State of the catchments 2010

Riverine ecosystems

Murray region

State Plan target

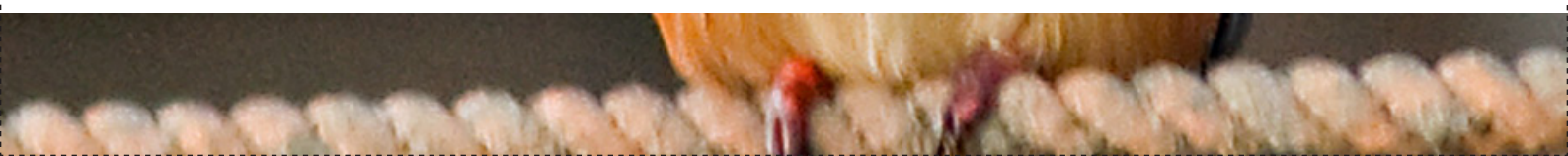
By 2015 there is an improvement in the condition of riverine ecosystems.

Background

The New South Wales Murray region is bounded by the Murray River to the south, the Murrumbidgee River catchment divide to the north and the Australian Alps to the east, spanning an area of 35,170 km^2 (Figure 1). The Murray River rises in the Australian Alps at 1430 m above sea level. The catchment above the Hume Dam reservoir is the major source of water for the Murray River and in an 'average year' can contribute 37 per cent of the total inflow into the Murray River. The total length of the Murray River is 2530 km, of which 1880 km creates the border between NSW and Victoria, before flowing to the river mouth in South Australia. The natural flow regime is characterised by high winter/spring flows and low summer/autumn flows resulting from runoff derived from its alpine head waters and associated tributaries. Forty-five creeks and rivers flow into the Murray River. The five longest tributaries are the Mitta Mitta River, Kiewa River, Tooma River, Black Dog Creek and Swampy Plain River. The Edwards and Wakool rivers are two major rivers that bifurcate from the main river and join the Murray River further downstream.

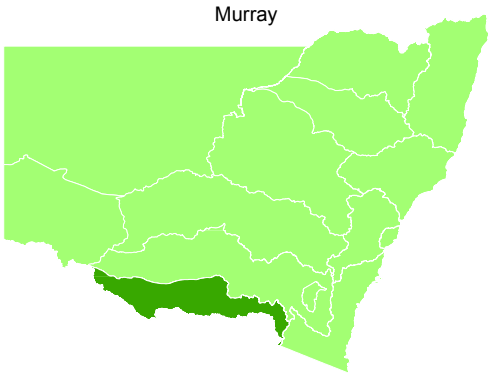
A detailed technical report describes the methods used to derive the information contained in this report. At the time of publication of the *State of the catchments (SOC) 2010* reports, the technical reports were being prepared for public release. When complete, they will be available on the NOW website: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



The Murray River flows through Hume Dam and encounters a number of regulatory structures in the Murray region. The process of river regulation has led to major alterations to the flow regime of the Murray River. Artificially high flow regimes and the historical removal of natural instream structures have resulted in stream bank instability and a significantly changed instream habitat and associated floodplain.

