State of the catchments 2010

Riverine ecosystems

Hunter–Central Rivers region

State Plan target

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

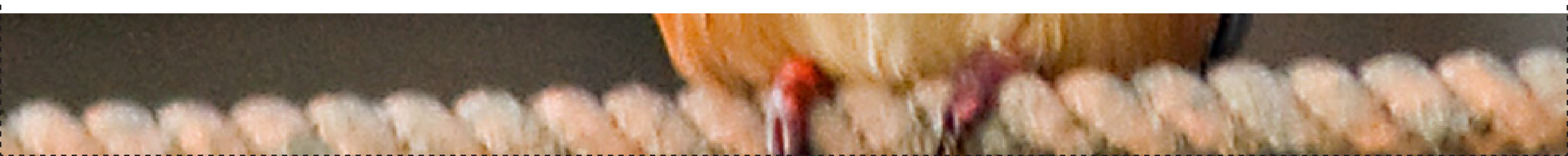
Background

The Hunter–Central Rivers region covers 37,000 km^2 of the east coast of New South Wales; from Taree in the north, to Gosford and the coastal waterways of the Central Coast in the south, and from Newcastle in the east to the Merriwa Plateau and Great Dividing Range in the west (Figure 1). The region's major waterways are the Manning, Karuah and Hunter rivers and the coastal waterways of Wallis Lake, Port Stephens, Lake Macquarie, Tuggerah Lake and Brisbane Water.

The Manning River flows over a length of 250 km and its tributaries rise immediately north of and within Barrington Tops at an altitude of 1400 to 1500 m above sea level. The major tributaries of the Manning catchment are the Barnard and Nowendoc rivers, rising in the northern part of the valley, and the Barrington and Gloucester rivers, rising in the southern highland areas. The Barrington and Gloucester rivers flow in a north-easterly direction and the Barnard River in an easterly direction through alluvial valleys before entering the Manning River. In the lower reaches, the river is tidal and is often saline to Abbotts Falls near Wingham.

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.

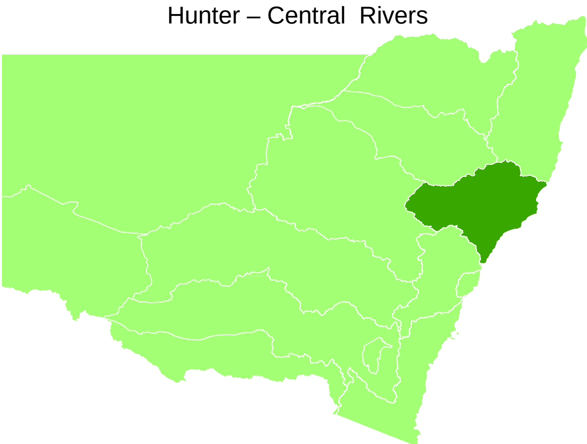
Note: All data on natural resource condition, pressures and management activity included in this SOC report, as well as the technical report, was collected up to January 2009.



The Karuah River–Great Lakes catchment is located below the Manning River catchment, with the Hunter River catchment in the south. The catchment is 4480 km^2 and has small rivers, including the Karuah River (100 km in length) which discharges into Port Stephens, and the Myall River (91 km in length), which discharges into the lower section of the Myall Lakes. The Karuah River rises in the lower slopes of Barrington Tops at 600 m above sea level and the Myall River rises at 350 m above sea level in the Kyle Range. Both small rivers flow in a parallel south-easterly direction, through narrow confined valleys onto the coastal floodplain.

The Hunter River valley covers an area of about 22,020 km^2 and extends further inland than any other coastal catchment in NSW. It is separated in the north-west by the Liverpool Ranges and in the west by the Great Dividing Range. The Hunter River rises in the Mount Royal Range at 205 m above sea level and is over 300 km in length. The major tributaries of the Hunter River include the Goulburn River, draining almost half the catchment in the south-west; the Paterson, Allyn and Williams rivers that drain higher rainfall valleys in the north-east, and Wollombi Brook, which drains the south-east of the catchment. Three major water storages built for irrigation and power generation water supply occur in the Hunter River catchment; these include Glenbawn Dam, through which the Hunter River flows, Glennies Creek Dam and Lostock Dam on the Paterson River.

Map of the catchment



Prepared by the Spatial Services Unit, March 2009, DWE Queanbeyan.

Figure 1 The Hunter–Central Rivers 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 is described for macroinvertebrates, fish and hydrology by using a five-point scale, a similar ranking process based on the Sustainable Rivers Audit (SRA) (Davies et al 2008). Trend information is provided for the water quality indicators: electrical conductivity, turbidity and temperature.

For the aquatic biota and hydrology indicators, different colour schemes are presented on the maps. A number of different methods were applied in the coastal regions, based either on a coastal adaptation of the SRA approach to condition assessment, or an interim approach where data or model availability did not allow an SRA style approach. Outcomes were not available for some areas. In all coastal regions, altitude zones could not be applied to macroinvertebrate modelling, as was done for the inland regions (ie SRA approach). For hydrologic condition mapping, where models were available, techniques based on the SRA approach were applied and the colour scheme on the map is similar to that used for inland regions (ie solid shading); for non-modelled catchments, hatching is used to indicate that a different method based on potential extraction pressures has been applied. The overall condition ratings have been applied based on whole of catchment, combinations of catchment management authority (CMA) areas, or major sub-region boundaries as applicable.

