for turbidity from 1976 to 2008.

The NSW discrete water quality data archive (Triton database managed by NSW Office of Water [NOW]) was evaluated using a long-term trend analysis (30–35 years), providing a preliminary understanding of the behaviour of EC, water 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 the trend results, 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 Macquarie River catchment, with one exception (Figure 2). The percentage of samples that exceeded turbidity guidelines was generally low to very low at all sites, with two exceptions (Figure 2). There was no recent water quality data for the Castlereagh River to allow any assessment of water quality condition.

Data confidence	Commentary
TP – medium	For TP, sites generally have eight samples collected during the sample period. Confidence in the degree of representativeness of these data for the period of record is medium. The sampling period was less than one year.
Turbidity – medium	For turbidity, sites on average have 11 samples collected over the sample period. Several sites have less than 10 samples collected during the sample period. Confidence in the degree of representativeness of these data for the period of record is medium. The sampling period was less than one year.

Water quality trend

Substantial gaps in the water quality data record meant that two-thirds of the trend results could not be reported. No trend results could be given for water temperature. Many sites showed an episodic increase in electrical conductivity between the late 1990s and 2002; however, the analysis only warranted the classification of two sites with a rising trend. Turbidity results were the least reliable; however, four sites had sufficient data to detect a rising trend in turbidity (Figure 3).

Data confidence	Commentary
EC – low Temperature – low Turbidity – low	Data confidence at all sites and for all parameters was diminished for a number of reasons. There were large data gaps throughout, particularly for temperature. Sampling times were not always recorded and were estimated for part of all of the records (12 noon was used as the default to match up with hourly instantaneous flow). In some cases, hourly instantaneous flow (ML/d) was unavailable so mean daily flow (ML/d) was used as the flow default. Sampling frequency was highly variable throughout all records. There were periods where the frequency was very low. Having more than one data source for each parameter made the data difficult and confusing to interpret. In some cases temperature readings were recorded to the nearest degree Celsius throughout the temperature records, which raised concerns regarding data precision. All sites had a period of record where the data source was listed as unknown or not recorded and the data quality was listed as unknown. The Macquarie River at Warren Weir, Macquarie River at Bruinbun, Macquarie River downstream of Burrendong Dam and Talbragar River at Elong Elong had a data gap from 2002 to 2007 in the turbidity record; however, the rising trend was still significant.

