REGIONAL STATE OF THE ENVIRONMENT 2012

For the Northern Rivers Catchment Management Authority region of NSW

NSW GOVERNMENT
Catchment Management Authority
Northern Rivers

Acknowledgements

Regional State of the Environment 2012

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The information contained in this publication is based on the technical knowledge and understanding of the authors and reviewers and is current at the time of preparation (November 2012).

However, users are reminded of the need to ensure that the information upon which they rely is up-to-date, and to check the currency of the information with appropriate government agencies or an independent advisor.

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Abbreviations and Units of Measurement

ASS	acid sulfate soils
BFT	biodiversity forecasting tool
CAP	catchment action plan
CMA	Catchment Management Authority
CZMP	coastal zone management plan
DPI	Department of Primary Industries
EHA	effective habitat area
EPA	Environment Protection Agency
GDE	groundwater dependent ecosystem
ICOLL	intermittently closed or open lakes or lagoons
IP&R	integrated planning and reporting
LEP	local environment plan
LGA	local government area
MER	monitoring, evaluation and reporting
MPA	marine protected area
NOW	NSW Office of Water
NRC	Natural Resources Commission
NRCMA	Northern Rivers Catchment Management Authority
NRM	natural resource management
OEH	Office of Environment and Heritage
OSMS	onsite sewage management system
Regional SoE	Regional State of the Environment Report 2012
SEQ	south-east Queensland Catchments
SLATS	statewide land cover and trees study
SoE	State of the Environment report
SMU	soil management unit
WSP	water sharing plan
WSUD	water sensitive urban design
WWTP	waste water treatment plant

Units of Measurement

CO_2-e	carbon dioxide equivalent	kL	kilolitre
ha	hectare	kWh	kilowatt hour
GJ	gigajoule	ML	megalitre
GWh	gigawatt hour	Mt	megatonne
kg	kilogram	ppm	parts per million

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Photo by Nigel Blake

INTRO

Introduction

This *Regional State of the Environment 2012* (Regional SoE) is the first prepared for the Northern Rivers Catchment Management Authority (CMA) Region of NSW. It involved collaboration between the 12 general purpose councils (councils) along the Region's coast, (from Port Macquarie-Hastings Council in the south to Tweed Shire Council in the north and including Lismore and Kyogle councils), three county councils, and the Northern Rivers Catchment Management Authority (CMA). It aims to report on environmental condition at both a regional and local level for the 2011–12 financial year.

The Regional SoE utilises both state and local data. State data is used to report on the Northern Rivers CMA Region ('CMA Region'). Local-level data is used to report on the council region which is made up of the 12 participating local government areas ('reporting region'). Figure 1 shows the location of these regions.

Initiated by the Department of Premier and Cabinet and brokered by the Northern Rivers CMA, the Regional SoE Report Project commenced in 2009, with a project working group developing a set of indicators specifically for the reporting region. The report is funded by the 15 participating councils with in-kind support from the Northern Rivers CMA which host the project officer. By working together, the councils in partnership with the CMA hope this report will inform not only communities, but also local and state government, and provide a regional perspective on the current environmental state while also providing locally-relevant information. The project collaboration and reporting process continues to develop, with lessons learned from this report ideally informing future reporting in the CMA Region.

State of the environment reporting

A state of the environment (SoE) report serves to inform the community and local and state governments on the *condition* of the environment in the reporting area, key *pressures* acting on the environment, and *responses* to those key pressures. This condition–pressure–response information can be used to increase community awareness of environmental issues, and to guide natural resource managers in prioritising and addressing management actions.

SoE reporting is a requirement for local government under the *Local Government Act 1993.* Amendments to the Act in 2009 altered the reporting schedule and structure, requiring a comprehensive SoE report every 4 years (in the year of an ordinary election). The SoE reports are part of the NSW Government Integrated Planning and Reporting (IP&R) framework. This framework guides each council's strategic planning and reporting, and requires the creation of a community strategic plan which incorporates environmental objectives among other things. Therefore this Regional SoE meets the reporting requirements of the IP&R framework and provides environmental benchmarks which councils and natural resource managers can use for better decision-making.

Objectives of the Regional SoE

The objectives of the Regional SoE include:

- To provide a common set of themes and indicators that report on meaningful trends in environmental health at a regional scale over time, with a shift in the emphasis towards indicators of natural resource condition rather than pressure and response.
- To enhance data gathering, sharing, assessment and publication processes across all stakeholders and reporting frameworks.
- To integrate, align and standardise local, regional and state reporting processes such as NSW SoE, State of the Catchments and regional natural resource management (NRM) prioritisation and investment processes.
- To develop a broader, more inclusive framework that captures more NRM programs and stakeholders.
- To provide a more accessible and meaningful report for community and decision-makers on the condition of the local environment and where resources are best placed to respond to community expectations.
- To reduce duplication of resources in SoE and NRM reporting.
- To link regional priorities and targets via the new 'Northern Rivers CMA Catchment Action Plan 2013–23' (draft currently on exhibition) and the environmental component of local government community strategic plans.

Relationship to other state-wide and regional reporting

This first Regional SoE for the Northern Rivers CMA Region attempts to integrate aspects of the following reporting that is undertaken in the Region:

- 'NSW Natural Resources Monitoring, Evaluation and Reporting Strategy' (NSW MER Strategy) which reports across a range of environmental themes across the State
- State of the Catchments which reports against catchment manage ment authority (CMA) regions
- Northern Rivers CMA which reports annually on Northern Rivers CMA investment, but does not currently consider the achievements of other NRM stakeholders (e.g. local governments)
- NSW SoE reports which are prepared without any tangible links to local government SoE or CMA reporting.

These frameworks report independently of each other and are not delivered in an integrated or strategic manner. As such, they do little to inform state-wide SoE reporting, the *NSW 2021* state plan targets, or regional NRM prioritisation and investment processes. It is a goal of the NSW MER strategy to better integrate and streamline regional NRM reporting to enable local government reporting to inform State of Catchment reporting and vice versa (DECCW 2010a).

This Regional SoE provides a first step towards integrated reporting across a range of stakeholders.

Regional partnership

The *Local Government Act 1993* encourages regional reporting as it provides not just an isolated assessment of an area with an arbitrary administrative boundary (a council area) but a catchment and regional picture incorporating a range of environmental features. It also encourages collaborations, which allow broadscale projects to be implemented with better regional outcomes, and assists with management of shared resources, particularly rivers and areas of special ecological significance.

The Regional SoE Report Project partnership is between the Northern Rivers CMA and participating general councils and county councils in the Northern Rivers CMA Region (Figure 1). NSW Government agencies are also involved in the project providing expertise and data.

Involved agencies include Department of Premier and Cabinet, Division of Local Government, Office of Environment and Heritage, Department of Primary Industries, Department of Lands, NSW Office of Water, Ministry of Health, and the Food Authority.

Participating councils are:

- Ballina Shire Council
- Bellingen Shire Council
- Byron Shire Council
- Clarence Valley Council
- Coffs Harbour City Council
- Kempsey Shire Council
- Kyogle Shire Council
- Lismore City Council
- Nambucca Shire Council
- Port Macquarie – Hastings Council
- Richmond Valley Council
- Tweed Shire Council
- Far North Coast Weeds
- Richmond River County Council
- Rous Water

Photo by: Walter Bailey

Figure 1: Councils participating in the Regional SoE 2012

The tablelands councils — Armidale-Dumaresq, Glen Innes Severn, Guyra, Tenterfield, Walcha and Uralla — whilst being part of the Northern Rivers CMA Region, have not participated in this regional report as their boundaries cross multiple CMA regions and they have an existing tablelands alliance with neighbouring councils. Lord Howe Island, although part of the Northern Rivers CMA Region, does not form part of this report as it reports directly to the Office of Environment and Heritage (OEH) and is not governed by the *Local Government Act 1993.*

In this report, the 'reporting region' refers to the area covered by the 12 participating councils, and 'CMA Region' refers to the entire Northern Rivers CMA Region.

Report structure, indicators and data

The report is presented in four parts. Part 1 is the summary of findings. This document contains part 2, the individual chapters on the four themes. Part 3 is a web-based document containing report cards for each council and county council involved in the report; and Part 4 is a web-based collection of case studies.

The four environmental themes are:

1. People and the Environment
2. Biodiversity and Vegetation
3. Land and Soils
4. Water.

These themes were selected as they are compatible with the State-wide standard and targets established by the Natural Resources Commission (NRC 2005), the body that guides NRM and monitoring, evaluation and reporting in NSW. Each theme contains a number of resource categories which each have indicators and measures. There are 16 resource categories in total. Indicators relate to condition, pressure or response. Themes, resource categories and indicators are shown in Table 1.

The indicators focus on environmental condition as a better reflection of environmental state rather than pressure and response. As the first Regional SoE Report, it was considered important to provide a baseline of enviromental condition for the reporting region to then use as a guide when reporting again in 2016.

Data has been provided by all participating councils and county councils, OEH, Department of Primary Industries (DPI), Northern Rivers CMA, NSW Office of Water (NOW), Landcare and WetlandCare Australia. Not all councils and agencies could supply all the requested data, so in some instances there are data gaps. Where there are data gaps that cannot be filled, they are noted in the respective data table, figure or text. Major data gaps exist for wetlands, riparian vegetation, rocky reef biota and water quality. These are detailed in the text and are also recognised widely at regional, state and national levels (see DECCW 2009b; DECCW 2010b; State of the Environment 2011 Committee).