Condition

Water quality

Condition was determined for the following indicators of water quality in the Hunter–Central Rivers 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 coastal rivers, the lower limit of the guideline was adopted (ie 2 and 6 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 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 Hunter–Central Rivers 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 early 1970s through to 2006–07 for EC; from the 1970s through to 2005–07 for temperature; and 1975 through to 2007 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, 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.

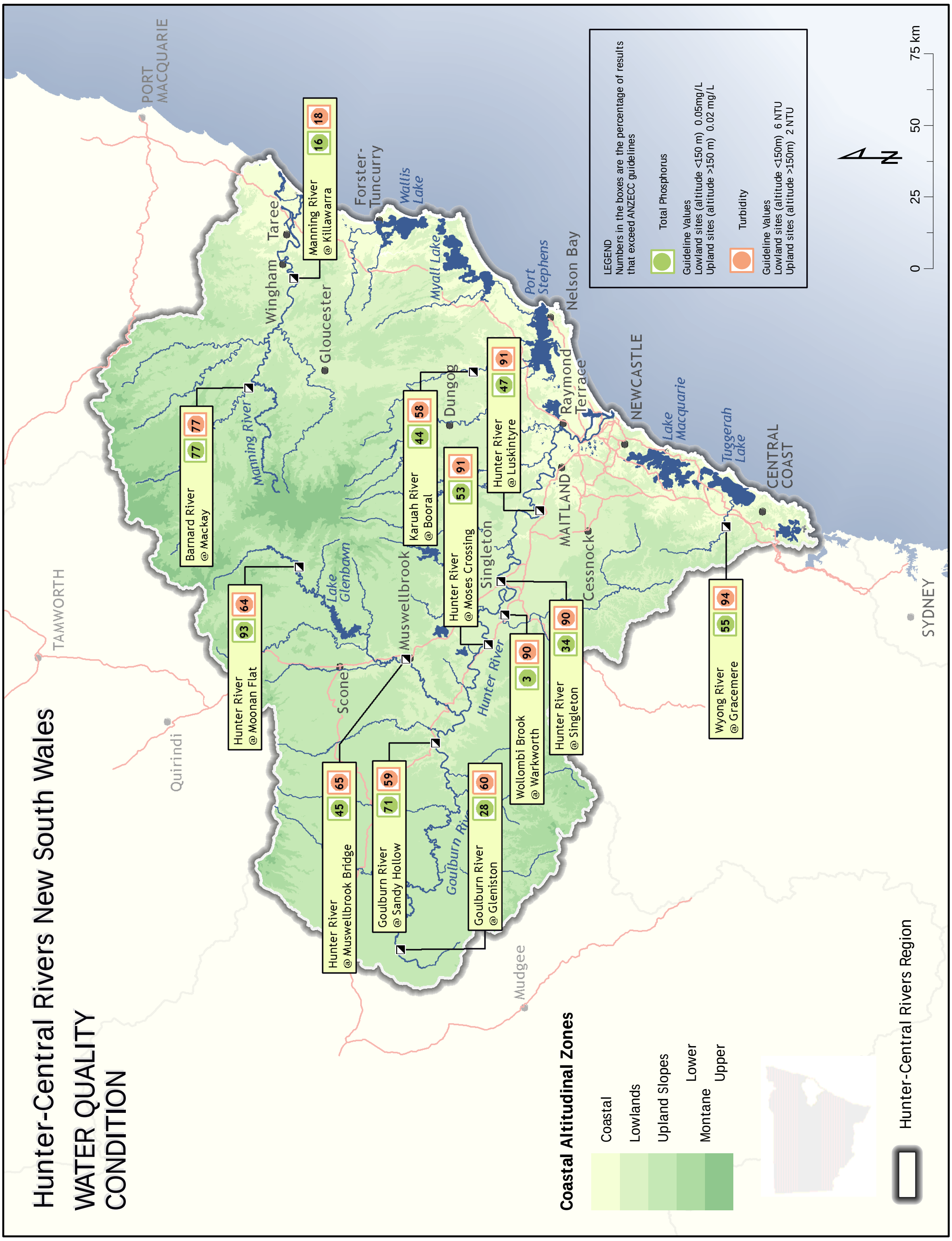
The percentage of samples that exceeded total phosphorus guidelines varied greatly between sites from very low to very high across the region, with the majority of sites having moderate results (Figure 2). The percentage of samples that exceeded turbidity guidelines was moderate or high at all sites, with one exception in the Manning catchment.

Data confidence	Commentary
TP – high Turbidity – high	For both TP and turbidity, sites have around 30 samples collected during the sample period. Confidence in the degree of representativeness of these data for the period of record is high.