Map of the catchment



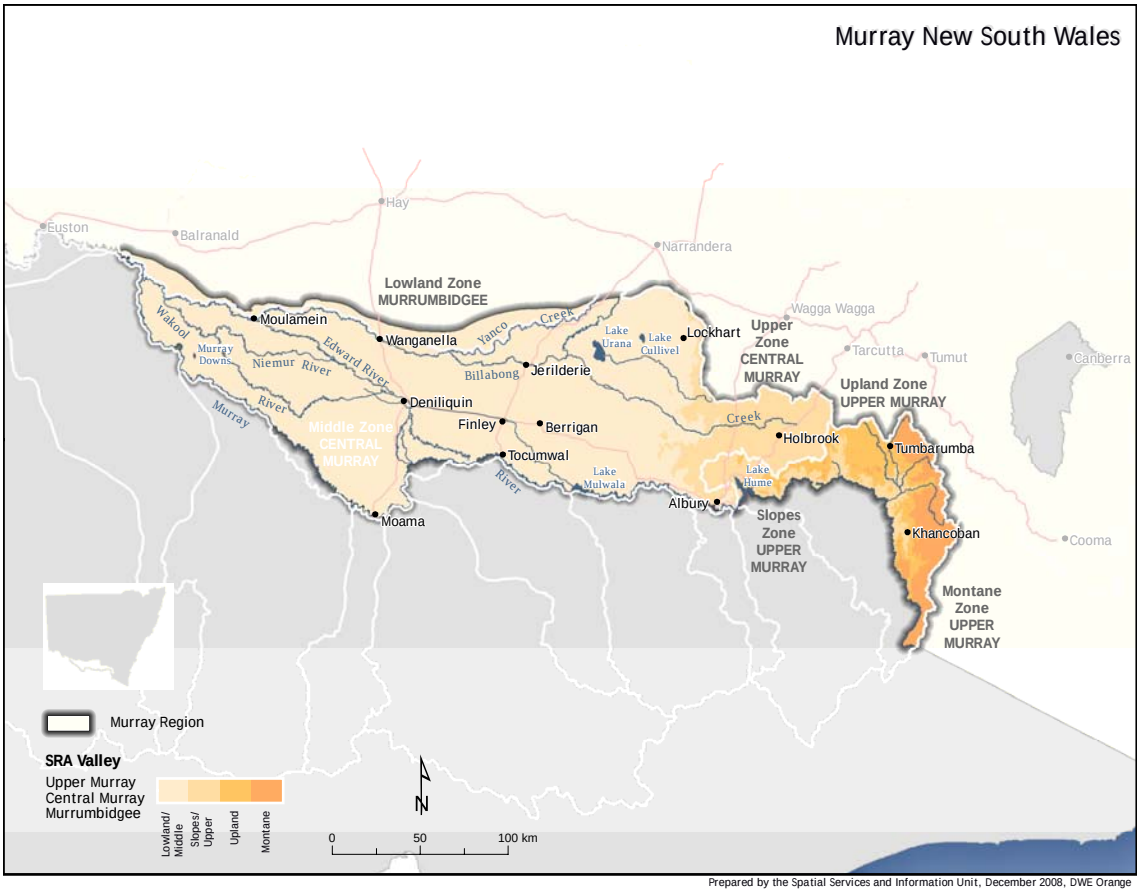


Figure 1 The Murray River region

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 Murray Catchment Management Authority (CMA) boundary, incorporating parts of the Upper Murray, Central Murray and Murrumbidgee SRA Valleys, as labelled on the maps. 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 the 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 Murray 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 Murray 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 1966 through to 2008; for temperature from 1969 to 2008; and for turbidity from 1974 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 generally low to very low across the whole catchment, except for a couple of sites where percentage exceedances were high to very high (Figure 2). The percentage of samples that exceeded turbidity guidelines was generally low across the whole region, with the exception of a couple of sites that had a moderate percentage of exceedances.

Data confidence	Commentary
TP – medium	For TP, sites generally have on average 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 at some sites.
Turbidity – high	For turbidity, sites generally have over 100 samples collected during the sample period. Confidence in the degree of representativeness of these data for the period of record is high. Data was given a high confidence rating when it satisfied – or nearly satisfied – the ideal situation of sampling period and sampling intervals of three years and once a month, respectively.

Water quality trend

Almost half the results showed stable trends in water quality (Figure 3). One site had a falling trend in surface water temperature, located in the lower catchment. A few sites in the lower region showed a decreasing trend in EC over the last decade; it will be interesting to see how these levels respond during wetter conditions in the future due to climate change. A couple of sites had a rising trend in EC in the slopes region. Turbidity results were the least reliable; however, several sites across the region had rising trends.