Data quality is highly variable, and a rating of data quality is provided for each indicator. Quality ratings were either provided by the data custodian or were based on discussion with the data custodian. High quality data indicates the data provider has confidence the data is accurate and reliable. Medium data quality is mostly accurate and reliable but has a small degree of error or uncertainty. Low quality data has inaccuracies and a large degree of uncertainty, which may be due to an incomplete dataset or the methods used to collect the data.

Photo: Yuraygir National Park, NSW
Photo by: Shane Ruming

Table 1: Themes, resource categories, indicators and measures used in the Regional SoE 2012 (C=Condition , P=Pressure, R=Response)

Section	Resource category	Indicator	Measure/s	C,P,R
		Theme 1: People and the environment		
1.1	**Regional climate characteristics**	Climatic conditions that prevailed in 2011–12	General description including rainfall, temperature and flooding	**C**
1.2	**Population characteristics and change**	Population growth and distribution	Census statistics from the Australian Bureau of Statistics for 2001, 2006 and 2011	**C**
		Population densities		**P**
1.3	**Climate change: reducing emissions and preparing for change**	Atmospheric carbon dioxide (CO_2) concentrations	CO_2 concentration in parts per million for 2012	**C**
		Annual greenhouse gas emissions — tonnes CO_2 equivalent (CO_2-e) per capita by LGA	Total energy consumption and emissions by LGA	**P**
			Council operational energy consumption (streetlights, service and infrastructure provision), total fuel consumption, and emissions by LGA	**P**
		Greenhouse gas abatement — tonnes of CO_2-e abated	Total renewable energy exported to the grid and tonnes CO_2-e abated by LGA	**R**
			Report on council abatement works for 2011–12 and estimated tonnes CO_2-e abated	**R**
1.4	**Surface water demand**	Extraction	Kilolitres consumed in total by LGA for 2010–12 and percentage residential and non-residential	**P**
			Total kilolitres consumed per connection by LGA 2010–12	**P**
1.5	**Waste**	Total waste generated	Total waste to waste management facilities by LGA and per capita for 2010–12	**C**
		Total waste diverted from landfill	Total waste recycled or diverted from landfill per capita for 2010–12	**R**
		Theme 2: Biodiversity and vegetation		
2.1	**Ecologically functional landscapes**	Habitat connectivity	Connectivity index based on Biodiversity Forecasting Tool (BFT) modelling	**C**
		Effective habitat area	Area based on BFT modelling	**C**
		Net vegetation change — clearing	Area cleared based on Statewide Landcover and Trees Study (SLATS) methodology	**P**
		Management of key habitats and priority areas	Number of national, state, regional and local plans and strategies in place to protect biodiversity	**R**
			Number of strategies, plans and programs guiding biodiversity management by LGA	**R**
2.2	**Native vegetation restoration**	Habitat areas restored	Area in hectares	**R**
		Environmental volunteers working on private and public land	Number of volunteer hours spent on habitat restoration	**R**
2.3	**Conservation reserves and agreements**	Actions to protect native vegetation	Area of land protected within the national park estate by LGA	**R**
		Council land-use zoning	Comparison of previous and current local environment plans (LEP) for area under environmental protection	**R**
		Land protected under conservation agreements	Number and area of agreements by type and agency	**R**
2.4	**Native flora and fauna**	Threatened species, populations and communities	Number by LGA	**C**
		Key threatening processes	Number by LGA	**P**
2.5	**Invasive species**	Extent of invasive weed species	Extent of area protected (hectares)	**C/P**
			High risk sites, pathways and priority sites identified (area, length and number)	**R**
		Extent of invasive weed control	Area and length of high risk sites and pathways treated	**R**
			Evidence of reduced weed impacts (area)	**R**
		Extent of pest fauna species	Current pest distributions	**C/P**

Table 1: Continued

Section	Resource category	Indicator	Measure/s	C,P,R
		Number of pest control programs	Current pest control programs by LGA	**R**
		Theme 3: Soils and land use		
3.1	**Soils**	Soil condition	Soil management unit condition by NSW MER Strategy indicator for 2012	**C**
3.2	**Land use**	Land managed within its capability	Land management by soil monitoring unit and NSW MER Strategy indicator for 2012	**P**
3.3	**Funded land and soils management activities**	State and federally funded soil and land management activities	Area of land under soil rehabilitation works	**R**
3.4	**Acid sulphate soils**	Extent of acid sulfate soils (ASS): hotspots and drainage density	Area of ASS hotspots, high and low risk ASS soils, and length of ASS drains	**P**
		Area of remediated acid sulfate soils, drains and associated wetlands	Area of ASS and associated wetlands remediated	**R**
		Theme 4: Water		
4.1	**Estuarine & freshwater rivers**	Water quality, macro invertebrates and fish condition	Ecohealth assessment results, NSW MER Strategy program results for water quality, macroinvertebrates, and fish condition	**C**
		Presence of riparian vegetation	Length or area of known riparian vegetation and condition of mapped riparian vegetation by LGA	**C**
		Waste water treatment plant (WWTP) performance	Volume and percentage of wastewater discharged to waterways and reused by LGA	**P/R**
		On-site sewage management system (OSMS) performance	Total number OSMS, number inspected per annum, number of failures and estimate of unknown or unregistered OSMS by LGA	**P/R**
		River restoration works and riparian vegetation restoration	Area or kilometres and activity or project type	**R**
		Stormwater improvement works and water sensitive urban design (WSUD) plans	Stormwater management and WSUD plans by LGA	**R**
			Stormwater improvement works for 2011–12 by LGA with associated costs	**R**
4.2	**Wetlands**	Wetland condition	Water quality, soil quality, biota and presence of pests from NSW MER Strategy program	**C**
		Wetland pressure	Catchment, hydrological and habitat disturbance and alteration from NSW MER Strategy program	**P**
		Wetland remediation	Area remediated by LGA	**R**
4.3	**Groundwater**	Groundwater quality	No data	**C**
		Groundwater extraction	Percent of long-term annual extraction limit allocated and risk category by groundwater source	**P**
		Number of groundwater dependent ecosystems (GDE) under water sharing plans	Water sharing plans status for 2012 and number of GDEs covered by them	**R**
4.4	**Near-shore marine**	Marine water quality	Beachwatch results for 2012 and marine Chlorophyll-a levels	**C**
		Rocky reef biota	Current status of seabed mapping, reef fish assemblages, mollusc and fish species richness and marine debris	**C**
		Area of marine protected areas	Area of marine protected areas in CMA Region and zoning for activities	**R**
		Coastline management	Status by LGA for coastal hazards mapping and coastal zone management plan preparation	**R**

The reporting region

The reporting region falls within the Northern Rivers CMA Region, which extends from the Camden Haven River south of Port Macquarie to the Queensland border in the north, and west to the tablelands (Figure 2). The Northern Rivers CMA Region is characterised some of the NSW coast's largest river systems, and by the Great Dividing Range and its presence so close to the coast. The coast itself is dotted with coastal lakes and estuaries, headlands and coastal wetlands. Just inland from the coastal lowlands is the escarpment of the Great Dividing Range, with hills and valleys and remnant forest. Further west the land rises to the plateau, with World Heritage–listed rainforest at Dorrigo, and surrounding agricultural land as the plateau extends west to the northern tablelands. The CMA Region is renowned for its biodiversity, with the Macleay–McPherson Overlap which results in both temperate and tropical species and ecosystems occurring in the same region, many at the extent of their range.
A similar overlap occurs in the adjacent marine waters, where temperate, subtropical and tropical waters meet, creating an outstanding diversity of marine life.

The Region's biodiversity is recognised through World Heritage areas, marine parks, an aquatic reserve, indigenous protected areas, and national parks and nature reserves which occupy 23% of the reporting region.

The area sustains increasing population levels, with associated industry, development and agriculture. Significant changes have occurred since European settlement, with major timber industries clearing large parts of the CMA Region in the late 1800s, clearing for agricultural use, and alterations of rivers and estuaries for water supply, cropping and other purposes. Current industries in the Region include grazing, timber, horticulture, cropping, commercial fishing, and tourism.

The Northern Rivers CMA Region faces a range of pressures including an increasing population centred on the coast, associated natural resource use and expanding urban areas. Monitoring of these pressures and their impacts is critical to allow timely management to prevent further degradation of an already impacted environment.