Water quality trend

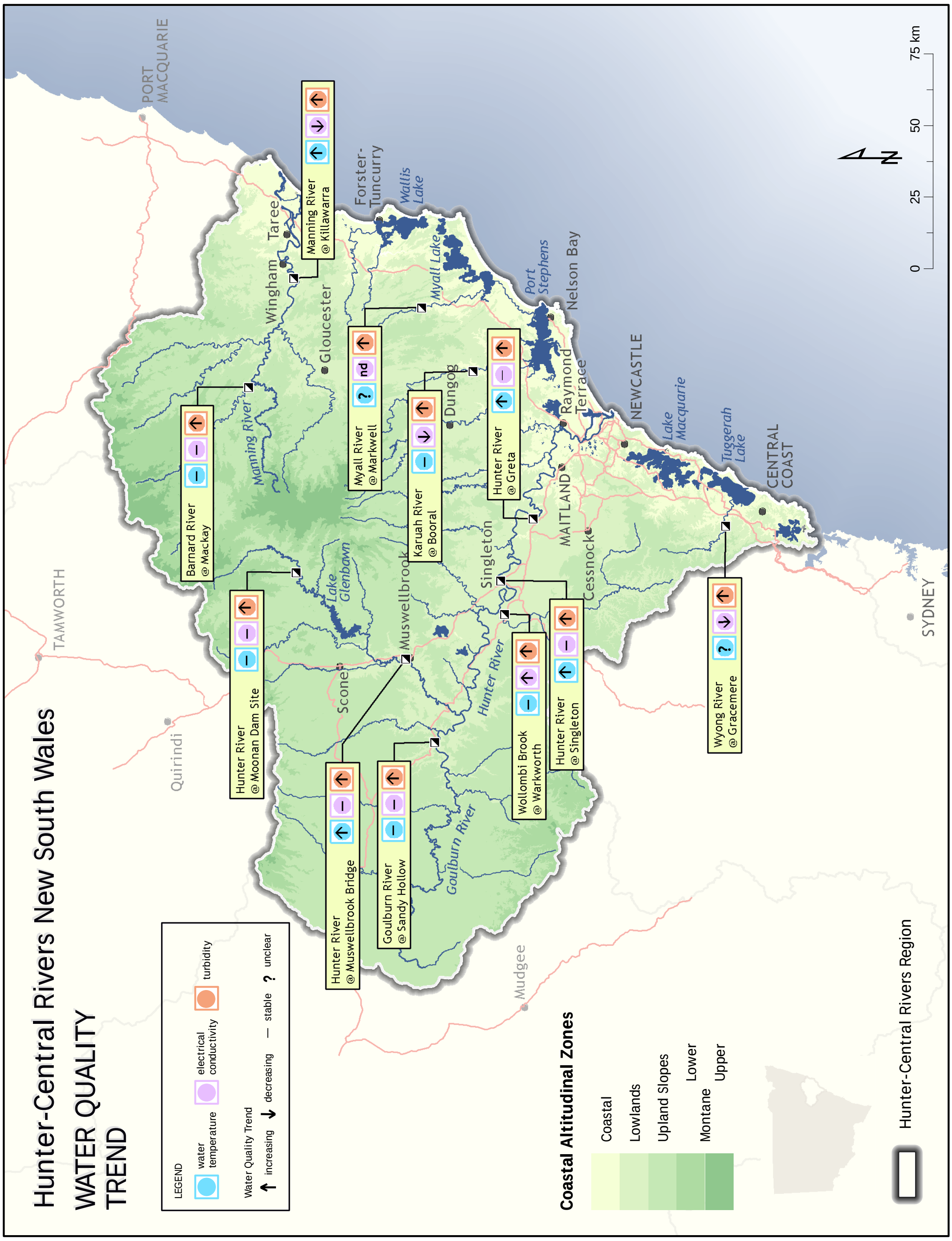
Half the sites had stable water temperature, while the remaining sites had a rising trend, with the exception of two sites that had insufficient data for analysis (Figure 3). Just over half the sites had a stable EC trend, three sites had a rising trend, one site had a decreasing trend and one site had insufficient data for analysis. All sites on the Hunter River had stable electrical conductivity. All sites recorded an increasing trend in turbidity.

Data confidence	Commentary
EC – low	Data confidence was diminished for all parameters across the catchments due to excessive data gaps.
Temp – low	Both EC and turbidity had significant data archival issues, due to the management of multiple data sources.
Turbidity – low	For temperature there were concerns about data collection issues (data precision) in the early record.



Prepared by the Spatial Services Unit, March 2009, DWE Queanbeyan.

Figure 2 Water quality condition sites and outcomes within the Hunter–Central Rivers region



Prepared by the Spatial Services Unit, March 2009, DWE Queanbeyan.

Figure 3 Water quality trend sites and outcomes within the Hunter–Central Rivers region

Note: For EC, Hunter River sites at Singleton, Muswellbrook Bridge, Moonan Dam and Greta have historically stable trends with a recent episodic decrease, possibly due to drought conditions.