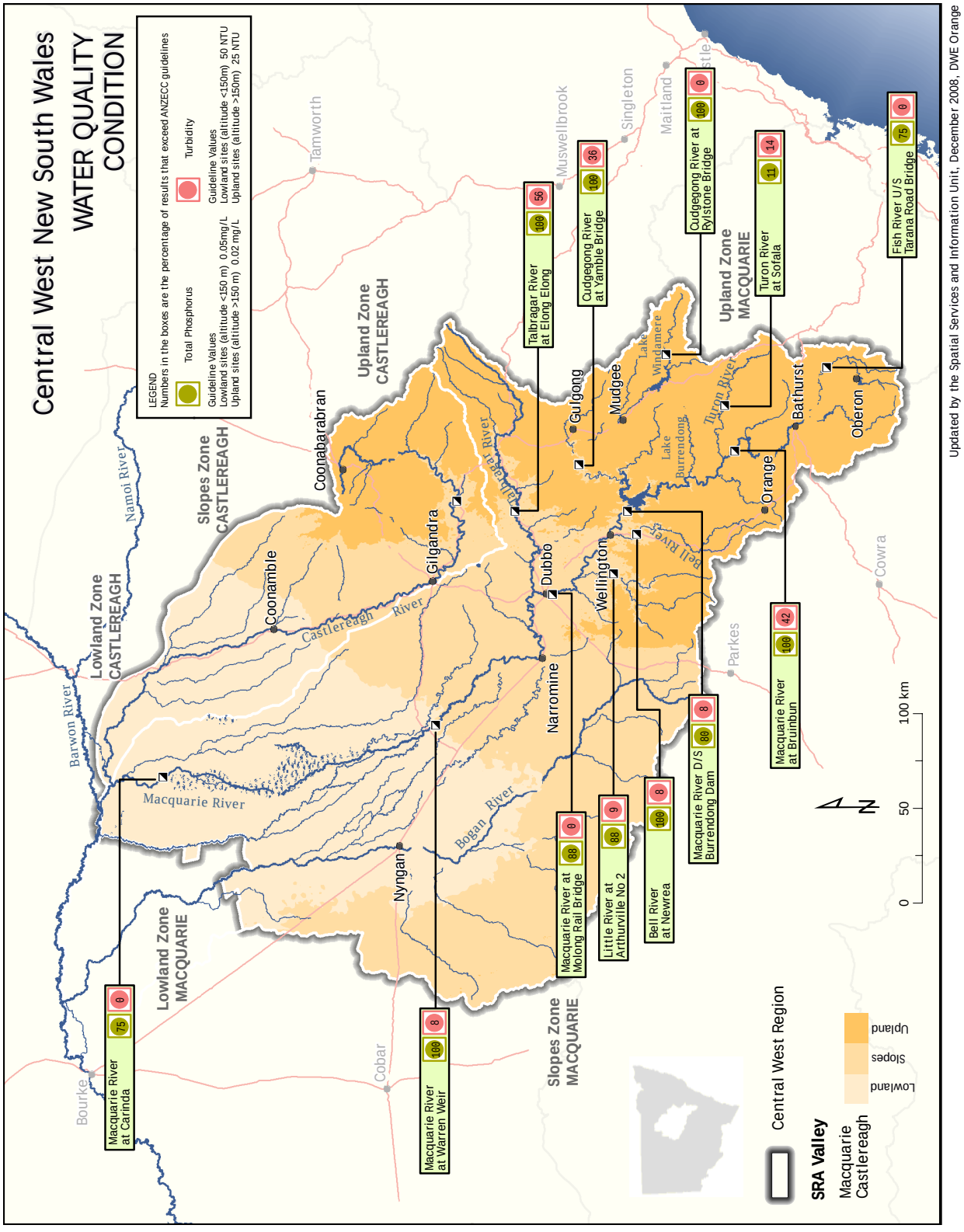


Figure 2 **Water qualifty condition across the Central West region**

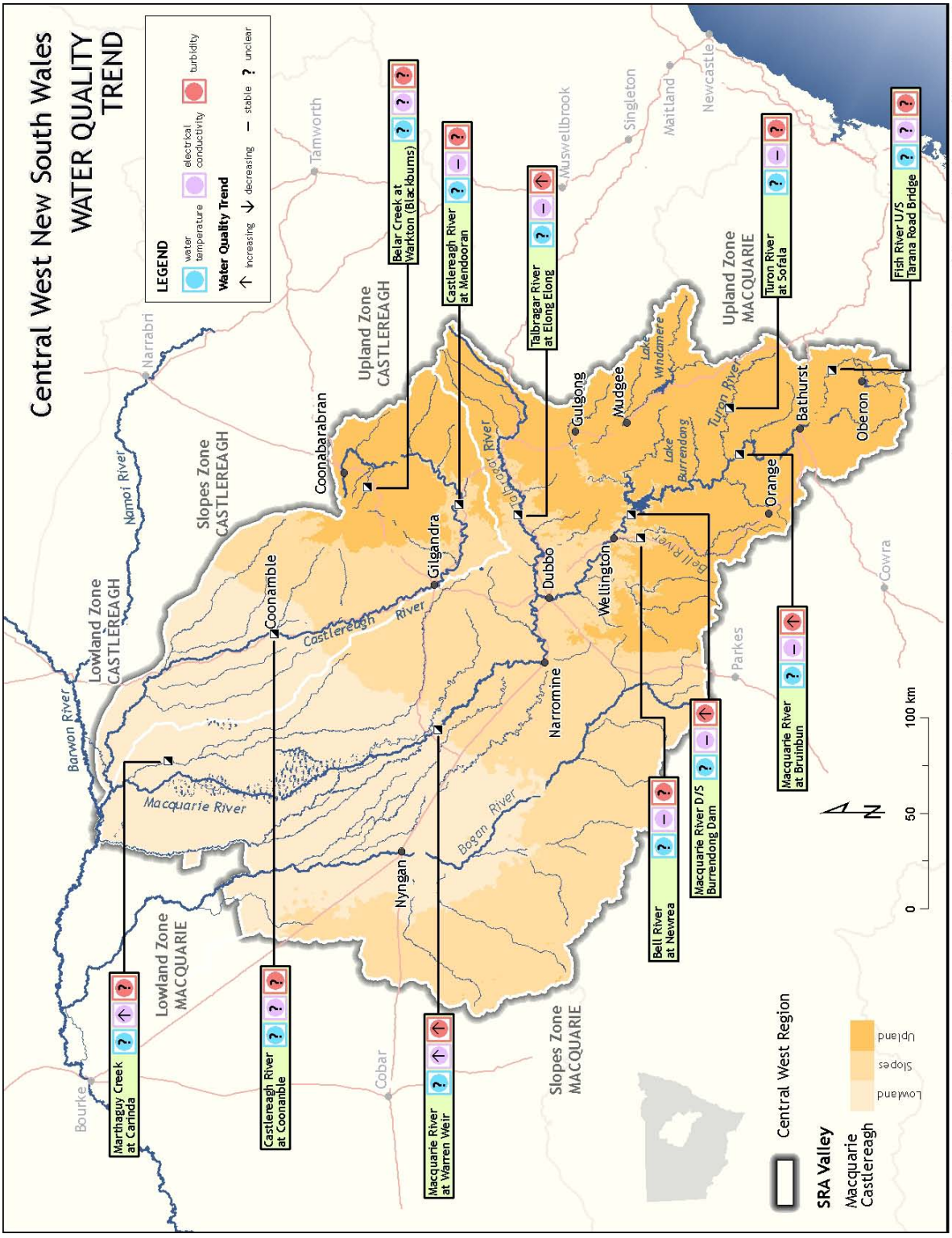


Figure 3 Water quality trend across the Central West region

NOTE: For EC, sites at Castlereagh River at Mendooran and Macquarie River downstream of Burrendong Dam have an historically stable trend with an episodic increase between the late 1990s and 2002, which is when the sampling record ends. The Macquarie River at Bruinbin and Talbragar River at Elong Elong show a similar trend until 2002, with sampling in 2008 indicating a possible return to lower levels of EC. Marthaguy Creek at Carinda had an historically rising trend with a similar episodic increase between the late 1990s and 2002.

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' (the proportion of 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 and the results presented in Davies et al (2008). There are several possible reasons for this:

- more data was available for this reporting than was used for SRA analysis and 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.

Data confidence	Commentary
Not assessed	Condition data derived from the Sustainable Rivers Audit (see www.mdbc.gov.au/SRA/river_health_check_-_sra_report_one).

