NSW GOVERNMENT

State of the catchments 2010

Riverine ecosystems

Northern Rivers region

State Plan target

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

Background

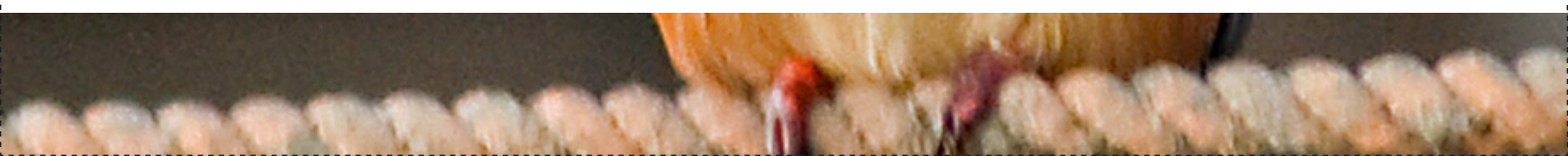
Covering 50,000 km^2, the Northern Rivers region extends three nautical miles east of the coastline incorporating the Solitary Islands and Cape Byron marine parks (Figure 1). It is 60 per cent freehold tenure and has 21,500 km^2 managed as Crown land, national park and state forest. The region includes the World Heritage-listed Lord Howe Island group, located 600 km east of Coffs Harbour. There are more than 500,000 residents in the Northern Rivers region, located in 18 local government areas (LGAs).

There are nine major river catchments in the region – the Tweed, Brunswick, Richmond, Clarence, Coffs Harbour Waterways, Bellinger, Nambucca, Macleay and Hastings. The region also includes significant coastal lakes and estuaries, such as Camden Haven, Lake Cathie, Lake Ainsworth, Terranora Broadwater, Lake Hiawatha and Minnie Water.

The largest catchment in the Northern Rivers area is the Clarence catchment covering 22,716 km^2. The Clarence River is the longest river in the region, at around 340 km. The highest point in the region is Round Mountain, at 1570 m above sea level, in Cathedral Rock National Park.

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.



Map of catchment

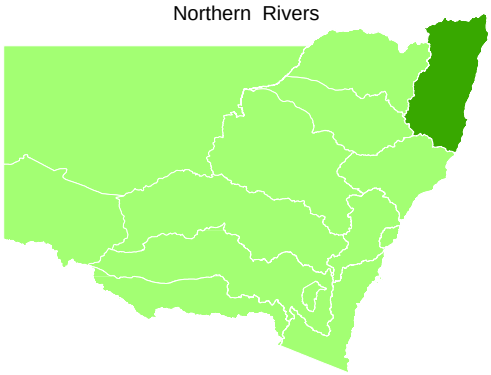


Figure 1 The Northern Rivers region

Assessment

Riverine ecosystem condition has been assessed using water quality, macroinvertebrate, fish and hydrology indicators. Condition is described for macroinvertebrates, fish and hydrology by using a five point scale, a ranking process similar to the Sustainable Rivers Audit (SRA) (Davies et al 2008). Condition information was not available for all water quality indicators. Trend information is provided for the following water quality indicators: electrical conductivity, turbidity and temperature.

The aquatic biota and hydrology indicators are represented as different colour schemes on the maps.

A number of methods were applied in the coastal regions, based either on a coastal adaptation of the SRA approach to condition assessment, or on an interim approach in cases where data or model availability did not allow an SRA style approach. Outcomes were not available for some areas. Altitude zones could not be applied to macroinvertebrate modelling in coastal regions, as was done for the inland regions (ie the 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

Water quality condition was not assessed for the Northern Rivers region area, as insufficient recent water quality data was available.

Trends (Figure 2) were determined for the following indicators of water quality in the Northern 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.

Period of records generally range from 1970 to 2008 for EC and temperature, and from 1977 to 2003 for turbidity.

The New South Wales discrete water quality data archive (ie 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.