Photo: Estuary Photo by: Richmond Valley Council

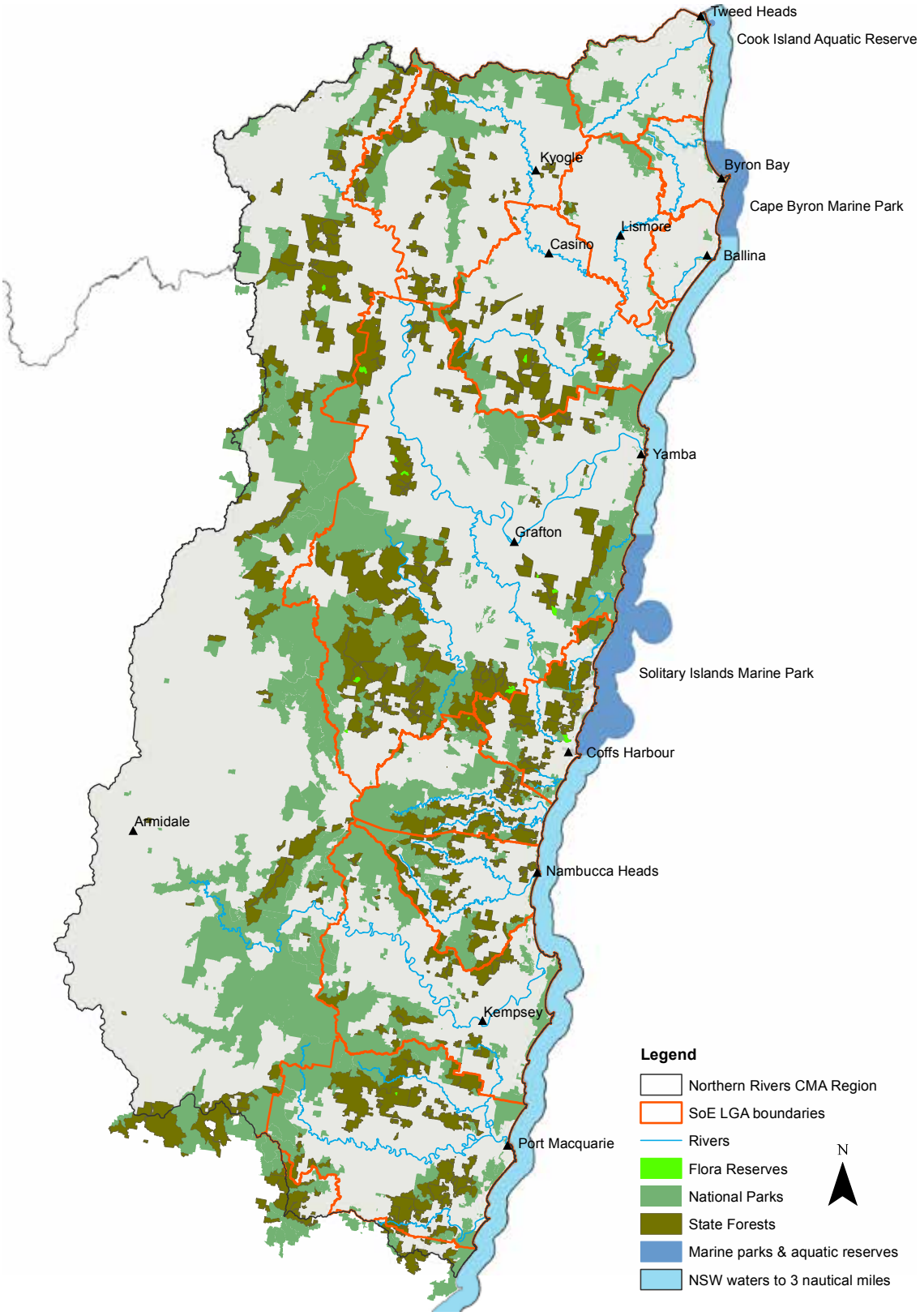


Figure 2: Key features of the Northern Rivers CMA Region

Bellwood restoration Nambucca Heads, NSW
Photo by Jacqui Ashby

1. People and the Environment

Population and growth place significant pressures on the natural environment, yet a healthy natural environment is essential for a liveable region. A growing population centred on the coast in already congested urban areas creates increased demand for energy, increased facilities for waste disposal, and increased surface water extraction. Climate change is placing additional pressures on the regional environment through changes in weather and extreme weather events.

These pressures need to be managed to ensure the natural environment is not further impacted by increasing population and climate change. This section discusses the current condition of the Region's population and climate, the pressures of population density, greenhouse gas emissions, water extraction and waste generation.

1.1 Regional climate characteristics

INDICATOR: Climatic conditions that prevailed throughout 2011–12 (CONDITION)
Data source: Bureau of Meteorology
Data quality: High

During 2011–12 the Northern Rivers CMA Region experienced a second La Niña cycle following on from the 2010–11 La Niña cycle, which was one of the strongest on record (BOM 2012a). This brought above average rainfall to the entire CMA Region, with January 2012 being the wettest on record in many parts of the Region, and the rest of the Region receiving their highest rainfall in 20 years. Flooding was extensive during January, February and early March 2012 in much of the Region, with relief later in March when rainfall was lower than average locally, while the rest of NSW experienced high rainfall. April 2012 brought increased rainfall again to the Region, particularly for the Tweed, while the rest of NSW dried out.

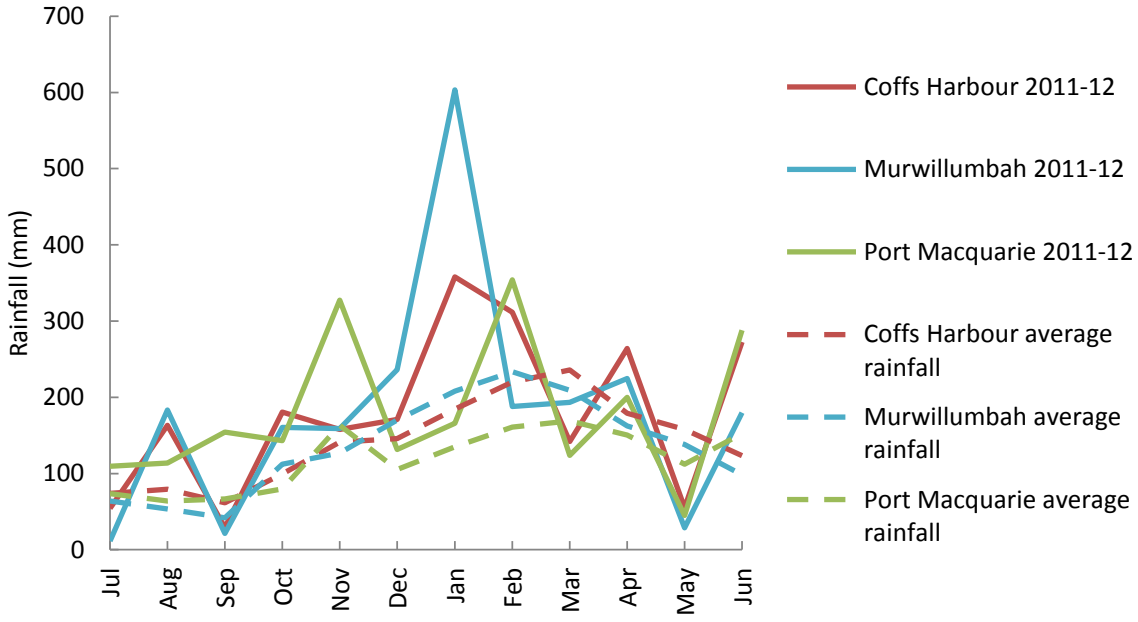


Figure 3: Rainfall for 2011–12 and average rainfall for three locations in the reporting region (Source: Bureau of Meteorology)

The La Niña cycle also brought cooler daytime maximum temperatures in summer and early autumn, and warmer night time minimums. January 2012 was 8°C cooler than the average due to the heavy cloud cover and increased rainfall (BOM 2012b). The end of autumn was colder than average due to clear dry conditions.

There was widespread flooding in Tweed, Byron, Clarence Valley, Bellingen, and Kempsey local government areas (LGA) in January 2012, with further rain in February resulting in many communities being isolated for some time. Figure 3 shows rainfall for three key locations for 2011–12 compared with the average. The figure shows that rainfall was above average for each of these locations during 2011–12, with Tweed receiving three times its average January rainfall in January 2012 (see Murwillumbah line), and Port Macquarie receiving double its average rainfall in November 2011 and February 2012.

Figure 4 shows rainfall anomalies for NSW for 2011–12 showing the extent of the extreme rainfall across NSW.

The extreme rainfall and widespread flooding caused water quality and river/estuary health issues due to the high nutrient and sediment loads that entered river systems during the floods. Some studies indicate that nutrient and sediment loads carried by floodwater are underestimated (Wallace et al. 2009). River systems do recover from floods, but reducing sediment and nutrient loads during flood events is possible with good land management practices and adequate riparian vegetation. These are discussed under Theme 4: Water.

Photo: Black-necked stork and spoon bills, 2009 flood waters Photo by: Clarence Valley Council

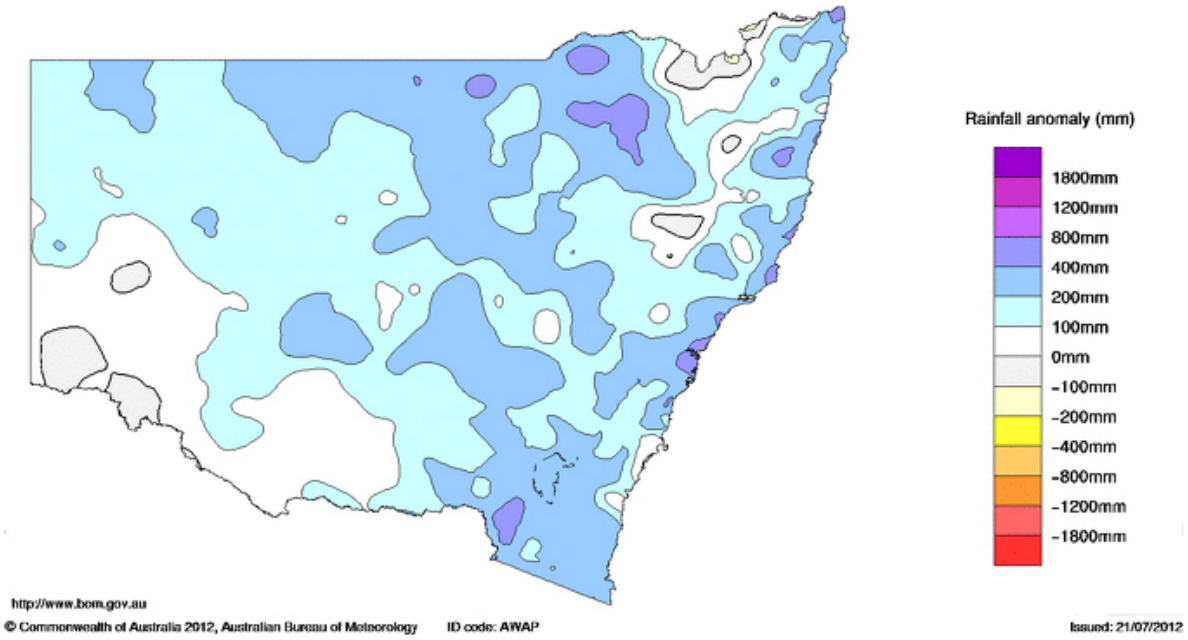


Figure 4: Rainfall anomalies for NSW for 2011–12 (Source: Bureau of Meteorology)