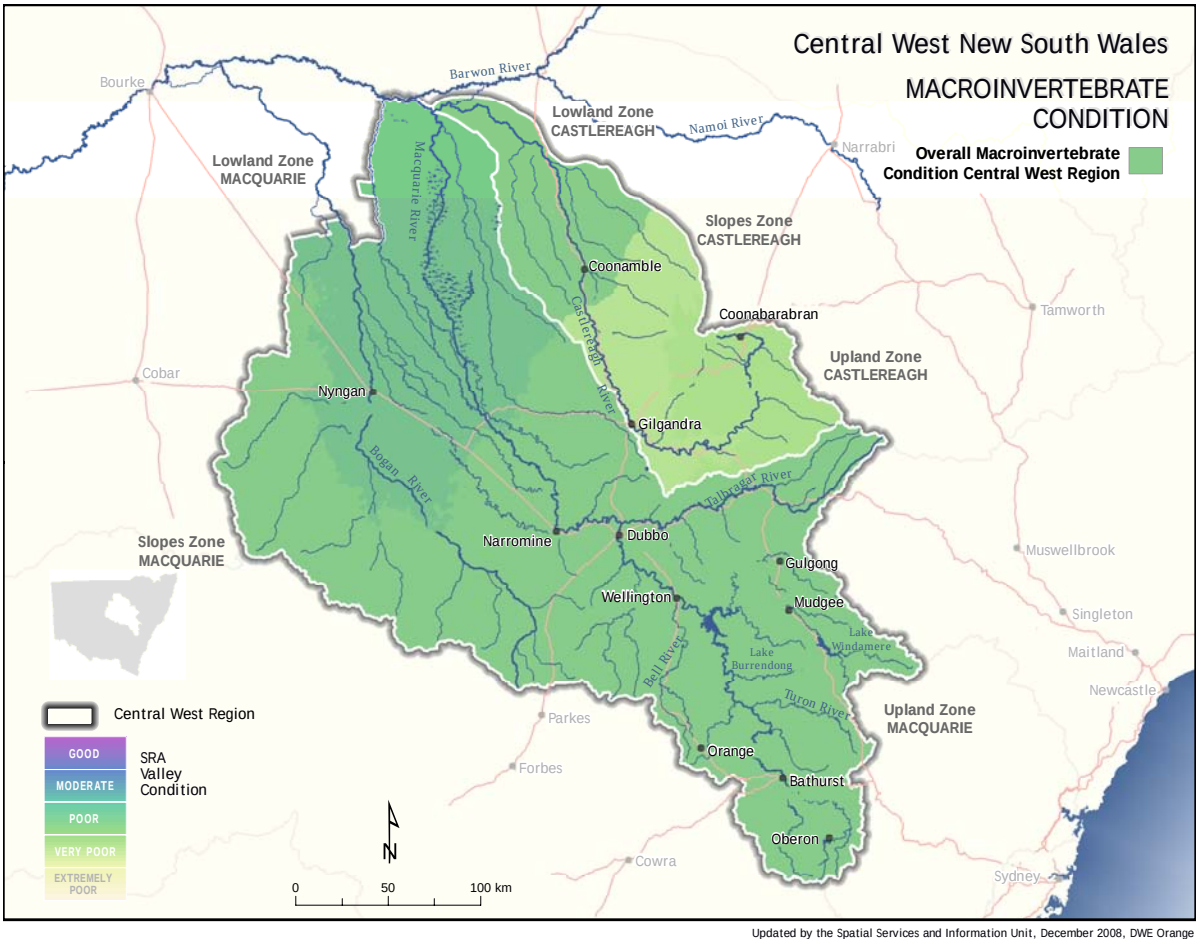


Figure 4 Macroinvertebrate condition across the Central West region

Fish condition

The overall fish condition was very poor (Figure 5), with both nativeness (the proportion of the fish assemblage that is native versus introduced fish) 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. Of the individual catchment zones, the Bogan River lowlands was in poor condition, the Macquarie River lowlands, slopes and uplands were in very poor condition and the Bogan slopes, Macquarie highlands and all zones in the Castlereagh catchment were in extremely poor condition. Nativeness was poor in the Macquarie slopes and Bogan lowlands, very poor on the Bogan and Castlereagh slopes and in the Macquarie and Castlereagh uplands and Macquarie highlands, and extremely poor in the Macquarie and Castlereagh lowlands. Expectedness was poor in the Bogan River lowlands, very poor in the Macquarie lowland, slopes and upland zones and extremely poor in all other catchment zones.

Data confidence	Commentary
Medium	All data was collected within the three-year period between 1 January 2006 and 31 December 2008. Data confidence is medium within individual catchments, catchment zones and across the region overall due to moderate variability in fish condition across sites.