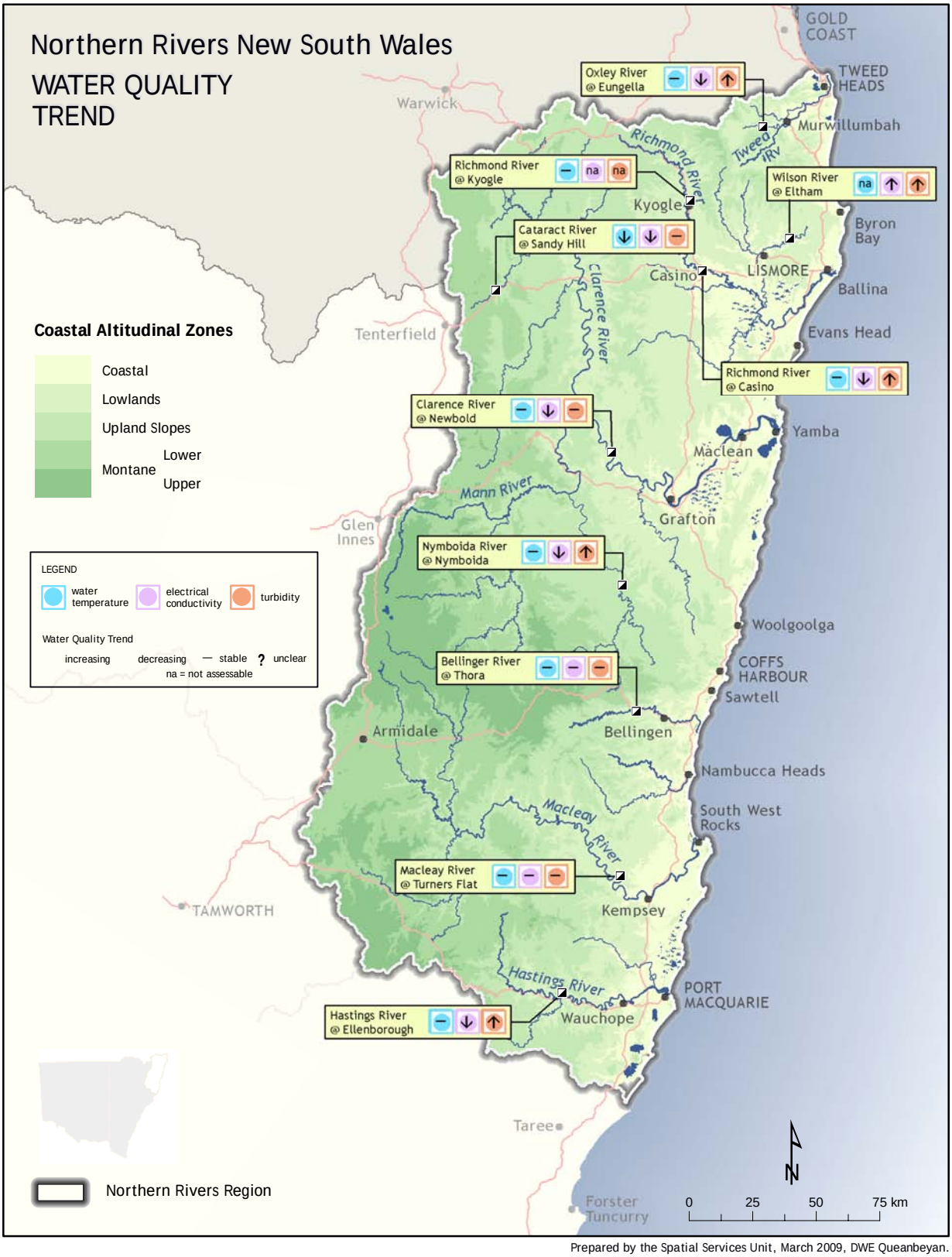
To quantify the level of confidence in archival water trend data, a debit point system was used to assess operational issues, excessive data gaps, data collection and archival issues (NOW in prep.). This provided the basis for applying a low, medium or high data confidence ranking.

Data confidence	Commentary
Not assessed	There is insufficient recent data to report on water quality condition in the Northern Rivers region

Water quality trend

All sites displayed a stable trend in water temperature, with the exception of one site in the upland slopes, which showed a declining trend, and another site that had insufficient data for analysis (Figure 2). Overall there were six sites across the region that had a falling EC trend, while one site on the coast had a rising trend. Turbidity results were the least reliable; however, just over half the sites displayed a rising trend and the remaining sites had stable turbidity, apart from one site with insufficient data for analysis. Caution should be applied to interpreting these turbidity results, as there was no data available for analysis after 2003. Further monitoring is required to confirm current trends.