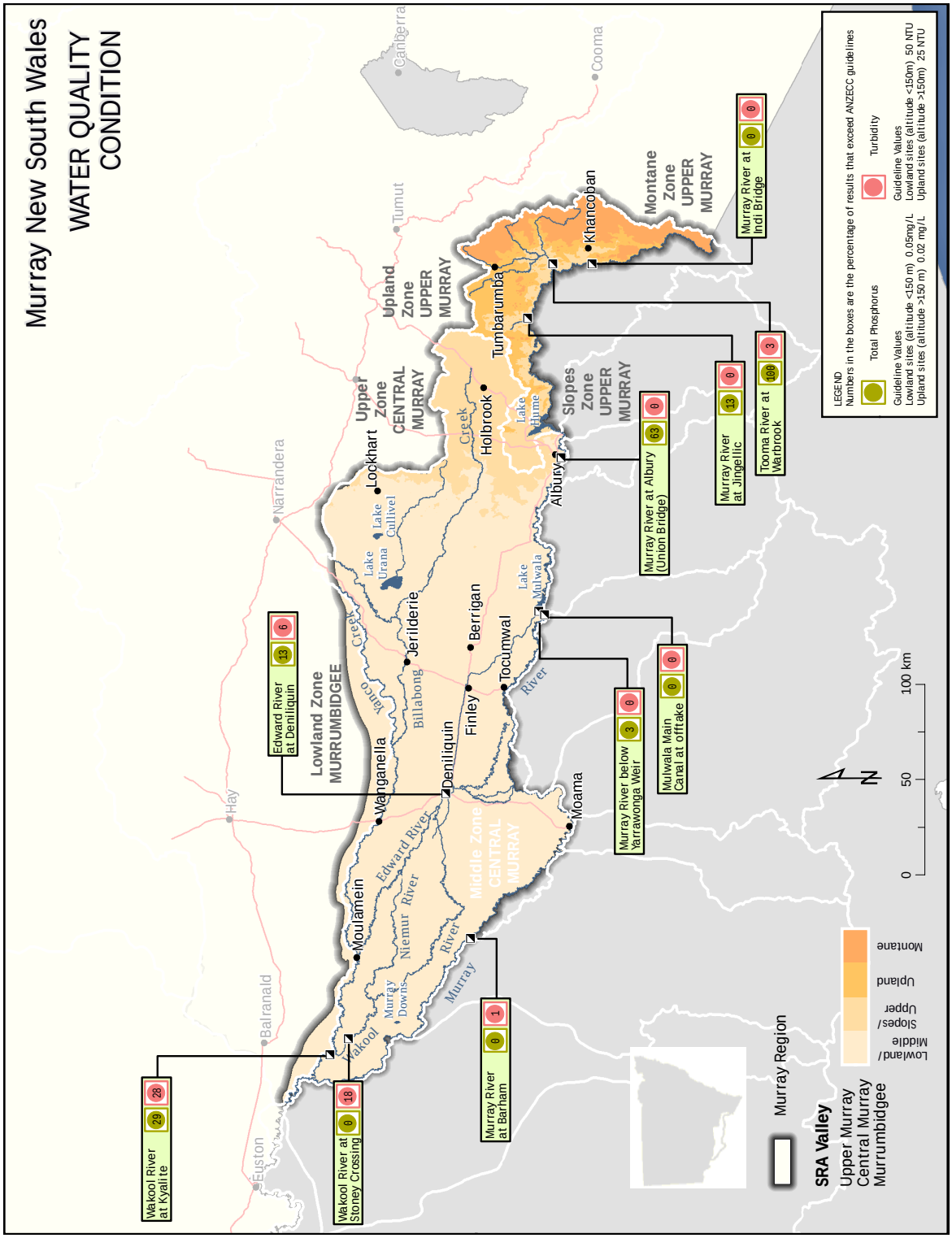


Figure 2 Water quality condition across the Murray region

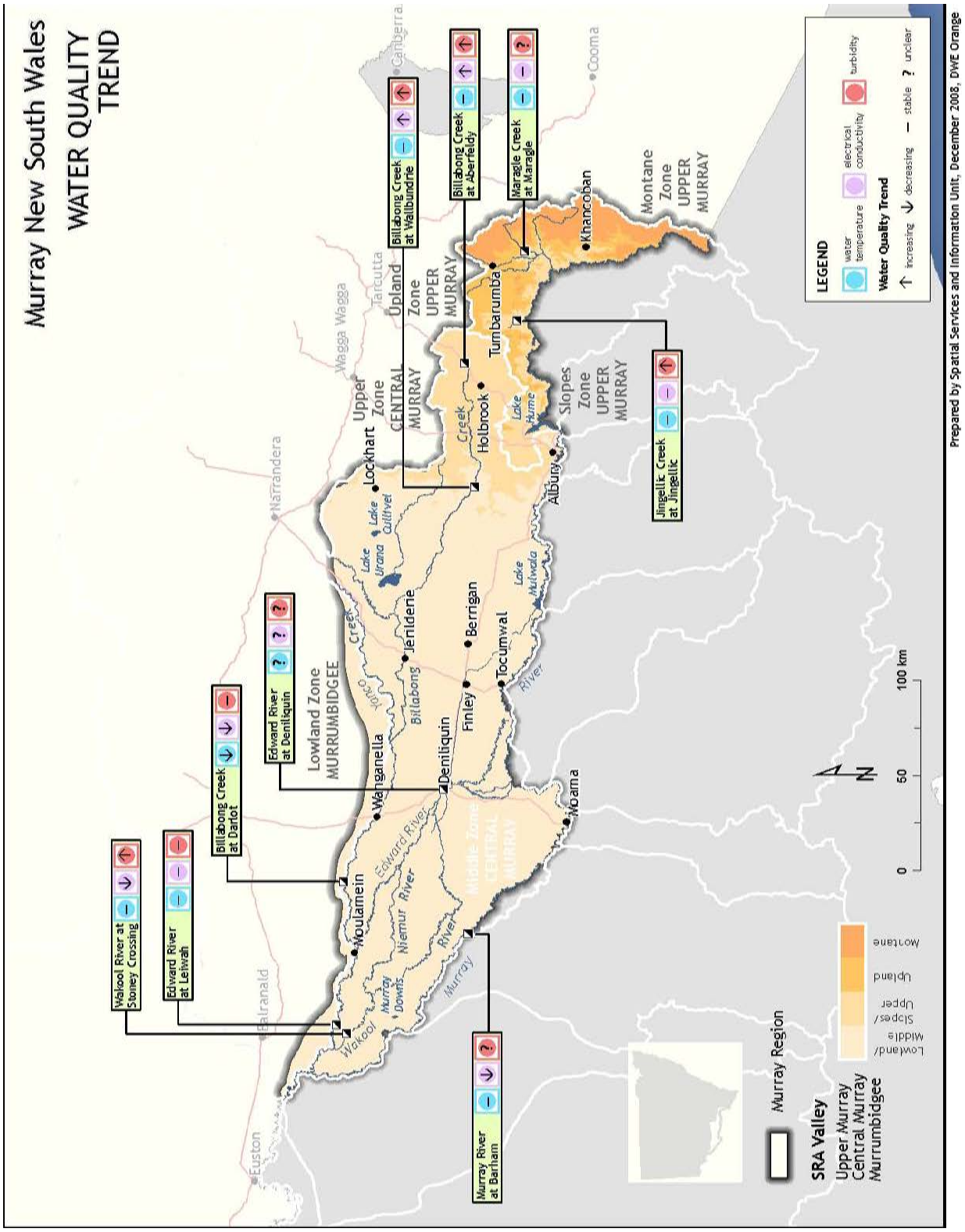


Figure 3 Water quality trend across the Murray River region

NOTE: For EC, Edward River at Leiwah has a historically stable trend with a recent episodic decrease, possibly due to drought conditions.

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. 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. For sites at Billabong Creek at Aberfeldy and Jingellic Creek at Jingellic, there was a data gap in the middle of the turbidity record; however, the rising trend was still significant.

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 reference condition) and 'nativeness' (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:

- 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.

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).