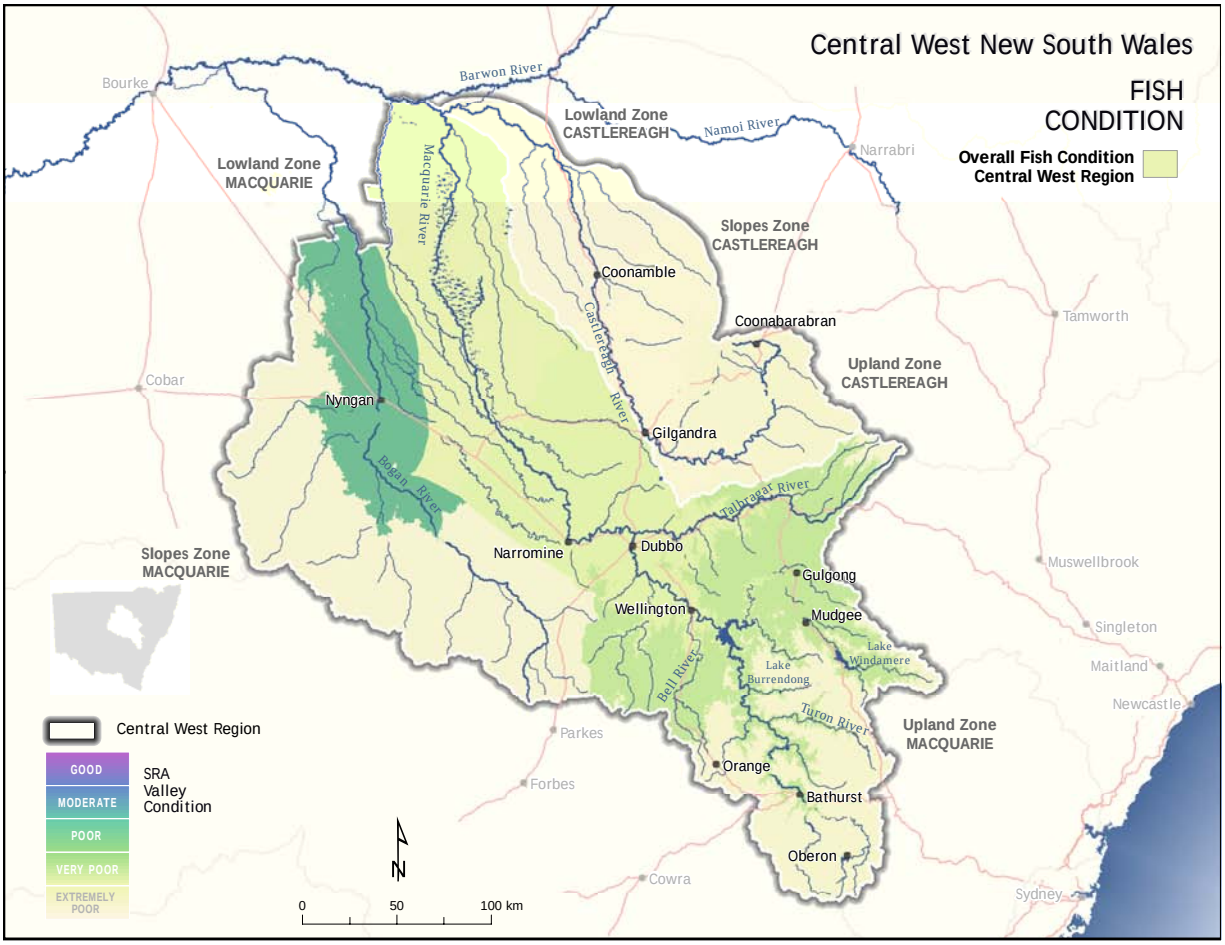


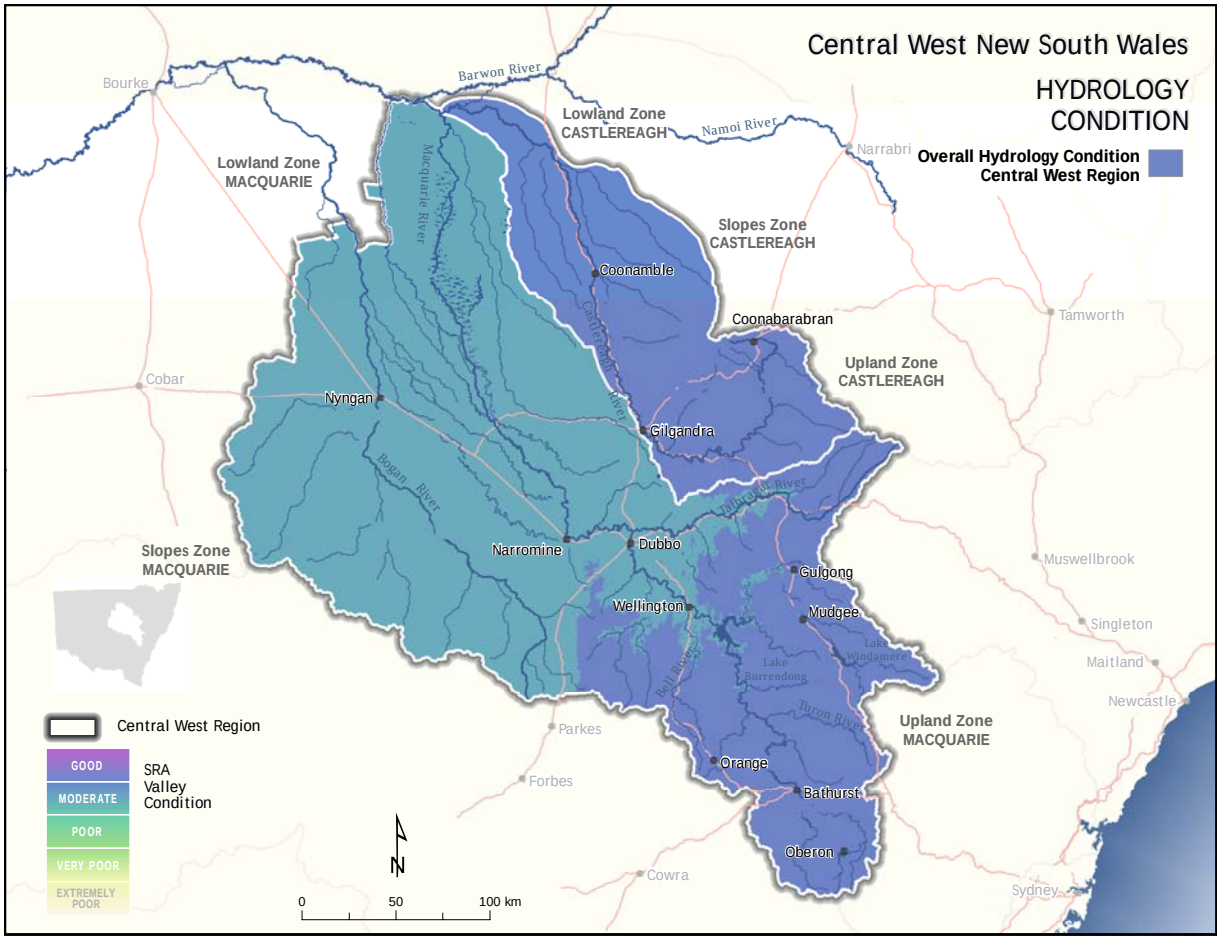
Figure 5 Fish condition across the Central West region