Data confidence	Commentary
EC – low Temp – low Turbidity – medium	Data gaps are an issue for all parameters. EC also suffered from erroneous and conflicting data. For temperature, the far northern sites suffered from data gaps, while the early archive lacked hour-of-day information and the mid-archive lacked precision. The main weakness for turbidity was that the record stopped in the early 2000s.



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

Figure 2 Water quality trend outcomes for the Northern Rivers region

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: ausrivas.canberra.edu.au/Bioassessment/Macroinvertebrates/Man/Sampling/NSW/NSW_Ausrivas_protocol_Version2_2004.pdf). The model for the Northern Rivers was developed to correspond to the entire 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. 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 3). The condition categories are defined as:

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 were 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.

The overall catchment condition score was calculated using the median of recent (2006–2008) AUSRIVAS O/E50 scores, that were scaled using the formula ([O/E50 – minimum O/E50]/range of scores).

Further details on the scoring system for macroinvertebrates are listed in the technical report for riverine ecosystems (NOW in prep.).

Fish assemblages

The Fish Condition Index (Figure 4) 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 SRA Report 1 (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 inclusion of randomly selected sites within 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.

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. At least seven sites were sampled per altitude zone per region, and this data can be viewed with more confidence.

Data confidence	Commentary
Overall catchment score – low	Data was analysed for the period 2006 to 2008. Confidence in the single catchment rating is low due to the high variance of O/E50 scores from samples across the catchments.
Catchment model outcomes – medium	Assessments at many of the sites were based on AUSRIVAS O/E50 scores from a single sampling event. This 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 was too incomplete to be incorporated into the models; therefore, 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.