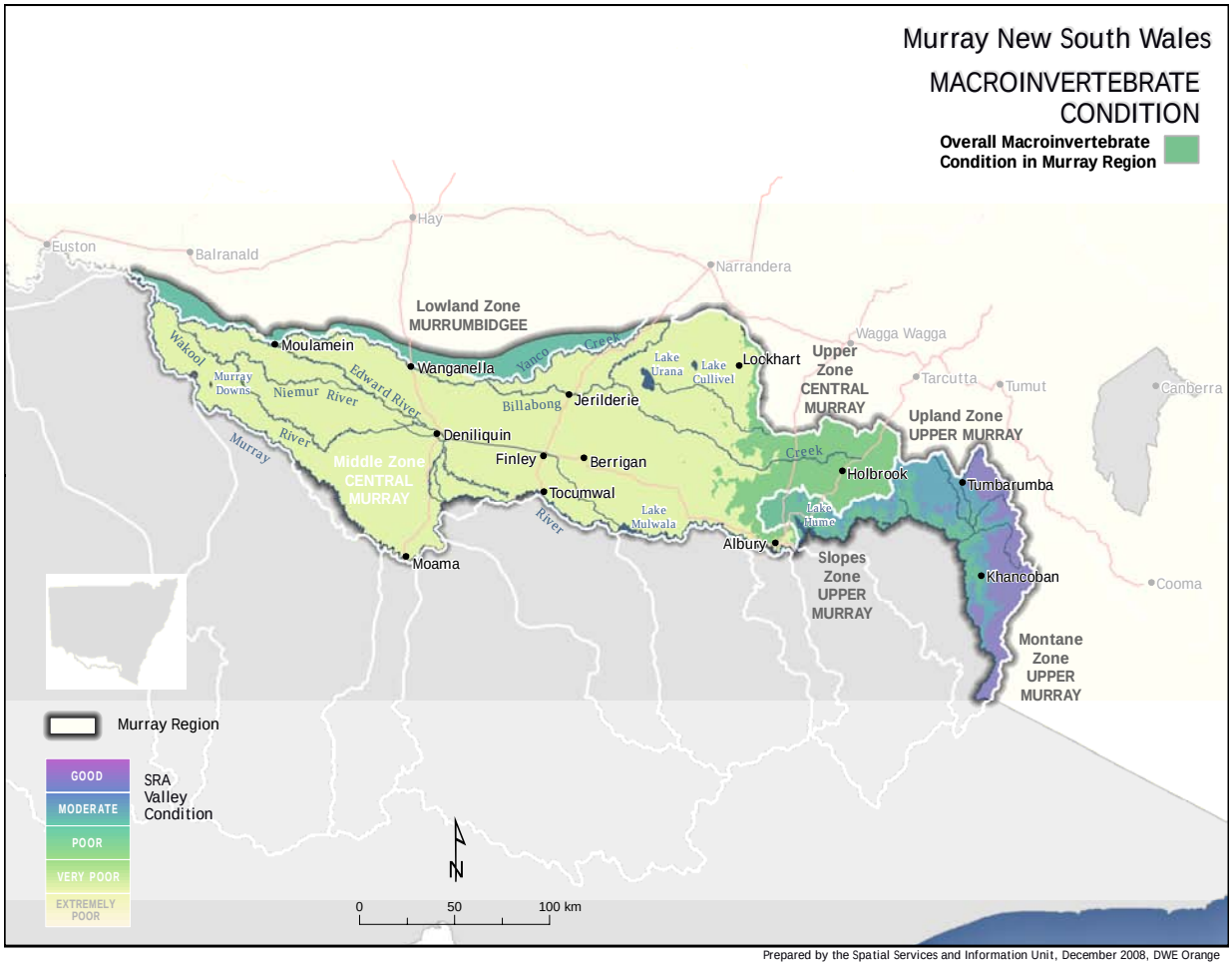


Figure 4 Macroinvertebrate condition across the Murray region

Fish condition

The overall fish condition was very poor (Figure 5), 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. Most individual catchment zones were in poor condition, except for the upper Murray upland zone, which was very poor, and the central Murray slopes zone and the upper Murray highlands zone, which were in extremely poor condition. Nativeness was poor in the lowlands zones and slopes zone of the upper Murray catchment, very poor in the upper Murray uplands and extremely poor in the central Murray slopes and upper Murray highlands. Expectedness was poor in the central Murray lowlands, very poor in the slopes and upland zones of

the upper Murray and in the Central Murray anabranch system, and extremely poor in the highland and central Murray slopes zones.

Data confidence	Commentary
Low to medium	All data was collected within the three-year period between 1 January 2006 and 31 December 2008. Data confidence ranged from low in the highlands and slopes zones, due to substantial inter-site variability within these zones, to medium in the lowland and upland zones, where inter-site variability was only moderate. Across the entire region, data confidence in the fish condition rating was medium due to the moderate variability across sites within the catchment.