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 condition of macroinvertebrate assemblages in the rivers of eastern NSW was modelled giving predictions of AUSRIVAS observed /expected (O/E) composition of macroinvertebrate fauna scores (see www.ausrivas.canberra.edu.au/Bioassessment/Macroinvertebrates/Man/Sampling/NSW/NSW_Ausrivas_protocol_Version2_2004.pdf). The model for the Hunter–Central Rivers was developed to correspond to the entire CMA region. The AUSRIVAS O/E scores were scaled so the maximum possible value was 1, representing the condition when there was no observed disturbance. The scaling was achieved by subtracting the minimum possible value for that region (based on the maximum possible value of the disturbance index) from the prediction for each subcatchment and then dividing this by the full range of possible values for the region. The scaled O/E scores were then mapped under five condition categories that represent different magnitudes of predicted loss of macroinvertebrate families compared with a relatively undisturbed reference condition (Figure 4):

1. **Very good –** loss of macroinvertebrate families was predicted to be less than five per cent and thus may be considered insignificant (O/E >0.95)
2. **Good –** loss of macroinvertebrate families was predicted to be less than 25 per cent (0.75<O/E<0.95)
3. **Moderate –** more than half of the macroinvertebrate families were predicted to be retained but over a quarter lost (0.5<O/E<0.75)
4. **Poor –** most macroinvertebrate families were predicted to have been lost but over a quarter remain (O/E 0.25-0.5)
5. **Very poor –** three quarters or more of the macroinvertebrate families were predicted to have been lost.

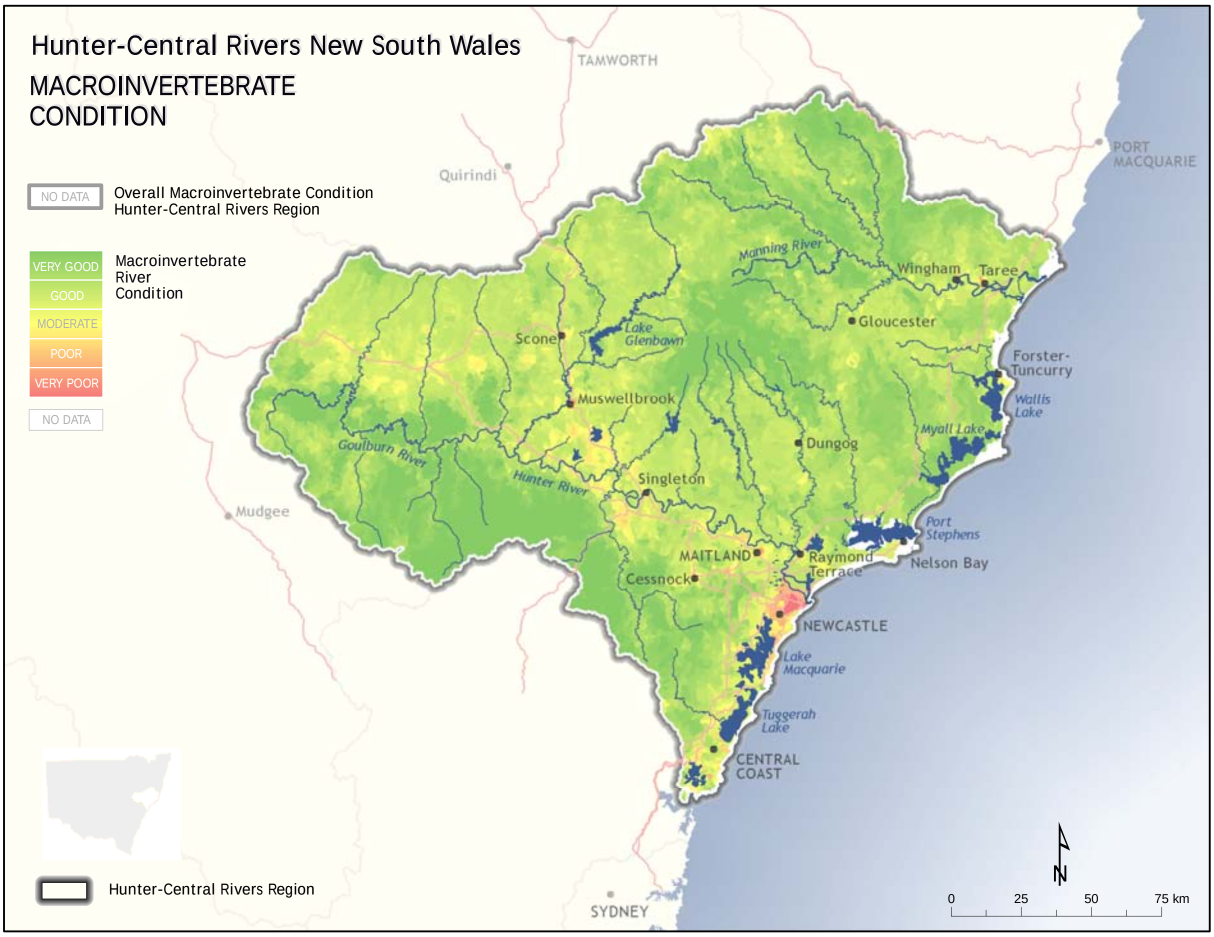
An overall catchment condition score was not assessed due to insufficient recent data. Further details on the scoring system for macroinvertenbrates are listed in the technical report for riverine ecosystem condition.

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 Pre-European Reference Condition for Fish (PERCH) scores derived for the calculation of the expectedness indicator for coastal catchments are based on existing data and a literature review, but have not yet undergone expert panel evaluation.