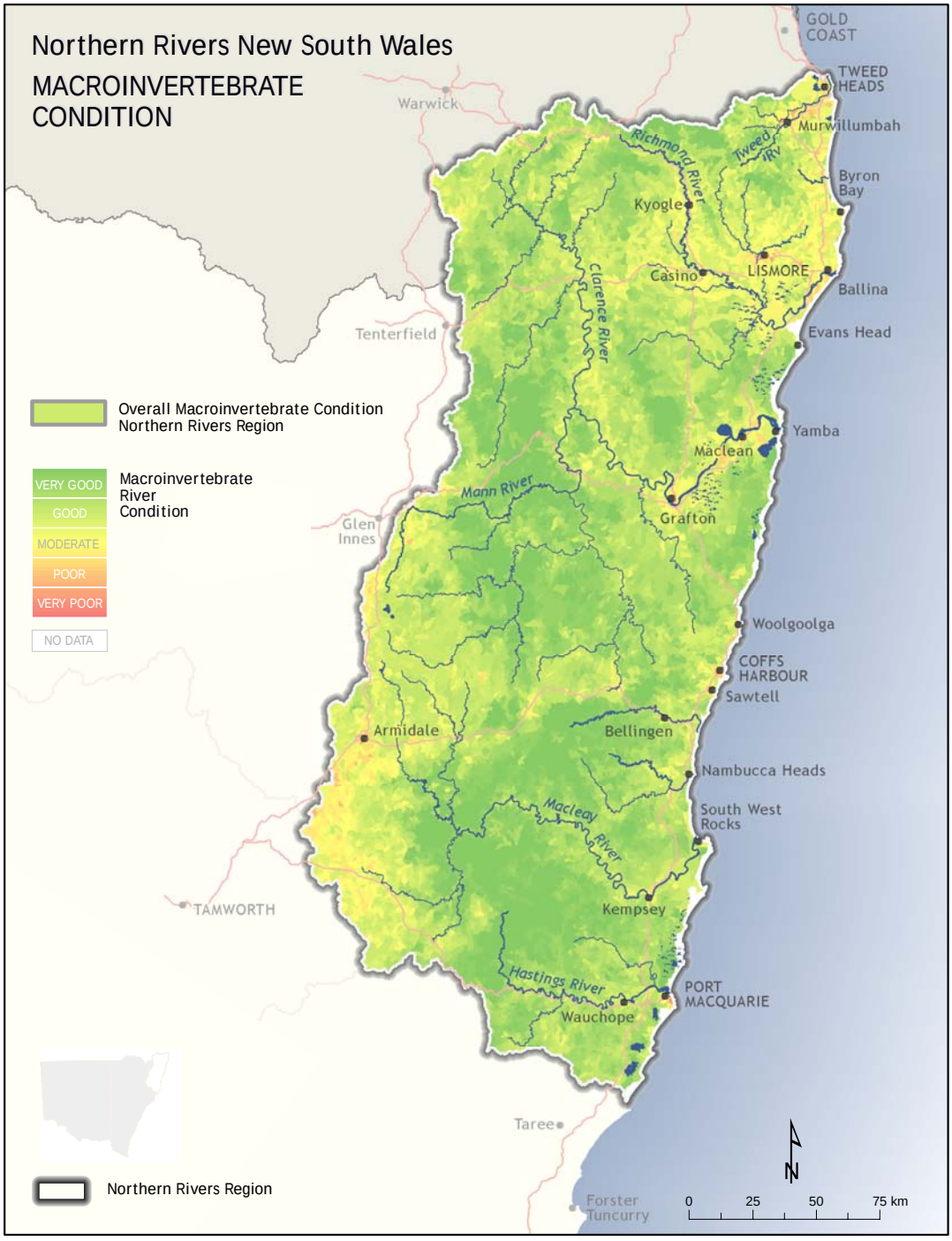


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Figure 3 Macroinvertebrate condition across the Northern Rivers region

Fish condition

Only a small amount of data is available for the Northern Rivers region, which is insufficient to make any statements about the condition of fish communities across the regional area (Figure 4). Data will be gathered for this region in November 2009.

Data confidence	Commentary
Low	All data was collected within the three year period between 1 January 2006 and 31 December 2008. Data confidence is low given that the fish condition ratings given were estimated from a small number of sites sampled as a preliminary exercise in 2006. Full fish assemblage sampling is scheduled from November 2009 and will be reported in the next series of state of the catchments reports.