1.2 Population characteristics and change

INDICATORS: Population growth and distribution (CONDITION)
Population densities (PRESSURE)
Data source: Australian Bureau of Statistics Data quality: High

The Northern Rivers CMA Region of NSW is one of the fastest growing areas in the State, with population growth centred on the coast, particularly in Tweed, Port Macquarie-Hastings and Coffs Harbour LGAs. Since 2006, the population of Tweed LGA has grown by 6.5% above the NSW average of 5.8%. Port Macquarie-Hastings increased by 5.1% and Coffs Harbour by 4.4%. However, if we look at growth over the last 10 years, the population of Tweed Shire increased by 15.7% between 2001 and 2011 — almost double the NSW increase of 8.8%. In the same period, Port Macquarie-Hastings and Coffs Harbour LGAs increased by 12.8 % and 11.1% respectively (see Table 2 and Figure 5).

By contrast, there were also areas of little or no growth between 2006 and 2011, with LGAs such as Bellingen and Kyogle having a slight reduction in population, and Byron, Lismore and Ballina having very slight increases at or below 1% (ABS 2012). The resulting regional profile is one of high coastal population pressure which reduces with increasing distance from the coast. However, coastal growth is centred on the largest towns, with many smaller coastal LGAs having planned for higher population increases (based on previous population estimates) which have not eventuated. This shift in predicted population changes specifically to major coastal centres indicates employment, industry and economic growth are influencing population change.

This population profile is typical of NSW and the east coast of Australia, and places increasing pressure on state and local governments to manage the disproportionate growth along the coastal fringe.

Table 2: Population by LGA for 2001, 2006 and 2011 with percent change
(Source: Australian Bureau of Statistics)

Local Government Area	2001	2006	2011	% change since 2006	% change since 2001
Ballina	38,159	40,293	40,753	1.1	6.4
Bellingen	12,731	12,959	12,886	-0.6	1.2
Byron	29,689	30,700	30,825	0.4	3.7
Clarence Valley	48,617	50,089	51,252	2.3	5.1
Coffs Harbour	63,062	67,932	70,933	4.4	11.1
Kempsey	27,374	28,568	29,188	2.2	6.2
Kyogle	9,817	9,672	9,537	-1.4	-2.9
Lismore	43,064	44,166	44,282	0.3	2.8
Nambucca	18,171	18,649	19,286	3.4	5.8
Port Macquarie-Hastings	65,378	71,284	74,949	5.1	12.8
Richmond Valley	21,183	22,143	22,697	2.5	6.7
Tweed	74,577	83,089	88,463	6.5	15.7
NSW	**6,575,217**	**6,816,087**	**7,211,468**	**5.8**	**8.8**

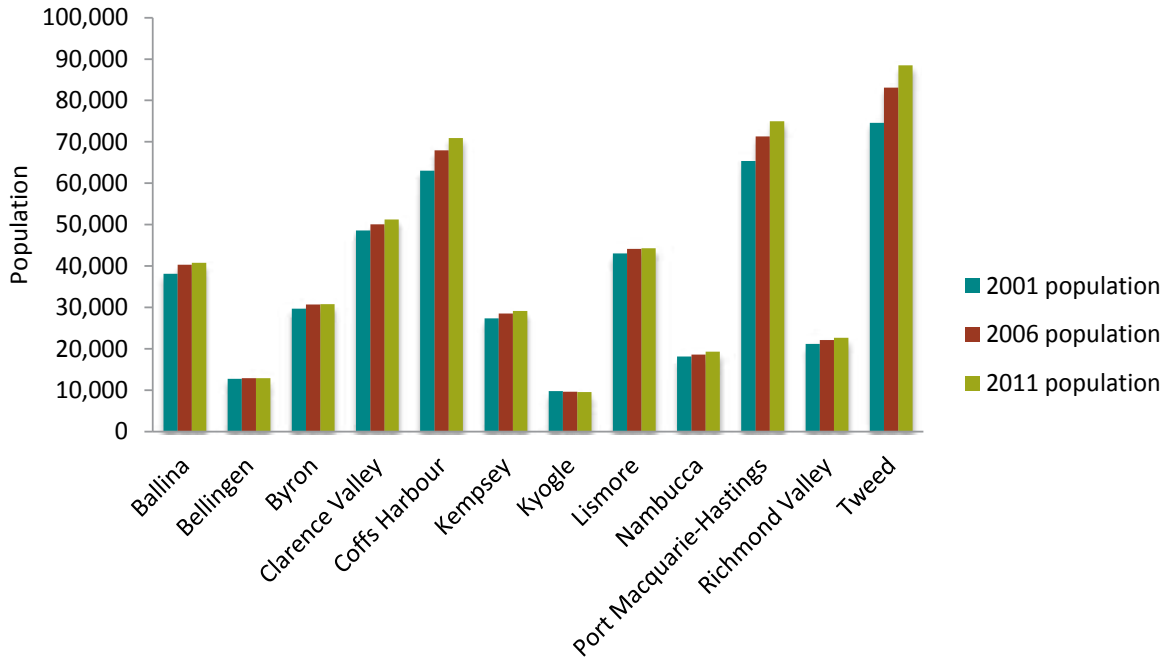


Figure 5: Population change by LGA for 2001, 2006 and 2011
(Source: Australian Bureau of Statistics)

Population density is highest in the Ballina, Tweed and Coffs Harbour LGAs, with densities of 80, 65 and 58 people per square kilometre respectively. Kyogle had the lowest population density at 2.6 people per square kilometre, with Clarence Valley next lowest at 4.8 (ABS 2012).

The range of population pressures across the region means each council needs to accommodate these pressures in their community strategic plans. Tweed, Port Macquarie-Hastings and Coffs Harbour councils need to plan for increased coastal pressures from increased population and densities, whereas Kyogle, Bellingen, Lismore and Byron must plan for stable or possible decreases in population.

1.3 Climate change: reducing emissions and preparing for change

INDICATOR: Atmospheric carbon dioxide concentrations (CONDITION)
Data source: CSIRO Data quality: High
INDICATORS: Emissions per capita and annual council emissions (PRESSURE)
Greenhouse gas abatement – tonnes of carbon dioxide equivalent (RESPONSE)
Data source: Commonwealth of Australia, councils, county councils, Essential Energy Data quality: Medium to high

In 2011–12 northern NSW experienced a second La Niña cycle following on from the extreme 2010–11 La Niña cycle — together forming the most extreme La Niña event on record. At this time, ocean temperatures in northern Australia were the warmest on record, reflecting the global trend of increasing air and water temperatures (BOM 2012a). Atmospheric concentrations of greenhouse gases are measured globally, and carbon dioxide is the greenhouse gas of greatest importance as it has been the largest contributor to global warming (IPCC 2007). Greenhouse gas emissions are calculated by converting them to carbon dioxide equivalent (CO_2-e), which allows comparison across all emissions relative to carbon dioxide concentration.

1.3.1 Atmospheric carbon dioxide concentrations

There are no local or regional data on carbon dioxide concentrations, so this section discusses national trends. Cape Grim in Tasmania has been monitoring the atmospheric concentration of carbon dioxide since 1976, and is one of the three premier baseline air pollution stations in the World Meteorological Organization's Global Atmosphere Watch network. The Cape Grim Baseline Air Pollution Station monitors southern hemispheric air, while in the northern hemisphere the Mauna Loa Observatory in Hawaii has been continuously monitoring and collecting data related to atmospheric change since the 1950s. The third monitoring station is in Greenland (CSIRO 2012).

In April 2012 the concentration of carbon dioxide at Cape Grim was 388.8 parts per million (ppm), indicative of the rising trend since 1976 (see Figure 6). Figure 7 shows the historical change in greenhouse gas concentrations from all known data sources over the past 1000 years (State of the Environment 2011 Committee).