The site selection, sampling and analytical procedure used in coastal catchments were largely as described in the SRA report (Davies et al. 2008) for inland valleys. The few minor exceptions were the addition of a fifth catchment zone in coastal valleys, called the coastal plain, which extended from 3 m to 35 m above sea level, a minimum distance of 2.5 km between sampled sites, the sampling of randomly selected sites that fell in impoundments and the measurement and inspection of an additional 20 random individuals per species per operation after the SRA sub-sampling requirement had been met. Most importantly, sampling was not available for the minimum of seven sites per altitude zone, or a minimum of 18 sites per valley in coastal catchments, as required by the SRA method. However, the minimum site number requirements for coastal valleys have not yet been analysed and may differ from inland ones. Therefore, results from zones within valleys and valleys themselves should be interpreted with caution. However, at least seven sites were sampled per altitude zone per region and these data can be given more confidence.

Data confidence	Commentary
Overall catchment condition: not assessed	There is insufficient recent data to calculate a score for these catchments.
Catchment model outcomes – medium	Assessments at many of the sites were based on AUSRIVAS O/E scores from a single sampling event which may be inadequate for representing the integrity of macroinvertebrate assemblages because of the large amount of uncertainty associated with each sample (Hose *et al.* 2004, Gillies *et al*. 2008). The five models developed for the coastal regions used all available macroinvertebrate assessments made between 1994 and 2008. Hence these maps represent the average condition of rivers since 1994. Disturbance indices used here (Stein *et al*. 2002) were developed at a continental scale and do not incorporate some disturbances that are known to affect river biodiversity such as instream barriers and degradation of the riparian zone and instream environment. The hydrological component of the disturbance index was based on data that were too patchy to be incorporated into the models so the current models do not account for the ecological degradation caused by flow regulation. The significance of the correlations underlying the regression models and the results of validation tests performed for each model suggest that the maps produced are likely to represent broad-scale patterns in the integrity of macroinvertebrate assemblages in the rivers of the five coastal regions.



Prepared by the Spatial Services Unit, March 2009, DWE Queanbeyan.

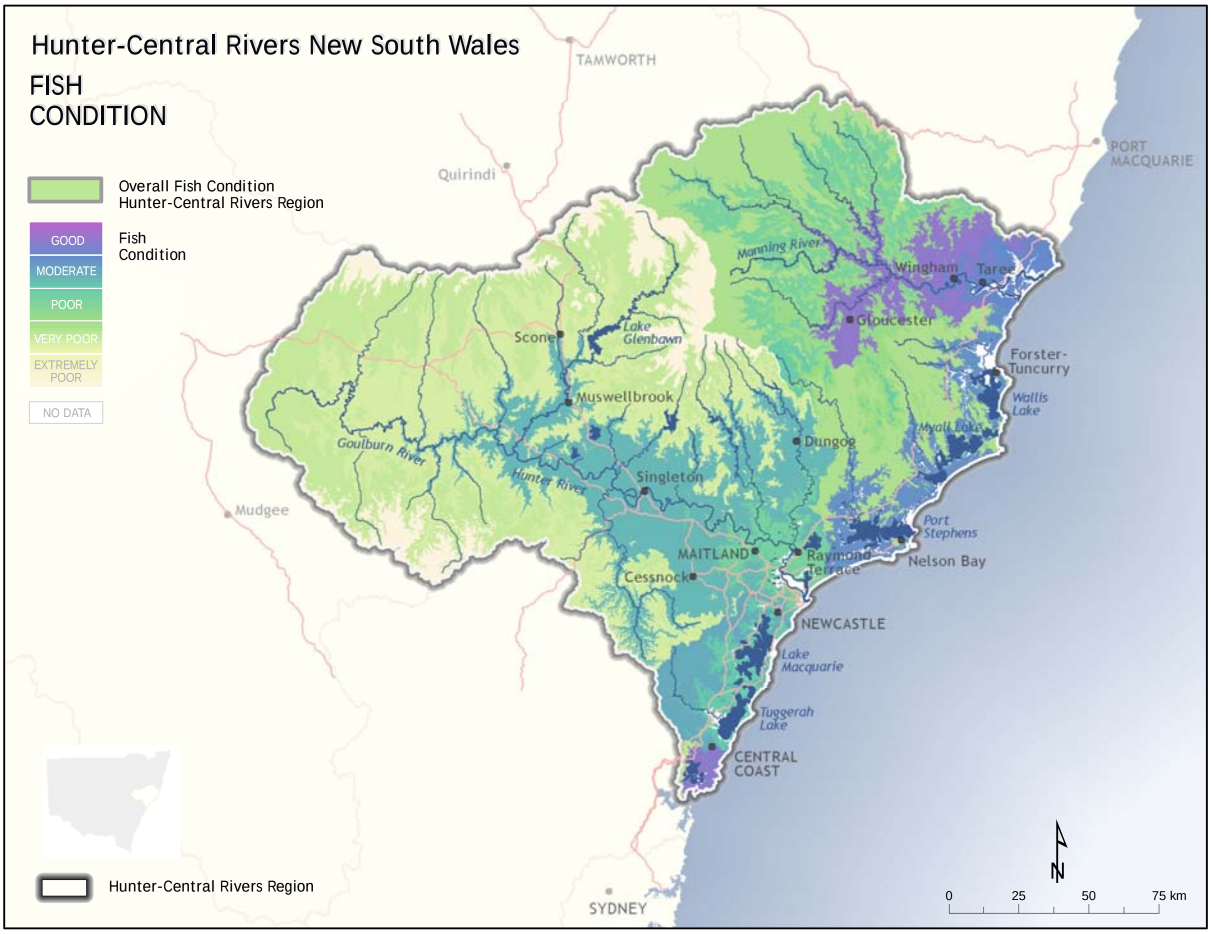
Figure 4 Macroinvertebrate condition across the Hunter–Central Rivers region