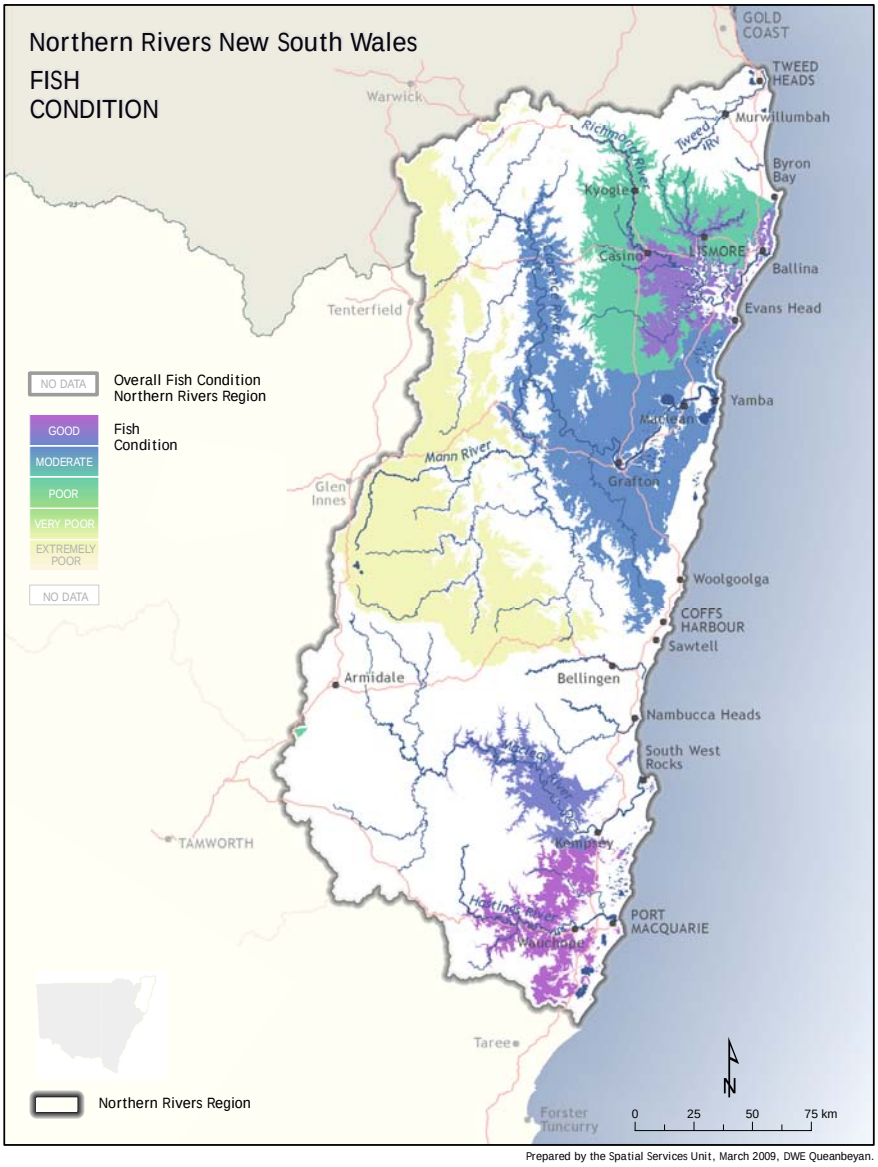

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Figure 4 Fish condition across the Northern Rivers region

Hydrology

Hydrologic condition (Figure 5) in catchments with hydrology models (Tweed River and Richmond 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; this is 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, Tweed and Richmond rivers, are rated as having a good general hydrology condition in the Coastal and Lowland altitude zones. The models do not extend into the higher reaches of the river system, hence are not classified, but are also expected to be good. In both of these systems the 'low and zero flow' indicator (one of five indicators used in the general hydrology classification) showed the greatest impact on streamflow, with a few locations earning a 'moderate' classification. The general classification is also reflected in the river systems without hydrology models, with most of the area classified good. Exceptions were streams such as:

- Mungay Creek – while there is little entitlement, there is also little flow in a dry year
- Malpas Dam catchment – due the entitlement associated with the dam
- Commissioners Waters – entitlement relative to flow dry years is high, giving it a moderate classification.

Hydrology condition

Data confidence	Commentary
Modelled altitude zone condition – medium	Condition data 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.