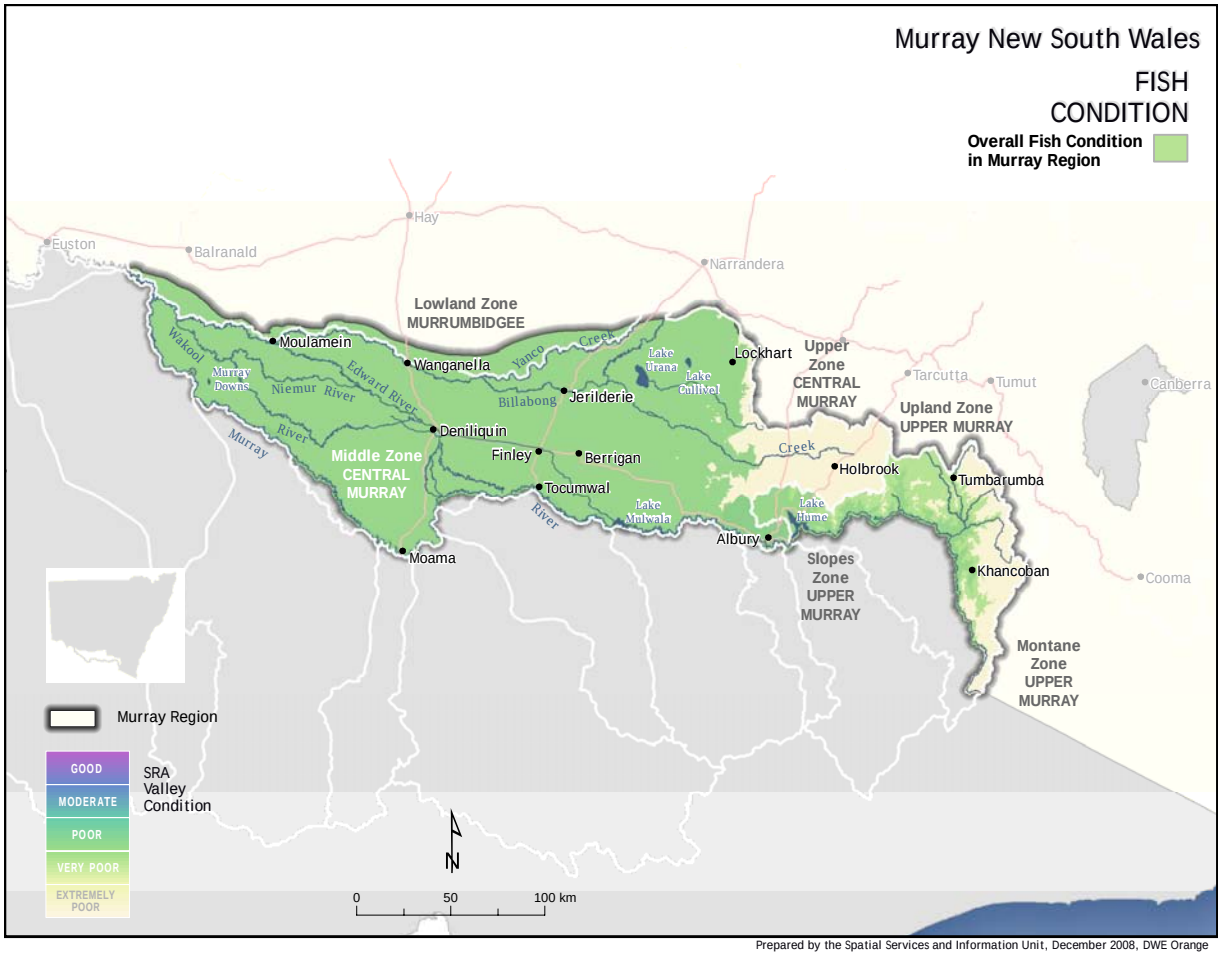


Figure 5 **Fish condition across the Murray River region**

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 Lower Murray Valley was in poor hydrological condition throughout (all Zones: poor). Overall, the flow regime has experienced substantial reductions in magnitudes of mean and median annual flows and high flows, substantial changes in variability and moderate changes in seasonality' (MDBC 2008).