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 MER sampling that were expected to have occurred in each basin zone before European colonisation) being very poor. Of the individual altitude zones, the lowland zone was in moderate condition, the upland zone was in poor condition, the slopes and highland zones were in very poor condition and the coastal plains zone was in extremely poor condition. Nativeness was good in the lowlands, moderate in the slopes and uplands, very poor in the highlands and extremely poor in the coastal plains zone. Expectedness was poor in the lowlands, very poor in the uplands and highlands and extremely poor in the coastal plains and slopes zones.

Across basins, the Manning and Lake Macquarie–Tuggerah Lake basins were in moderate condition and the Hunter and Karuah basins were in poor condition. Nativeness was good in the Manning, Karuah and Lake Macquarie–Tuggerah Lake basins, but only moderate in the Hunter basin. However, expectedness was poor in the Manning and Lake Macquarie–Tuggerah Lake and very poor in the Hunter and Karuah basins.

Data confidence	Commentary
Low to medium	All data was collected within the three year period between 1 January 2006 and 31 December 2008. At the regional scale, data confidence at the altitude zone level was medium in the coastal plains, lowlands, slopes and upland zones, due to moderate inter-site variability across sites within the region, but low in the highlands zone due to substantial spatial variability. Data confidence at the overall regional level is medium, due to moderate variability between sites across the region. At the individual basin and for altitude zones within basins, data confidence varies from medium to low depending on zone and basin size, with higher confidence in larger basins and zones due to the larger numbers of sampling sites, and medium or low confidence in smaller individual basins and zones supported by less data.



Prepared by the Spatial Services Unit, March 2009, DWE Queanbeyan.

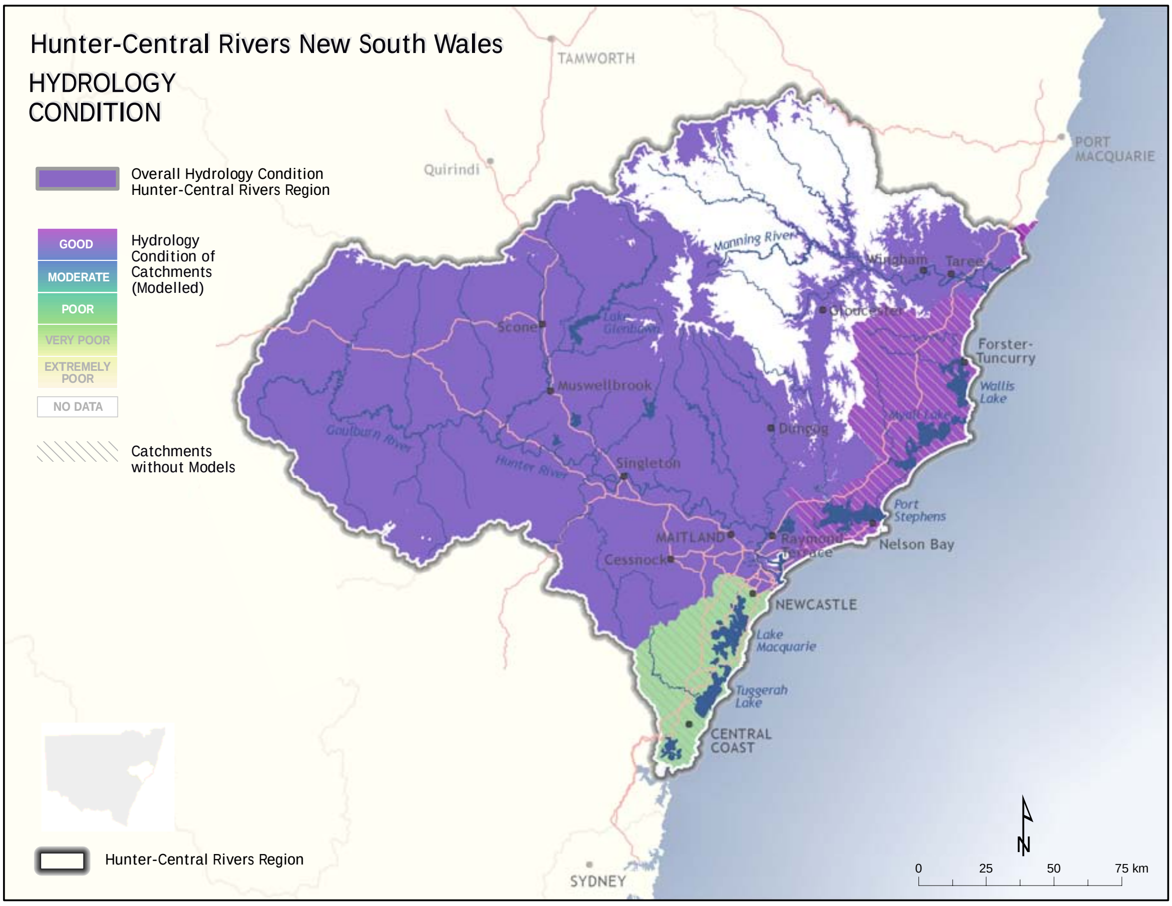
Figure 5 Fish condition across the Hunter–Central Rivers region