Photo: Rigby House, Coffs Harbour
Photo by: Si-Clean Energy, Coffs Harbour

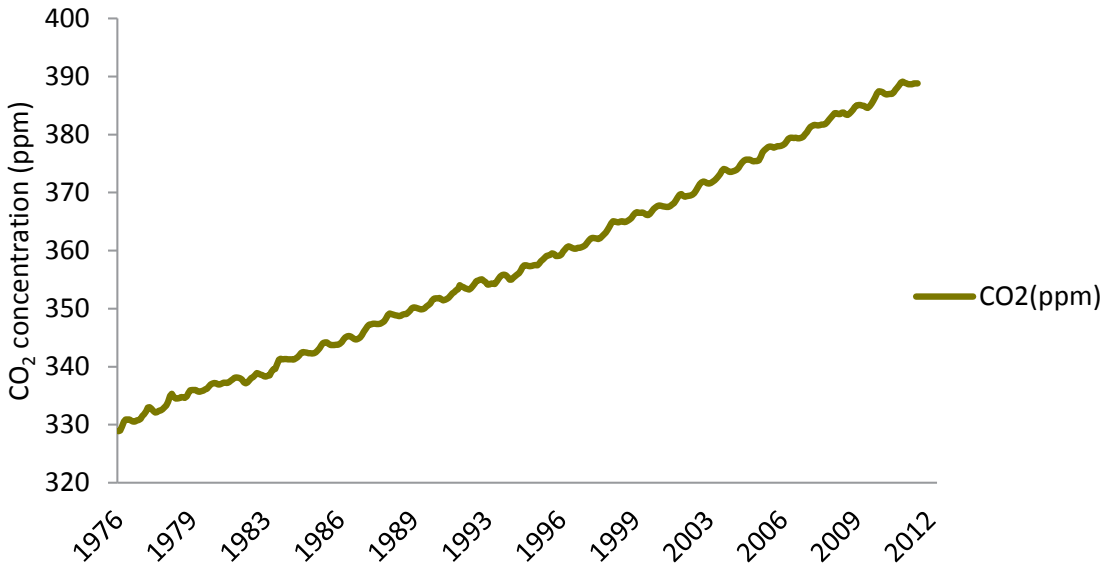


Figure 6: Atmospheric carbon dioxide concentrations measured at Cape Grim, Tasmania (Source: CSIRO)

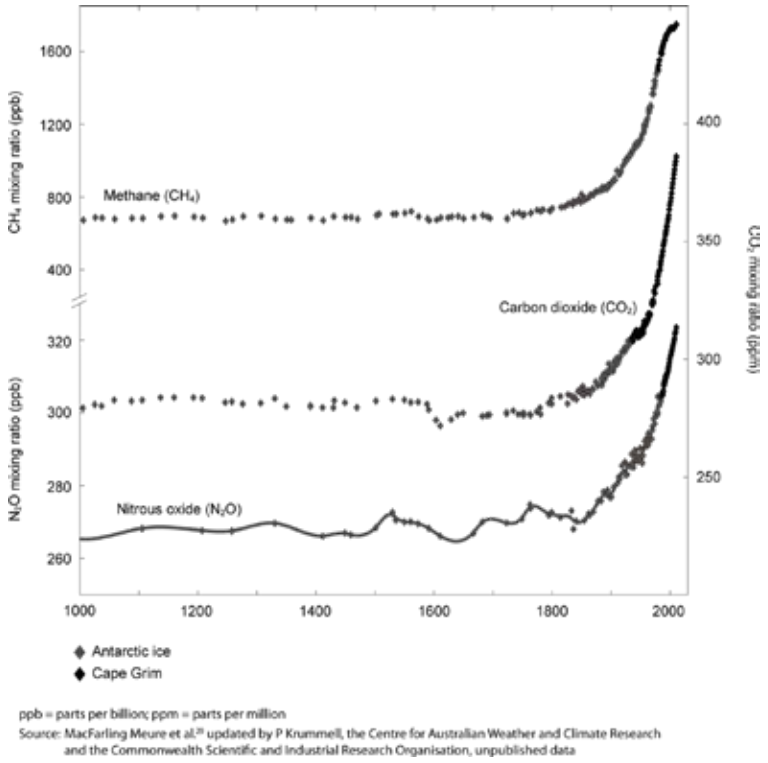


Figure 7: Major greenhouse gas levels over the past 1000 years
(Source: State of the Environment 2011 Committee)

1.3.2 National greenhouse gas emissions

There are no local data so this section discusses national trends. Australia's annual emissions for the year to March 2012 are estimated to be 546.8 megatonnes (Mt) CO2-e which represents an increase of 0.3% compared to the year to March 2011. Increases in emissions in the year to March 2012 came from transport and agriculture: primarily diesel use in heavy vehicles and increased livestock numbers due to restocking at the end of drought conditions.

Electricity consumption decreased, associated with the cooler weather conditions brought by the La Niña cycle, and there were some decreases in emissions from industry (Department of Climate Change and Energy Efficiency 2012).

Reporting from Australia's national greenhouse gas inventory indicates emissions are steadily returning to the peak observed in the year to March 2009. Per capita, Australians currently emit 25.4 tonnes CO_2-e per annum. Nationally since 1990, emissions have grown by 30.8% from 418.0 Mt CO_2-e to the present level of 546.8 Mt CO_2-e. Figure 8 shows the increase by sector, with electricity showing the strongest growth, followed by stationary energy and then transport (Department of Climate Change and Energy Efficiency 2012).

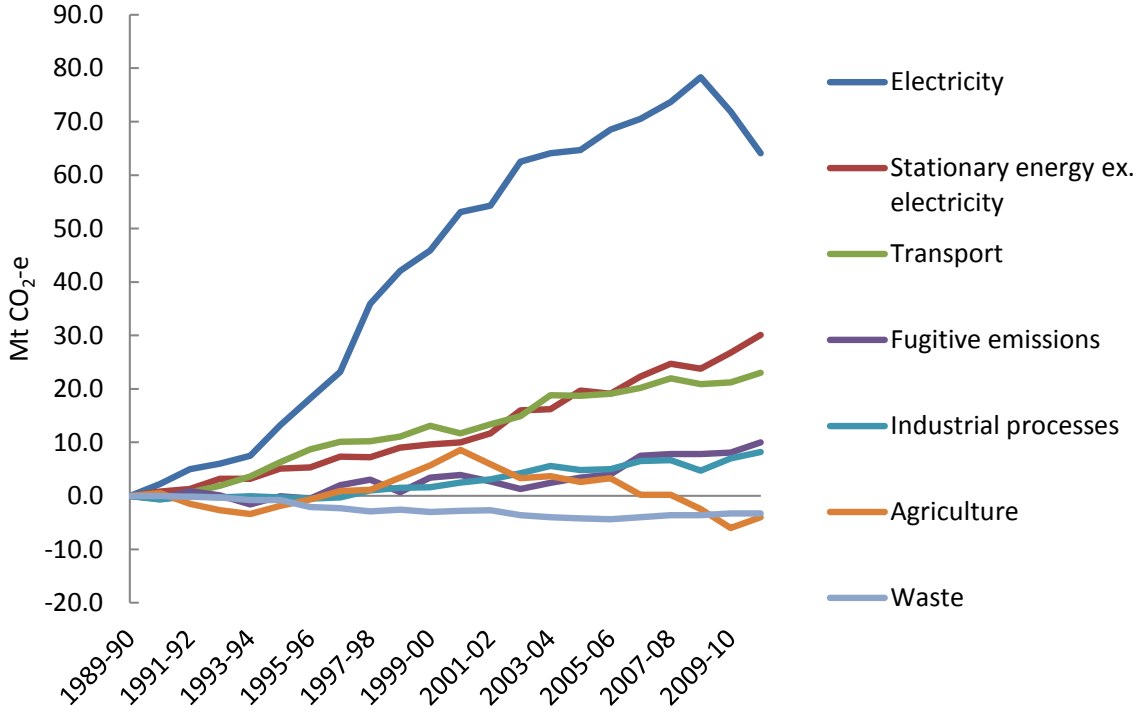


Figure 8: Carbon dioxide equivalent emissions by sector
(Source: Department of Climate Change and Energy Efficiency)

1.3.3 Local greenhouse gas emissions

With electricity being the highest sector contributing to greenhouse gas emissions in Australia, reducing energy consumption is essential to reducing emissions.

Additionally, reducing energy consumption is essential to manage the electricity demands of a growing population.

Regional greenhouse gas emissions

Essential Energy, the primary energy provider in the CMA Region, provided total energy consumption data by postcode for 2011–12, which was apportioned to the relevant LGA. This information was used to generate per capita energy consumption for each LGA and for the reporting region (see Table 3 and Figure 9). Results show that per capita energy consumption is fairly consistent across the reporting region, with an average of 7.6 tonnes CO^2-e emitted per person.

Table 3: Electricity consumption and greenhouse gas emissions by LGA
(Source: Essential Energy)

Local Government Area	Total electricity consumption (GWh)	Electricity consumption per capita (kWh)	Tonnes CO_2-e emitted per capita
Ballina	337	8,277	7.4
Bellingen	91	7,081	6.4
Byron	280	9,093	8.2
Coffs Harbour	495	6,984	6.3
Clarence Valley	578	11,280	10.2
Kempsey	187	6,413	5.8
Kyogle	98	10,266	9.2
Lismore	344	7,771	7.0
Nambucca	156	8,114	7.3
Port Macquarie-Hastings	546	7,291	6.6
Richmond Valley	200	8,822	7.9
Tweed	743	8,404	7.6
Reporting region	4,058	8,495	7.6
Total tonnes CO_2-e emitted for the reporting region: 3,652,383 tonnes			

For the reporting region, a total of 4,058 gigawatt hours of electricity was consumed, emitting 3.65 million tonnes of CO_2-e.