'The Central Murray Valley was in moderate hydrological condition throughout' (MDBC 2008).

'The Upper Murray Valley was in moderate to good hydrological condition (Slopes Zone: moderate to good; Upland and Montane Zones: good). Overall, the flow regime showed substantial changes in volumes, variability and the magnitudes of high and low flows in the Swampy Plain River and the Murray downstream of Khancoban Pondage, but elsewhere little difference from reference condition' (MDBC 2008).

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 Upper Murray, Central Murray and Murrumbidgee SRA Valleys.

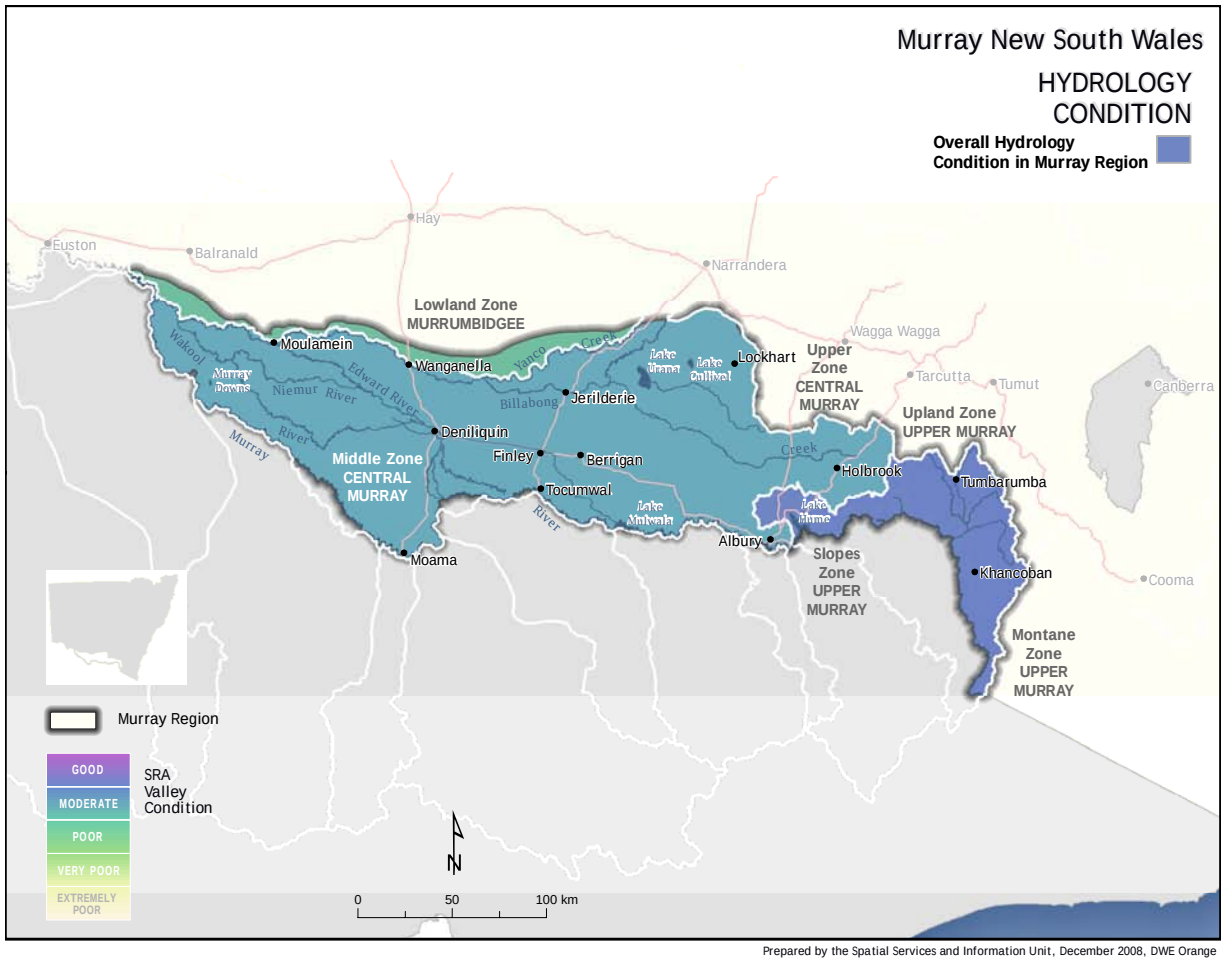


Figure 6 Hydrologic condition across the Murray River region

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 (see 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 Central Murray	Lowlands	47
Upper Central Murray	Lowlands	52
	Slopes	0
	Slopes	46
	Uplands	33
	Highlands	15