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 Macquarie Valley was in moderate to good hydrological condition overall (Lowland, Slopes Zones: moderate; Upland Zone: good). Slopes and Upland Zone sites showed moderate differences from reference to near reference condition. High flows and annual flows for the Macquarie at Carinda had decreased by 25% and 40%, respectively, relative to reference condition, indicating substantial changes to the hydrology of the Macquarie Marshes', (MDBC 2008).

> 'The Castlereagh Valley was in good hydrological condition, with hydrology index scores (HI) for the three sites all equal to 100. All sites were in near reference condition, across all indicators. Data were available for only three sites, and the furthest downstream, at Coonamble, is over 100 km from the end of the valley and upstream of several tributary inflows. Assuming little or no modification to flow downstream of Coonamble, or in tributaries below that point, the flow regime appears little modified from natural conditions', (MDBC 2008).



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

Figure 6 Hydrologic condition across the Central West region

Hydrology condition

Data confidence	Commentary
Altitude zone condition – medium	Condition data derived from the Sustainable Rivers Audit (see www.mdbc.gov.au/SRA/river_health_check_-_sra_report_one).
Overall region condition – medium	Condition data interpreted from the Sustainable Rivers Audit combining the conditions of the Castlereagh and Macquarie SRA Valleys.

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
Bogan	Lowlands	62
	Slopes	27
Castlereagh	Lowlands	11
	Slopes	22
	Uplands	31
Macquarie	Lowlands	15
	Slopes	42
	Uplands	29
	Highlands	31

Water management

Alteration of natural temperature patterns

The temperature of water within aquatic environments, such as rivers, affects natural ecological processes. Water storages (dams) have the potential to release water that can be unseasonably cold during the warmer months. The change in water temperature in the river system downstream of a dam is referred to as cold water pollution (CWP) (Preece 2004). The table below shows storages that are likely to be associated with CWP, their priority and to what extent downstream effects (>5ºC peak depression) will be detected (where available) (Preece 2004). It should be noted that the known extent downstream is still uncertain and further monitoring will improve those temperature profiles.

Dam	Priority	Extent downstream	Impacted river
Burrendong	High	400 km	Macquarie
Windamere	Medium	Not available	Cudgegong

Burrendong Dam on the Macquarie River provides a regulated supply of water for irrigation, primarily for cotton. Thermal stratification of the storage occurs from spring to autumn and water releases reduce the water temperature downstream of the storage (Preece 2004).

Windamere Dam is located on the Cudgegong River and is affected by CWP due to bulk water transfers downstream to Burrendong Dam resulting in a localised effect.

Oberon Dam on the Fish River was not assessed at the time by Preece (2004) due to its very low environmental releases. It will, however, need to be assessed for CWP effects when a water sharing plan (WSP) is developed for the water source, and environmental flow releases are implemented.