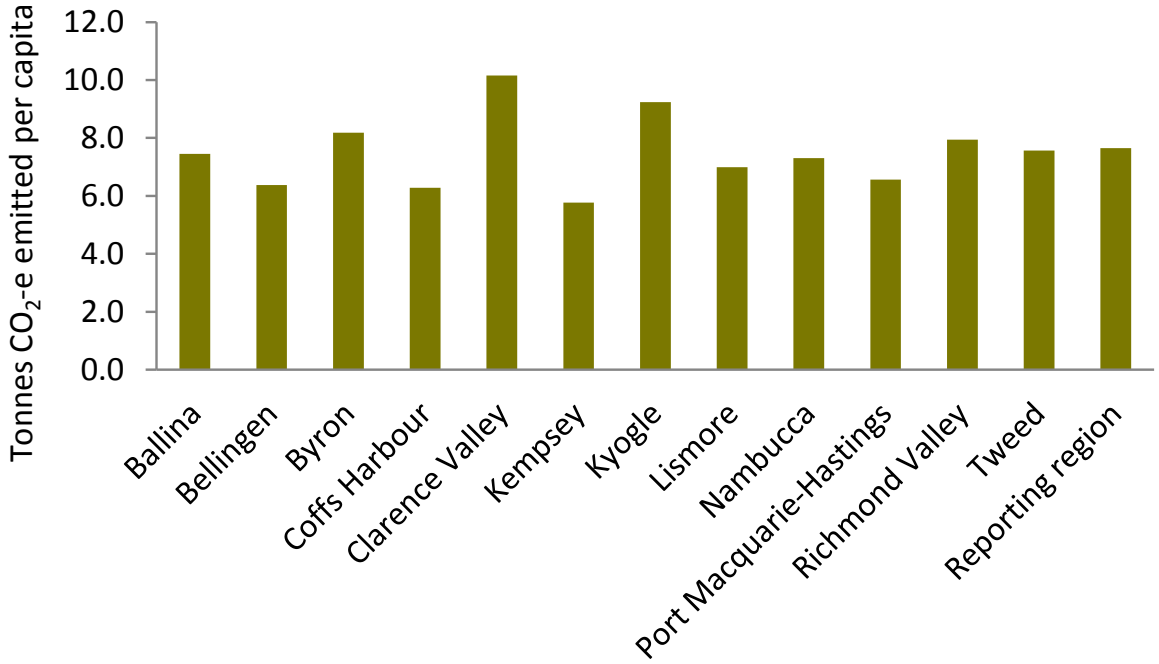


Figure 9: Tonnes CO_2-e emitted per person from electricity consumption for 2011-12 (Source: Essential Energy)

Council greenhouse gas emissions

Council energy and fuel consumption was obtained for 2011-12. Council energy consumption includes all council assets and buildings such as office and library buildings, depots, sewerage treatment plants, water treatment facilities, swimming pools and street lighting. Fuel consumption includes use by all council vehicles and plant equipment. For all councils, emissions from general electricity consumption are the largest contributor to the total greenhouse gases, and consumption is highly variable. Coffs Harbour, Kempsey and Tweed councils have the highest per capita electricity consumption, with Nambucca and Richmond Valley having the lowest. Greenhouse gas emissions from streetlighting are generally stable across all councils, however Coffs Harbour council has the lowest streetlighting energy consumption per capita, and Lismore and Kempsey councils the highest. Fuel consumption is also variable across the reporting councils, with Kyogle, Richmond Valley and Lismore having the highest per capita fuel consumption, and Byron the lowest. Table 4 and Figure 10 summarise greenhouse gas emissions by LGA for electricity, fuel and streetlighting. However, emissions should not be directly compared between LGAs as the services provided by the three county councils span multiple northern LGAs and need to be taken into consideration when interpreting the emmissions of individual LGAs. Richmond River County Council services Ballina, Lismore and Richmond Valley LGAs; Far North Coast Weeds services Tweed, Byron, Ballina, Kyogle, Lismore, and Richmond Valley LGAs and Rous Water supplies water to Ballina, Byron, Lismore and Richmond Valley LGAs. In the southern LGAs, these services are all provided by individual LGAs.

Table 4: Greenhouse gas emissions by LGA and per capita for electricity, streetlighting and fuel consumption by councils for 2011-12 (Source: Councils)

Local Government Area	Electricity	Street lighting	Fuel	Total emissions tonnes CO_2-e	Tonnes CO_2-e per capita
		Tonnes CO_2-e per capita			
Ballina	0.18	0.040	0.04	10,415	0.26
Bellingen	0.13	0.027	0.07	2,851	0.22
Byron	0.16	0.029	0.03	6,640	0.12
Clarence Valley	0.13	-	0.05	-	-
Coffs Harbour	0.21	0.025	0.04	19,412	0.27
Kempsey	0.21	0.051	0.06	9,482	0.32
Kyogle	-	0.041	0.12	-	-
Lismore	0.13	0.052	0.06	10,492	0.24
Nambucca	0.11	0.033	0.05	3,666	0.19
Port Macquarie-Hastings	-	-	0.03		-
Richmond Valley	0.08	0.043	0.08	4,747	0.21
Tweed	0.20	0.029	0.04	23,610	0.27

County Councils	Electricity emissions tonnes CO_2-e	Fuel emissions tonnes CO_2-e	Total emissions tonnes CO_2-e
Far North Coast Weeds		60.8	
Richmond River County Council	3,795	37.4	4,135
Rous Water		241.3	

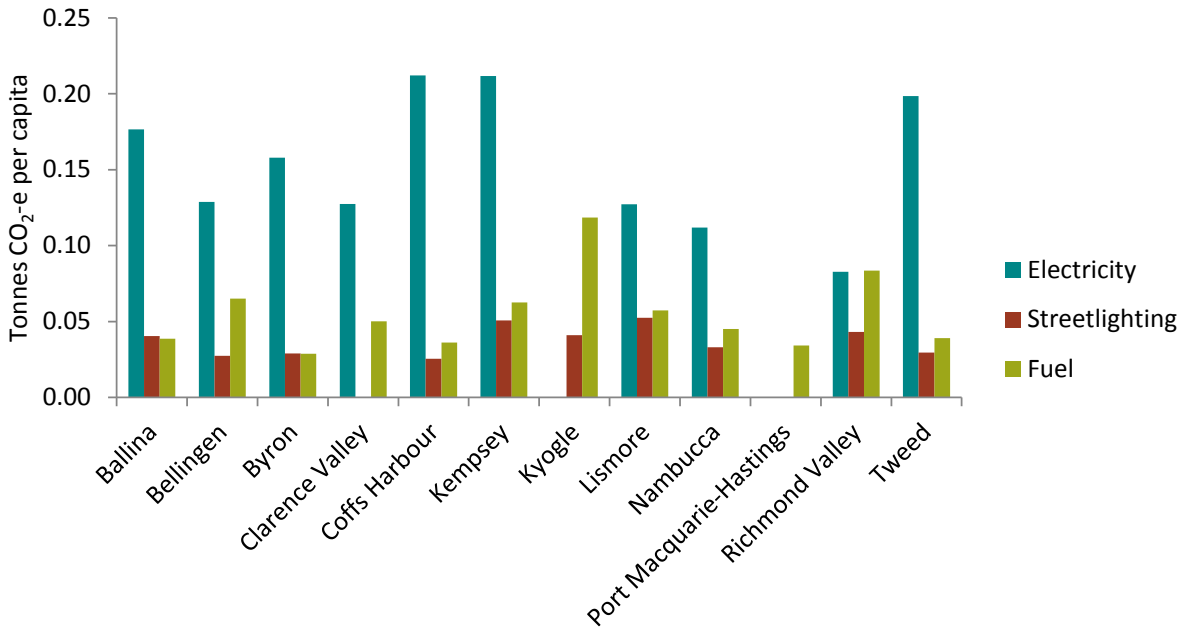


Figure 10: Greenhouse gas emissions by LGA and per capita for electricity, streetlighting and fuel consumption by councils in 2011-12 (Source: Councils)

1.3.4 Greenhouse gas abatement

In response to increasing greenhouse gas emissions, councils are actively reducing their energy and fuel consumption. The recent introduction of the carbon tax in 2012 has implications for some Northern Rivers Region councils and businesses, with two councils in the reporting region (Clarence Valley and Port Macquarie-Hastings) subject to the carbon tax due to their landfill operations.

Under the Cities for Climate Change program, councils within the reporting region have implemented a variety of measures to reduce energy and fuel consumption such as:

- upgrading streetlighting to low energy lighting
- installing solar power on multiple council buildings
- retrofitting office building lighting and air conditioning to increase energy efficiency
- improving fleet vehicles
- using specialised monitoring services to identify where further efficiencies can be made
- conversion of methane to energy from waste management facilities

Table 5 provides a summary of measures to reduce emissions that councils in the reporting region have implemented. Not all actions have had emissions estimates calculated, but the various initiatives have resulted in at least 31,464 tonnes CO_2-e being abated in the reporting region.

Table 5: Tonnes CO2-e abated through council initiatives (Source: Councils)

Local Government Area	Abatement description	Tonnes CO_2-e abated 2011-12
Ballina	Comprehensive fleet management system, use of biodiesel, 5 council buildings with solar power, continuous energy monitoring and regular energy audits, streetlighting upgrade complete	442
Bellingen	Streetlighting upgrade, swimming pool management changes, waste water treatment plant upgrades, solar system installations, improved vehicle management	300
Byron	Streetlighting upgrade in 2011, three solar power installations, five solar hotwater installations	6,400
Clarence Valley	Currently upgrading vehicle fleet to more fuel efficient and diesel vehicles	
Coffs Harbour	Large solar power installation at Rigby House, Administration building retrofit, bicycle fleet for short trips, streetlighting upgrade in 2002 still performing well, and the Englands Rd landfill gas flare	9,960
Kempsey	Large solar power installation for depot will be operational for 2012-13 year, ongoing vehicle efficiency monitoring with software, streetlighting upgrade undertaken in 2009	
Lismore	Use of biodiesel in vehicles and removing 6 cylinder vehicles, waste water treatment plant improvements, community and council education	251
Nambucca	Streetlighting energy efficiency upgrade to be conducted in 2013	
Port Macquarie - Hastings	Solar power installation on the library building and council administration building air-conditioning retrofit	150
Richmond Valley	Solar power installation (40kWh) and insulation of records room. Upgrading of streetlighting to be conducted in 2013	61
Tweed	Stotts Creek methane gas extraction system, streetlighting upgrade in 2011, vehicle fleet improvements increasing the use of diesel and four cylinder vehicles, solar power installations on 22 council buildings	13,900
	TOTAL	31,464

With the success of the various solar power incentives programs, 8.5% of houses in NSW now use solar power.