Hydrology

Hydrologic condition (Figure 6) in catchments with hydrology models (Hunter River, Karuah River and Manning River systems) 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.

Hydrologic condition for the other coastal streams measures the degree to which annual flows in a dry year can be affected by extraction; calculated by comparing annual water entitlement to annual flow in a low flow year (ie driest 10 per cent of years). In these streams, where instream impoundments are generally small, this indicator of hydrologic condition also reflects the extraction pressure on low flows. Increases in the frequency and duration of low-flow periods have significant potential to influence riverine ecosystems.

The river systems with hydrology models – the Hunter, Manning, and Karuah rivers – are rated as having a good general hydrology condition in the coastal and lowland altitude zones, and in the Hunter in the higher altitude zones as well. The models for the Manning and Karuah rivers do not extend into the higher reaches of the river system, and are therefore not classified, but are also expected to be good. The seasonality indicator (one of five indicators used in the general hydrology classification) shows the impacts of river regulation in the Hunter River with a few locations rated as poor or moderate. The general classification of the river systems without hydrology models varies. The entitlements for urban water supply in the Central Coast catchments indicate that it is relatively high in relation to flow in dry years, hence the poor classification, while the remainder of these river systems were classified as being in good general hydrology condition.



Prepared by the Spatial Services Unit, March 2009, DWE Queanbeyan.

Figure 6 Hydrologic condition across the Hunter–Central Rivers region

Hydrology condition

Data confidence	Commentary
Modelled altitude zone condition – medium	Condition data were derived from calibrated hydrologic models and indicators calculated by the same method as used in the Sustainable Rivers Audit.
Un-modelled catchment condition – low	Condition data for many of the smaller streams included estimates of annual flows for ungauged catchments.
Overall region condition – low	Overall condition is a combination of both modelled and un-modelled methods of assessing hydrologic condition hence includes estimates of annual flows for ungauged catchments.

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
Manning	Coastal Plain	100
	Lowlands	100
	Slopes	100
	Uplands	100
	Highlands	30

Karuah	Coastal Plain	100
	Lowlands	63
	Slopes	100
	Uplands	100
Hunter	Coastal Plain	54
	Lowlands	99
	Slopes	36
	Uplands	50
	Highlands	1
Macquarie–Tuggerah	Coastal Plain	74
	Lowlands	91
	Slopes	No data
Hawkesbury–Nepean	Coastal Plain/Lowlands	No data

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 (>5°C 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
Glenbawn	Medium	Not available	Hunter
Glennies Creek	Medium	Not available	Glennies Creek
Lostock	Medium	45 km	Paterson

Glenbawn Dam on the Hunter River provides regulated river releases for town water supply and major industrial uses such as the Bayswater and Liddell power stations. The storage thermally stratifies and discharges cooled water downstream (Preece 2004).

Glennies Creek Dam on Glennies Creek provides water for diversion to town water supply, as well as regulated river releases for irrigation and industry. Large temperature differences occur immediately below the dam; however, due to small discharges, the effects remain relatively localised (Preece 2004).

Lostock Dam on the Patterson River supplies water for pasture irrigation, town water supply and riparian users. Temperature testing in January downstream of the storage records lower temperature readings by several degrees compared to natural flow, indicating a CWP effect below the storage (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 cold water pollution. 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^2)
1a	Wyong Weir	Wyong River	60
1b	Seaham Weir	Williams River	100
3a	Liddell Gauging Station	Hunter River	200
3b	Locketts Crossing	Cooloogolook River	60
5	Dora Creek Weir	Dora Creek	40
6	Barnsley Weir	Cockle Creek	40
7	Farm Weir at Dyers Crossing	Khoribakh Creek	60
8	Brushy Hill Road Causeway	Pages River	100

All the weirs listed above remain priority sites. Stroud Weir had been remediated with a full-width rock-ramp and removed from the list.

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 and specify regional targets and activities to contribute to achievement of the state-wide targets. The Hunter–Central Rivers CAP can be found at: www.hcr.cma.nsw.gov.au/articles/news.asp?news_id=15.

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 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 aim to make improvements in the management of NSW water resources by providing flow patterns that are more beneficial for the river environment, particularly during low flow periods.

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 to adjust future WSPs to account for climate change impact.

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 activities to address the pressures on riverine ecosystems are the same as those listed in the land capability response report.