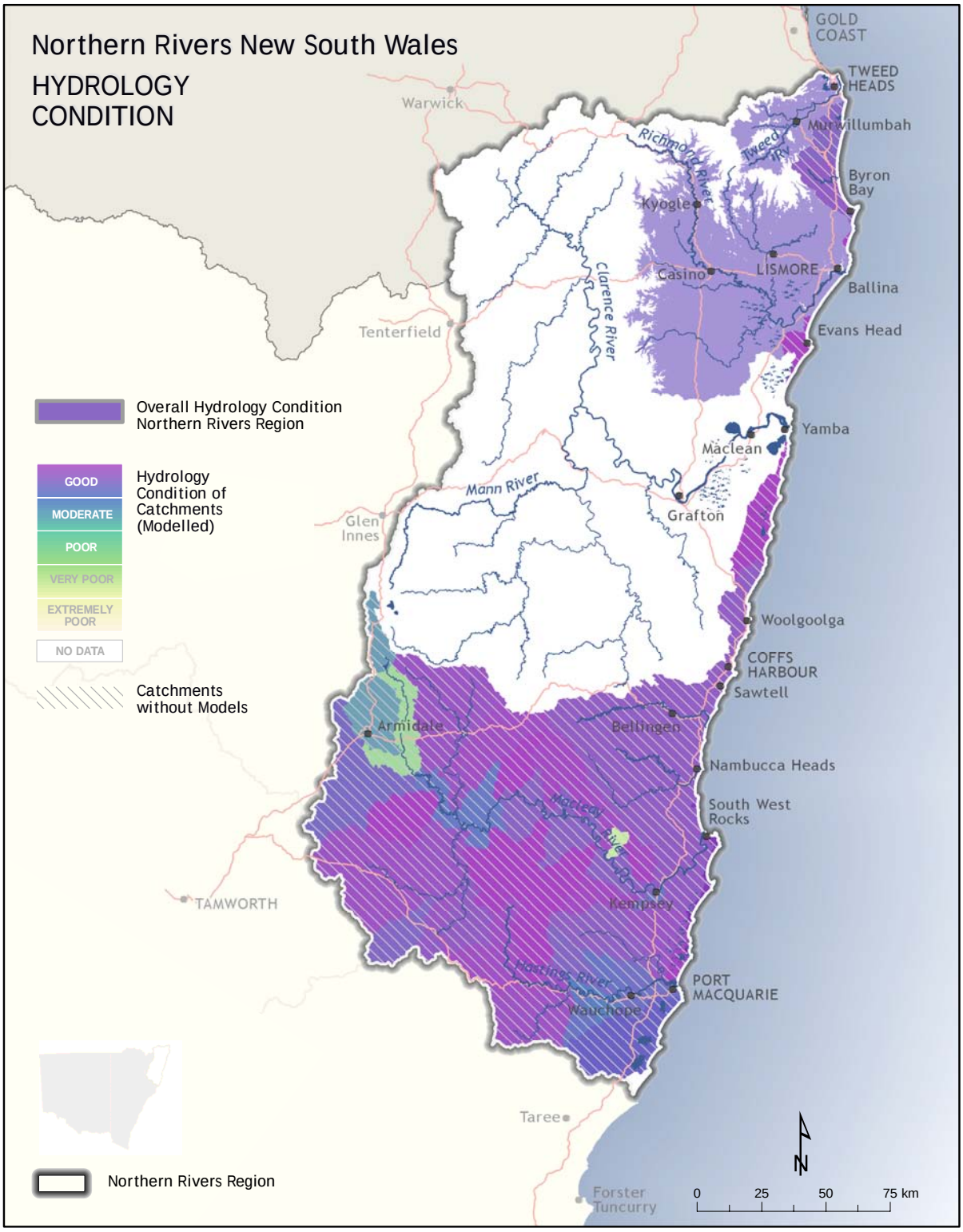

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Figure 5 Hydrologic condition across the Northern Rivers region

NOTE: The Clarence catchment is highlighted as 'no data'. This catchment may have modelling outcomes provided in 2009.

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
Tweed	Coastal Plain	No data
	Lowlands	No data
	Slopes	No data
	Uplands	No data
	Highlands	No data
Brunswick	Coastal Plain	No data
	Lowlands	No data
	Slopes/Upland	No data
Richmond	Coastal Plain	100
	Lowlands	100
	Slopes	No data
	Uplands	No data
	Highlands	No data

Clarence	Coastal Plain	100
	Lowlands	88
	Slopes	No data
	Uplands	No data
	Highlands	43
Bellinger	Coastal Plain	No data
	Lowlands	No data
	Slopes	No data
	Uplands	No data
	Highlands	No data
Macleay	Coastal Plain	No data
	Lowlands	82
	Slopes	No data
	Uplands	No data
	Highlands	0
Hastings	Coastal Plain	No data
	Lowlands	100
	Slopes	No data
	Uplands	No data
	Highlands	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 on the next page shows storages that are likely to be associated with CWP, their priority and the extent to which 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
Toonumbar	Medium	Not available	Iron Pot Creek

Toonumbar Dam has sufficient depth to develop marked thermal gradients; however, summer discharge is reasonably low and therefore only creates small, localised CWP effects (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 to find alternative habitat during extreme events such as drought. Construction of weirs, dams and road crossings can limit or prevent migration, resulting in loss or depletion of certain fish species upstream of such barriers.

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

Rank	Barrier name	Watercourse	Potential increase in habitat area (km)
1	Manyweathers Weir	Richmond River	2
2	Cookes Weir	Richmond River	213
3	Kyogle Water Supply	Richmond River	500
4	Sportsmans Ck Weir	Sportsmans Creek	20
5	Nymboida Weir	Nymboida River	50
6a	Stewarts River Weir	Stewarts River	64
6b	Shannon Brook Weir	Shannon Brook	106
8	Goolmangar Ck Weir	Goolmangar Creek	60
9	Hickeys Creek Weir	Hickeys Creek	60
10	Cob-o-Corn Weir	Cob-o-Corn Creek	90
11	Eden Creek Weir	Eden Creek	101
12	Mullumbimby Weir 1	Mullubmimby Creek	6
13	Fawcetts Creek Weir 1	Fawcetts Creek	56

14	Fawcetts Creek Weir 2	Fawcetts Creek	3
15	Fawcetts Creek Weir 3	Fawcetts Creek	42
16	Mullumbimby Weir 2	Mullumbimby Creek	8
17	Glenugie Creek Weir	Glenugie Creek	43

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 lifecycle cues
- Unknown environmental tolerances of biota.