Figures released in April 2012 by the Clean Energy Regulator show that the Northern Rivers CMA Region has five of the top 10 NSW solar postcodes (see Table 6).

Table 6: Postcodes with the highest number of household solar installations
(Source: Renew Economy 2012)

Local Government Area	Postcode	Suburbs	% houses with solar power systems
Ballina	2477	Alstonville, Wardell, Wollongbar, Rous, Meerschaum Vale	21.20%
Tweed	2486	Banora Point, Tweed Heads South, Bilambil	20.00%
Tweed	2484	Murwillumbah	18.40%
Ballina	2478	Ballina, Lennox Head	17.30%
Tweed/Byron	2483	Brunswick Heads, Ocean Shores, Billinudgel	16.60%

Data provided by Essential Energy for 2011–12 shows that approximately 128 kilowatt hours of renewable electricity were fed back to the grid per person in the reporting region, generally originating from solar power installations on homes and business buildings. This resulted in an overall CO_2-e abatement of 110 kilograms per person, or a total of 54,890 tonnes for the reporting region as shown in Table 7. This information will continue to be obtained over the next four years to compare the change in the amount of renewable energy fed back to the grid for the next SoE report.

Table 7: Renewable energy generated per capita (Source: Essential Energy)

Local Government Area	Total renewable energy produced (GWh)	Renewable energy produced per capita (kWh)	Tonnes CO_2-e abated per capita
Ballina	7.0	171.5	0.15
Bellingen	1.7	134.4	0.12
Byron	4.1	133.5	0.12
Coffs Harbour	5.9	82.5	0.07
Clarence Valley	6.7	129.9	0.12
Kempsey	2.2	76.6	0.07
Kyogle	1.2	129.4	0.12
Lismore	5.5	125.1	0.11
Nambucca	2.0	101.1	0.09
Port Macquarie-Hastings	8.8	117.1	0.11
Richmond Valley	2.9	127.4	0.11
Tweed	13.0	147.1	0.13
Reporting region	61.0	127.7	0.11
Total CO_2-e abated for the reporting region: 54,889.8 tonnes			

Ballina and Tweed LGAs have the highest level of renewable energy generation, with Kempsey and Coffs Harbour the lowest generators as shown in Figure 11. Although there is an increase in the uptake of renewable energy generation by businesses and the community, the quantity of energy produced is very low compared with the overall level of electricity consumption. At this point, renewable energy fed back to the grid only accounts for 1.5% of electricity consumption across the reporting region.

Following page: photos from Tweed Shire Council

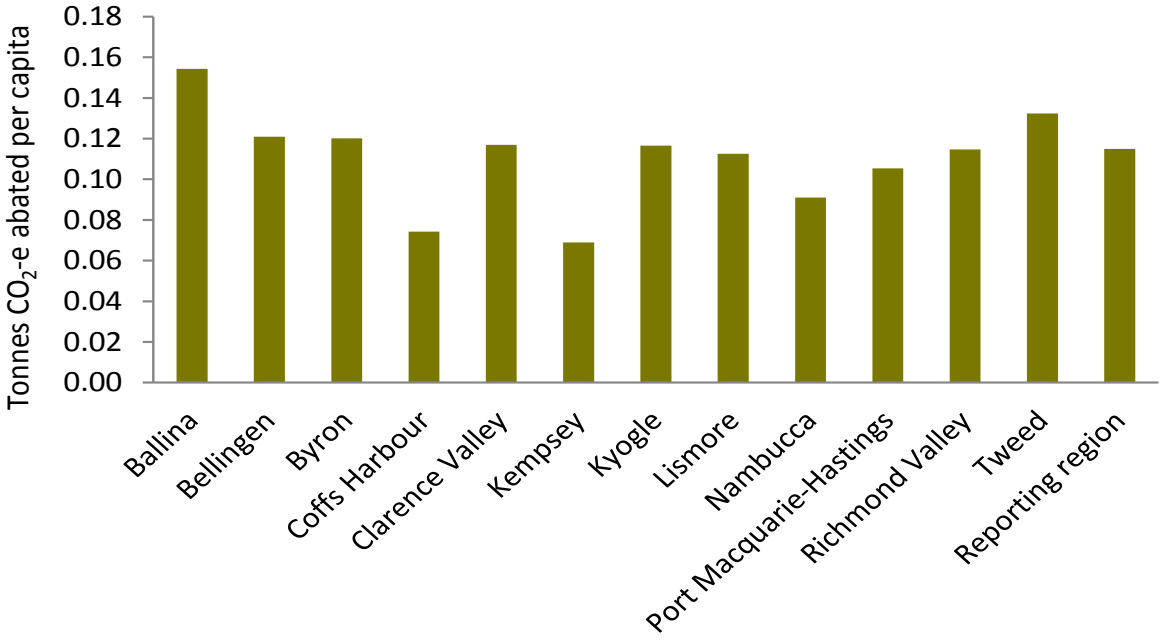


Figure 11 : Renewable energy fed back to the grid in the reporting region in 2011–12
(Source: Essential Energy)


DAEDONG

1.4 Surface water demand

INDICATOR: Surface water extraction (PRESSURE)
Data: Data source: Councils and county councils
Data quality: High

Water extraction places pressure on our rivers and on groundwater, particularly during low rainfall times when river flows are low and aquatic life can be impacted. Water-saving initiatives have been in place for some time in the CMA Region, and thanks to the high rainfall the Region receives, strict water restrictions have not had to be implemented. The water consumption figures in Table 8 show that consumption of mains water per connection has remained steady over the past two years in most areas.

Table 8: Water consumption in the reporting region (Source: Councils)

	2010-11			2011-12				
Local Government Area	Total ML	Number of connections	KL per connection	Total ML	Number of connections	KL per connection	Trend	Residential/Non-residential split
Ballina	2,744	11,093	247	2,731	12,268	223	steady	78% / 22%
Bellingen	1,151	4,334	266	1,178	4,371	269	steady	46% / 54%
Byron	2,763	11,409	242	2,668	11,600	230	slight decrease (5%)	61% / 39%
Coffs Harbour	5,758	24,410	236	6,421	24,650	260	slight increase (9%)	56% / 44%
Clarence Valley	4,567	19,492	234	4,561	19,766	231	steady	60% / 40%
Kempsey	3,434	11,362	302	3,321	11,409	291	steady	47% / 53%
Kyogle	367	1,913	192	363	1,915	190	steady	74% / 26%
Lismore	3,302	13,158	251	3,260	13,248	246	steady	67% / 33%
Nambucca	1,535	6,690	229	1,476	5,884	251	slight increase (9%)	51% / 49%
Port Macquarie-Hastings	5,730	29,950	191	5,567	30,250	184	steady	70% / 30%
Richmond Valley	-	-	-	1,908	7,350	260	-	36% / 64%
Tweed	8,487	24,110	352	8,275	24,258	341	steady	62% / 38%
Rous Water*	11,142	-	-	11,132	-	-	steady	-
Reporting region				41,728	166,969	248	-	-

*Rous Water supplies water to Ballina, Byron, Lismore and Richmond Valley LGAs, who then measure consumption within their LGAs

Some areas rely on groundwater for general water supply, such as Kempsey Council, which sourced 43% of its water supply from groundwater in 2010–11 and 37% in 2011–12. Rous Water also have four bores which supply groundwater when required, however, these bores have not been used in the past two years. A change in rainfall conditions may increase the reliance on groundwater for general water supply over the next few years. The condition of groundwater is discussed under the Water theme (Section 4.3).

1.5 Waste

INDICATORS: Total waste generated (PRESSURE)
Total waste diverted from landfill (RESPONSE)
Data: Data source: Councils and county councils
Data quality: High

With increasing populations and the increased costs and issues associated with waste disposal, councils are working to reduce the total amount of waste generated and the amount of waste sent to landfill, and increase reuse and recycling. The reporting region is facing waste disposal challenges, as landfills are nearing capacity in many LGAs, costs are increasing, and emissions from landfills are leaving some councils with shared landfill facilities exposed to the newly introduced carbon tax. As such, councils are endeavouring to reduce waste from all sectors.

Councils in the reporting region provided waste data for two years from 2010–12, shown in Figure 12 and Table 9.