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
Hume	High	300 km	Murray
Khancoban	High	120 km	Swampy Plains

The Hume Dam on the Murray River provides regulated water for urban use, irrigation and hydro-electric power generation. While temperature differences are less severe than for other high priority dams, the Hume Dam has an extremely large summer discharge, warranting the high score (Preece 2004).

Khancoban Dam on the Swampy Plains River is a re-regulation dam with a primary role to collect water from the Murray 2 Power Station for release into Swampy Plain River at uniform discharge. A shallow storage, short retention times and various water sources lead to cooling of the river downstream of the dam (Preece 2004).

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 CWP. NOW, in partnership with other key agencies, is implementing a strategy to control CWP from dams identified for priority action in NSW.

Artificial barriers to fish passage

Many fish species migrate up and down rivers to breed or 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	Stevens Weir	Edward River	3803
2	Edward River Offtake Regulator	Edward River	901
3	Gulpa Creek Regulator	Gulpa Creek	159
4	Windouran Dam	Billabong Creek	103
5	Carooboon Dam	Billabong Creek	111
6	Hartwood Weir	Billabong Creek	44
7	Chinamans Dam	Billabong Creek	41
8	Traceys Dam	Billabong Creek	22.6
9	Jerilderie Town Weir	Billabong Creek	71
10	Algudgerie Weir	Billabong Creek	39
11	Wakool Regulator	Wakool River	62
12	Yallakool Creek Regulator	Yallakool Creek	491
13	Colligen Creek Regulator	Colligen Creek	157
14	Boonoke Homestead Weir	Billabong Creek	37

15	Wanganella Town Weir	Billabong Creek	70
16	Piccaninni Dam	Billabong Creek	16.6
17	Hartwood Homestead Weir	Billabong Creek	18
18	Lower Woolshed Dam	Billabong Creek	23
19	Ole Coree Weir	Billabong Creek	25
20	Widgee Weir	Wakool River	50
21	Road Paddock Dam	Billabong Creek	14

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 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 Murray CAP can be found at www.murray.cma.nsw.gov.au/includes/documents/pdf/Vol_1_CAP.pdf.

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 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 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
- provide 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 Murray region include the WSPs discussed earlier, and The Living Murray Initiative, which is aiming to recover 500 GL of environmental water for six icon sites on the Murray River by June 2009. NSW has committed to recover 249 GL (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

During the period from July 2006 to June 2008, the Murray CMA has undertaken the following activities at the regional level in relation to the riverine ecosystems theme:

Multiple condition/pressure actions

- More than 5900 hectares (or 560 kilometres) of riparian zone revegetation and conservation management completed
- Tuppal Creek Management Plan completed
- Indi River Management Plan completed
- Environmental water management plan and riverine management plans developed.

Fish

- Removal of two fish barriers
- Murray Catchment Remediation of Obstructions to Fish Passage Plan.

At the regional level, DOP is undertaking a number of activities to address pressures including the

Murray Regional Environmental Plan No 2 – Riverine Land (1994), which established policies for protecting and managing the region's important riparian areas. These policies, as relevant, will be carried through into new LEPs.

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

- research by the Murray–Darling Freshwater Research Centre eg optimising response of fish to environmental watering
- Murray–Darling Basin Authority SRA monitoring work eg monitoring flows, macroinvertebrates and fish
- Murray riparian restoration work undertaken by NOW with Murray–Darling Basin Authority funding
- Murray Irrigation Limited's Jimmaringle Creek investigation
- Charles Sturt University's research in the Murray catchment, for example into the sources and severity of mortality during the early life stages of freshwater fish
- stormwater rubbish management by local governments
- Monash University's riparian restoration experiment project.

Local level

The DOP also provides for local planning measures and activities to address a number of pressures. These measures include:

- working with DECCW, NOW & 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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