Management activity

State level

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

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 aim to make improvements in the management of NSW water resources by providing flow patterns that are more beneficial to 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 initiative being undertaken to meet this challenge is to adjust future WSPs to account for climate change impacts. Other pressure-specific initiatives are listed below.

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
- deliver environmental education relating to the aquatic environment, eg Waterwatch program
- support the development and implementation of Integrated Water Cycle Management Plans
- develop regional water quality guidelines
- regularly monitor water quality at strategic locations to assess the long-term trends and changes in condition.

Fish

- Research distribution and barriers to movement for aquatic organisms in the Clarence catchment.

Multiple condition/pressure actions

- Develop an Ecosystem Health Monitoring Program in partnership with local and state governments, the community and industry
- Develop and implement River Health Plans within priority areas.

Some of the specific NSW Government actions to address the target in the Northern Rivers region are described below.

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 the protection of environmental values.

The planning process creates a strategic framework to identify, assess and prioritise land-uses and to assist in 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 the 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 via the development of regional growth strategies to guide sustainable growth and to protect valuable natural and cultural assets. The development of these regional strategies is undertaken with the involvement of the CMAs.

Regional level

At the regional level, the Northern Rivers CMA made a $1.5 million investment in 2007–08 to undertake the following activities in relation to the riverine ecosystems theme:

Multiple condition/pressure actions

Enhancement/rehabilitation of riverine corridor:

- 165 ha of riparian zone protected by fencing, protecting 45 km of stream bank
- over 60 ha of pest plant control undertaken
- almost 4.5 km of bank length stabilised by engineering works
- over 750 m of stream bed stabilised by river bed control works
- over 60 alternative stock water sites installed protecting almost 30 km of stream bank
- over 8000 riparian plants established by revegetation to re-establish over 30 ha of riverine corridor.

Water quality

Water monitoring/environmental education activities include:

- 41 catchment education events held

- key networks maintained with 12 LGAs participating in key networks
- the Ecosystem Health Monitoring Strategy finalised for Northern Rivers
- Waterwatch components established in targeted area projects.

Hydrology

Adopting an approach to integrated water cycle management (IWCM) has involved:

- 78% of LGAs participating in the IWCM planning process
- 17% of LGAs completing the IWCM planning process
- 17% of LGAs participating in the IWCM implementation process.

Macro water sharing plans (MWSPs) have involved:

- 69% plan completion on average across nine catchments
- 100% of catchments actively participating in the planning process
- 11% plan implementation on average across nine catchments
- Bellinger MWSP implemented.

Multiple condition/pressure actions

The DOP regional planning measures in the Northern Rivers region include:

- the *Far North Coast Regional Strategy* (2006), which will sustainably manage the region's expected high growth rate while protecting the unique environmental assets, cultural values and natural resources of the region over a 25-year period
- the *Mid North Coast Regional Strategy*, which also applies to parts of the Northern Rivers region. The 25-year strategy will guide sustainable growth while protecting the region's valuable natural environmental and agricultural assets. Both strategies will be reviewed every five years
- working with DECCW on the development of a regional conservation plan for both the Far North Coast and the Mid North Coast regions.

Local level

Multiple condition/pressure actions

DOP provides for a range of local planning measures and activities, including:

- working with DECCW, NOW and I&I in developing standard NRM clauses for councils to incorporate into their new local environmental plans (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
- integrating NRM with local strategic planning, which has been hampered by the lack of spatial data on NRM values, or the provision of data late in the planning process.

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

Local government

- Significant investment into the enhancement/rehabilitation of the riverine corridor through the development and implementation of River Health Plans and Estuary Management Plans. Projects exist, for example, in the Coffs Harbour City Council and Port Macquarie Hastings Council areas.

Landcare

- Significant investment into the enhancement/rehabilitation of the riverine corridor via landholder voluntary contributions to Northern Rivers CMA and LGA projects.

Further reading

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