The NSW Government is working with dam owners, community groups and environmental scientists to identify the areas most seriously affected, and to find methods to mitigate or prevent cold water pollution. NOW, in partnership with other key agencies, is implementing a strategy to control cold water pollution from dams identified for priority action in NSW.

Artificial barriers to fish passage

Many fish species migrate up and down rivers to breed or to find alternate 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	Marebone Weir	Macquarie River	100
2	Gin Gin Weir	Macquarie River	95
3	Narromine Weir	Macquarie River	120
4	Warren Shire Council Weir	Macquarie River	102
5	Dubbo City Council Weir	Macquarie River	135
6	Dubbo State Water Weir	Macquarie Weir	3
7	Wellington Erosion Control Weirs	Bell River	143

Marebone Weir has undertaken a concept design for a fishway and is going to detailed design.

Narromine Weir is currently undergoing a scoping plan for a fishway and will eventually go to concept design.

The concept design for a vertical slot fishway for Dubbo City Council Weir has been completed.

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 in-stream channels

- Decline in natural replenishment of in-stream wood.

Introduction of pest species

- Aquatic and riparian weeds.

Water management

- Alteration of natural flow patterns.

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 address each of the state-wide targets at the regional level. The Central West CAP can be found at www.cw.cma.nsw.gov.au.

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 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 environment through 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 The 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:

- progress 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
- maintain water quality that is 'fit-for-purpose' through the NSW Diffuse Source Water Pollution Strategy, stormwater management and regulation of point source pollution
- effectively implement the monitoring, evaluation and reporting strategy
- provide a framework for councils to develop stormwater management objectives
- decision support tools and information to land managers
- develop regional water quality guidelines
- undertake ongoing water quality monitoring at strategic locations to assess the long-term trends and changes in condition.

Some of the specific NSW Government actions to address the target in the Central West region include the NSW RiverBank, the Rivers Environmental Restoration Program and the Wetland Recovery program, which have purchased 21,900 ML of entitlements in the Macquarie valley to be used to enhance wetland and river health
(see www.environment.nsw.gov.au/environmentalwater/index.htm).

Multiple condition/pressure actions

The Department of Planning (DOP) advocates that the planning system, in conjunction with relevant agencies and local government, has an important role in natural resource management (NRM) and protection of environmental values.

The planning process creates a strategic framework to identify, assess and prioritise land-uses and, to assist in the strategic investment for the revitalisation/management of natural resource values. These reflect two streams in the integration of NRM and environmental protection – a 'strategic planning stream' and an 'investment stream'. These connections occur at a regional and local level and are important in the delivery of regional strategies (prepared by DOP) and local growth management strategies, local environmental plans (LEPs) and state of the environment reports

prepared by local councils.

The DOP state level measures that may enhance riverine condition include state environmental planning policies (SEPPs) (eg Rural Lands SEPP).

DOP also provides a regional context for planning through the development of regional growth strategies to guide sustainable growth and protect valuable natural and cultural assets. The development of regional strategies is undertaken with the involvement of the CMAs.

Regional level

At the regional level the Central West CMA is undertaking the following activities in relation to the riverine ecosystems theme:

Multiple condition/pressure actions

- Consulting with the community
- Supporting other groups and individuals performing NRM activities
- Encouraging native riparian vegetation buffer strips along streams.

Aquatic biota

- Managing aquatic pest and weed species.

Water quality

- Managing active gully systems to also improve water quality and aquatic habitat values
- Improving the stability of stream beds and banks to reduce sedimentation, turbidity and nutrient loads – leading to improved water quality and habitat values
- Influencing programs to increase water use efficiency, and reduce extraction from and pollution of the Central West riverine ecosystems
- Monitoring activities that include water quality and riparian projects.

A number of other groups are undertaking significant work to address pressures in the region that are contributing to better outcomes for riverine ecosystems including:

- landholders/primary producers within the Central West region
- Streamwatch
- Aboriginal communities
- community groups (including Landcare)
- local councils and urban communities
- NSW and Commonwealth Government agencies.

Local level

DOP also provides for local planning measures and activities to address a number of pressures including:

- working with DECCW, NOW and the I&I in developing standard NRM clauses for councils to incorporate into their new LEPs as part of the NSW Government's planning reform initiative

- preparing a practice note to provide guidance to councils on the environmental protection zones in the standard LEP instrument and how they should be applied in the preparation of LEPs. DOP is working on similar guidance for waterways and riparian corridors
- working with local councils as they develop their local strategic plans.

Further reading

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