Specific NSW Government actions that address the target in the Hunter–Central Rivers region include the WSPs discussed above.

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 and protection of environmental values.

The planning process creates a strategic framework to identify, assess and prioritise land-uses, and to assist with the strategic investment in the revitalisation/management of natural resource values. These reflect two streams in the integration of natural resource management (NRM) and environmental protection – a 'strategic planning stream' and an 'investment stream'. These connections occur at regional and local levels 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).

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

The DOP regional planning measures in the Hunter–Central Rivers region include:

- the Lower Hunter Regional Strategy, which applies to part of the Hunter–Central Rivers region. The regional strategy will guide the Lower Hunter's growth for the next 25 years. It identifies future development areas, principal land-use types, settlement patterns and conservation outcomes. It establishes important green corridors to protect and enhance the region's strong natural environmental and biodiversity assets, which link with the green corridors of the far north coast and mid north coast regions
- the Mid North Coast Regional Strategy, which also applies to the Hunter–Central Rivers region (ie Greater Taree and Great Lakes LGAs)
- The Central Coast Regional Strategy (2008) also applies to part of the Hunter–Central Rivers region. The strategy establishes a 25-year planning framework to provide for population growth and employment while protecting the natural environment. DECCW is preparing a regional conservation plan that will protect sensitive environments and biodiversity
- The Williams River Catchment Regional Environmental Plan (1997) aims to improve the environmental quality of the catchment by managing the use of resources in an ecologically sustainable manner. It links to an agency-agreed regional planning strategy that incorporates total catchment management principles so that diverse actions, development control decisions and public authority approvals are coordinated.

At the regional level, the Hunter–Central Rivers CMA is undertaking the following activities to address pressures in relation to the riverine ecosystems theme:

- engaging landholders to implement a range of riparian actions to improve the condition of both instream habitats and the riparian corridor. Such actions include riparian weed management, establishing native riparian vegetation, protecting intact riparian corridors, instream works to stabilise channels and banks and to provide habitat, maintenance of flood mitigation structures and the installation of stock exclusion fencing and off-stream stock watering points
- catchment activities to improve the instream and riparian condition include soil erosion management, native vegetation protection and rehabilitation, nutrient runoff management, urban stormwater and quality improvement devices and improved grazing management practices
- education and community capacity building activities that are undertaken at numerous sites across the region to increase landholder awareness of how land management activities influence riverine ecosystems and to increase landholder capacity to implement remediation actions.

Fish

Instream habitat improvements are achieved through the removal or modification of priority instream barriers to fish passage and installation of engineered log jams to create habitat heterogeneity.

Water quality

Waterwatch activities in the region are focused on building student and landholder awareness of riverine ecosystems and providing them with the support and equipment to monitor the water quality of streams in their local area.

Local level

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

Multiple condition/pressure actions

- working with DECCW, NOW and 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 guide 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.

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

- the Upper Hunter River Rehabilitation Initiative, a partnership between Mount Arthur Coal, Bengalla Coal, Macquarie University and numerous smaller partners established to rehabilitate 8 km of the upper Hunter River below Muswellbrook
- the Hunter River Rehabilitation Project, a partnership between Singleton Shire Council and Xstrata Coal, with the intention of rehabilitating over 11 km of riparian vegetation on the Hunter River at Singleton
- many coal companies are investing funds from their corporate social obligation budget to implement riparian remediation works in the Upper Hunter.

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].

Davies PE, Harris JH, Hillman TJ & Walker KF 2008, *SRA Report 1: A Report on the Ecological Health of Rivers in the Murray–Darling Basin, 2004–2007*, prepared by the Independent Sustainable Rivers Audit Group for the Murray–Darling Basin Ministerial Council.

Gillies CL, Hose GC & Turak E 2008, 'What do qualitative rapid assessment collections of macroinvertebrates represent? A comparison with extensive quantitative sampling,' *Environmental Monitoring and Assessment*, DOI 10.1007/s10661-008-0186-9.

NOW in prep., 'Evaluation of water quality data and historical trends in New South Wales, Australia: Technical report for the Riverine Ecosystem Theme, as part of the New South Wales Monitoring, Evaluation and Reporting Strategy', NSW Office of Water, Sydney.

NSW Department of Primary Industries 2006, *Reducing the Impact of Weirs on Aquatic Habitat – New South Wales Detailed Weir Review*, Lower Murray Darling CMA region, Report to the New South Wales Environmental Trust, NSW Department of Primary Industries, Flemington, NSW.

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

Preece R 2004, *Cold water pollution below dams in New South Wales – A desktop assessment*, Water Management Division, Department of Infrastructure, Planning and Natural Resources, Sydney.

Stein JL, Stein JA & Nix HA 2002, 'Spatial analysis of anthropogenic river disturbance at regional and continental scales: identifying the wild rivers of Australia', *Landscape and Urban Planning*, 60: 1-25.

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).

Fax: (02) 9995 5999. TTY: (02) 9211 4723.

Email: info@environment.nsw.gov.au Website: www.environment.nsw.gov.au

DECCW 2010/436 ISBN 978 1 74232 749 5 November 2010

Cover photo: DECCW – 'kingfisher'