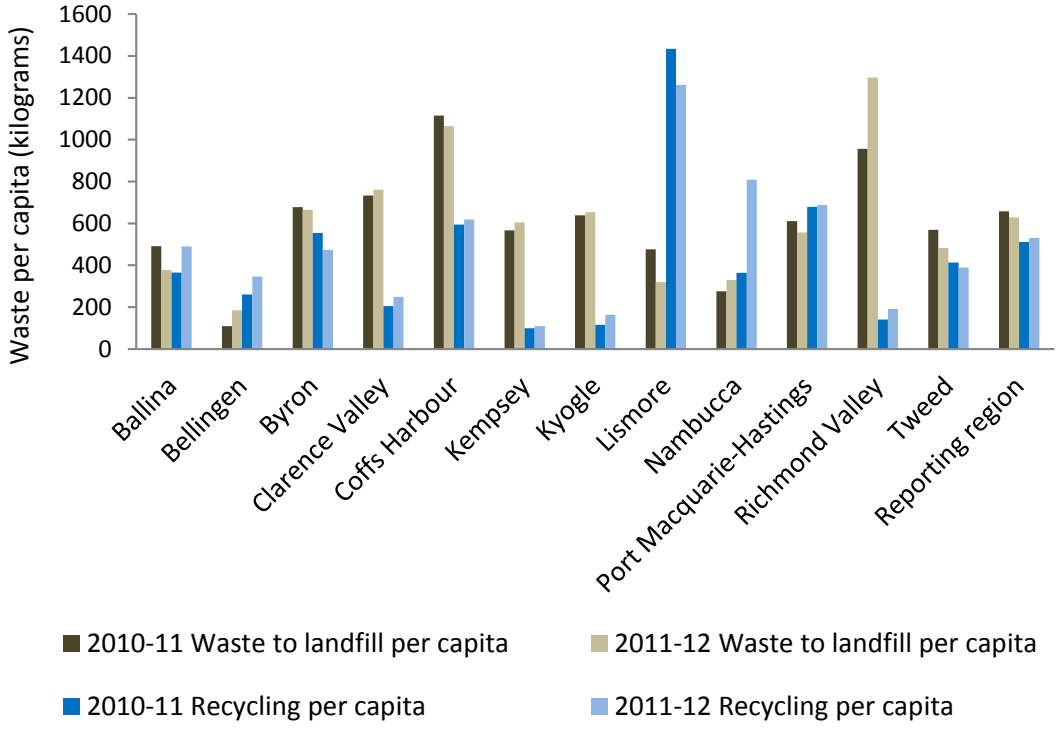


Figure 12: Waste generated and recycling per capita by LGA (Source: Councils)

Data indicates a regional trend to reduced total waste, with a regional waste reduction of 11,909 tonnes (2%) between 2010 and 2012. Waste sent to landfill decreased by 16,682 tonnes (5%) over the two-year period, and the amount of waste recycled increased by 4,772 tonnes (2%). Total green waste diverted from landfill made the biggest increase, increasing by 9.2% over the two-year reporting period.

Per capita the reporting region sent 658 kilograms of waste to landfill in 2010–11, down to 624 kg in 2011–12; and recycled 511 kg waste in 2010–11, increasing to 521 kg per person in 2011–12.

The individual councils across the reporting region varied in their performances over the two-year reporting period, as shown in Table 9.

Table 9: Waste per capita in the reporting region in 2010 and 2012 and two-year trends
(Source: Councils)

	Total waste per capita (kg)			Total waste to landfill per capita (kg)			Total waste recycled per capita (kg)		
LGA	2010-11	2011-12	% change	2010-11	2011-12	% change	2010-11	2011-12	% change
Ballina	855.7	867.9	1% rise	490.8	377.5	23% drop	364.9	490.4	34% rise
Bellingen	369.3	531.4	44% rise	109.2	185.1	70% rise	260.1	346.3	33% rise
Byron	1,232.6	1,138.9	8% drop	678.0	665.0	2% drop	554.5	473.9	15% drop
Clarence Valley	938.6	1,010.2	8% rise	733.5	761.3	4% rise	205.1	248.9	21% rise
Coffs Harbour	1,709.1	1,683.1	2% drop	1,115.0	1,064.3	5% drop	594.0	618.9	4% rise
Kempsey	666.3	713.6	7 % rise	566.4	604.5	7% rise	99.9	109.1	9% rise
Kyogle	753.8	818.1	9% rise	638.3	654.4	3% rise	115.5	163.7	42% rise
Lismore	1,910.0	1,580.9	17% drop	475.7	319.7	33% drop	1,434.3	1,261.2	12% drop
Nambucca	640.4	810.3	27% rise	276.3	227.2	18% drop	364.1	583.1	60% rise
Port Macquarie-Hastings	1,289.6	1,245.3	3% drop	610.6	557.0	9% drop	679.0	688.3	1% rise
Richmond Valley	1,097.5	1,488.7	36% rise	956.1	1,297.2	36% rise	141.4	191.4	35% rise
Tweed	982.1	872.5	11% drop	568.9	483.0	15% drop	413.2	389.5	6% drop
Reporting region	1,169.5	1,145.5	2% drop	658.1	624.4	5% drop	511.4	521.0	2% rise

There are difficulties reporting on waste by LGA as each council collects waste data differently, and many waste operators collect waste from more than one council area, and may dispose of it in another area. Therefore the figures reported here are accurate for the reporting region, but may not be accurate at LGA-level. For example, Lismore Council had the greatest decrease in waste overall per person, with a 17% reduction over the two-year period. However, part of this decrease was due to 6,000 tonnes of waste being diverted to Richmond Valley Council's facilities. When taken into account, Lismore still had a reduction in total waste generated of 10%, the second biggest reduction after Tweed. Tweed and Byron councils significantly reduced their waste by 11% and 8% respectively, and Coffs Harbour and Port Macquarie-Hastings councils showed small reductions in overall waste.

Bellingen Council had the lowest level of waste generation in the reporting region at 531.4 kg per capita, followed by Kempsey at 713.6 kg per capita and Nambucca at 810.3 kg per capita. The highest levels of waste generation per capita were in Clarence Valley at 1,683.1 kg per capita, followed by Lismore at 1,580.9 kg per capita.

Bellingen Council has the largest increase in waste per person overall (44%), followed by Richmond Valley (36%) and Nambucca (27%). However, Nambucca's increase was in recycling (60% increase) rather than waste to landfill, whereas Bellingen had a large increase in waste to landfill (70%) with a 33% increase in waste to recycling. Despite these increases, Bellingen and Nambucca remain some of the lowest contributors to waste per capita in the reporting region. Richmond Valley is now receiving waste previously sent to Lismore's facilities, so when this is taken into account, Richmond had a local increase of 11.5%.

Many LGAs within the reporting region are trialling methods to reduce waste and associated greenhouse gas emissions. Tweed Council is generating energy from waste, with 2,973 megawatt hours produced in 2011–12, abating an estimated 12,900 tonnes of CO_2-e emissions. Byron Shire has installed a pilot landfill gas flare at the Myocum landfill facility. The flare is projected to destroy 5,900 tonnes of CO_2-e in 2012–13, which will significantly reduce council's carbon footprint. The Coffs Coast Resource Recovery Facility operates a gas flare which abates an estimated 9,800 tonnes CO_2-e. Ballina Council has decreased the overall amount of waste going to landfill as recycling participation has increased and organic waste has been diverted from landfill and composted. Targeted education and communication initiatives continue and research into energy harnessing innovations is in progress.

Photo by: Clarence Valley Council

Mongrove seedling

Photo by Nigel Blake

2. Biodiversity and Vegetation

The Northern Rivers CMA Region of NSW is renowned as one of the most biologically diverse areas in Australia. Appropriate management of pressures on biodiversity and vegetation is essential to ensure current condition is maintained or improved as per the targets in *NSW 2021: A plan to make NSW number one,* NSW MER Strategy and the Northern *Rivers Catchment Action Plan.*

These targets include:

NSW 2021:

- Protect and restore priority land, vegetation and water habitats (Goal 22)
- Manage weeds and pests; protect and conserve land, biodiversity and native vegetation; protect rivers, wet ands and coastal environments.

NSW Monitoring, Evaluation and Reporting (MER) Strategy:

- By 2015 there is an increase in native vegetation extent and an improvement in native vegetation condition.
- By 2015 there is an increase in the number of sustainable populations of a range of native fauna species.
- By 2015 there is an increase in the recovery of threatened species, populations and ecological communities.
- By 2015 there is a reduction in the impact of invasive species.

Northern Rivers CMA Catchment Action Plan (currently under review)

- By 2016, improve the condition of native terrestrial and aquatic ecosystems.

This section discusses the current condition of the Region's biodiversity and vegetation; the pressures of habitat loss, clearing and invasive species; and the responses by state and local government to species and vegetation protection, management of key habitats and restoration programs.

Photo by: Walter Bailey

2.1 Ecologically functional landscapes

INDICATORS: Habitat connectivity and effective habitat area (CONDITION)
Net vegetation change – clearing (PRESSURE)
Data: Data source: OEH

INDICATOR: Management of key habitats and priority areas (RESPONSE)
Data: Data source: Government agencies (various), councils and county coucils

The reporting region covers a diverse area of habitats and vegetation types, and assessing the current condition of these vegetation types and habitats is an ongoing task. Vegetation condition in the reporting region has been determined using a variety of existing datasets from OEH which are discussed below.

2.1.1 Habitat connectivity and effective habitat area

Vegetation condition for the Northern Rivers CMA Region was assessed in *State of the Catchments 2010* (DECCW 2010b)-DECCW 20106. Results are summarised in Figure 13 which shows percent of the CMA Region by vegetation condition based on the national vegetation condition classification.Condition states used in this system are as follows.

- residual: native vegetation community structure, composition and regenerative capacity is intact with no significant perturbation from land-use or land management practices
- modified: native vegetation community structure, composition and regenerative capacity is intact but perturbed by land-use or land management practices
- transformed: native vegetation community structure, composition and regenerative capacity is significantly altered by land-use or land management practices
- transformed/replaced-adventive mosaic: vegetation that cannot be readily classified as either transformed (native) or replaced-adventive (non-native) on the basis of available state-wide datasets
- replaced: managed: native vegetation is replaced with cultivated vegetation
- removed: vegetation removed to leave non-vegetated land cover.

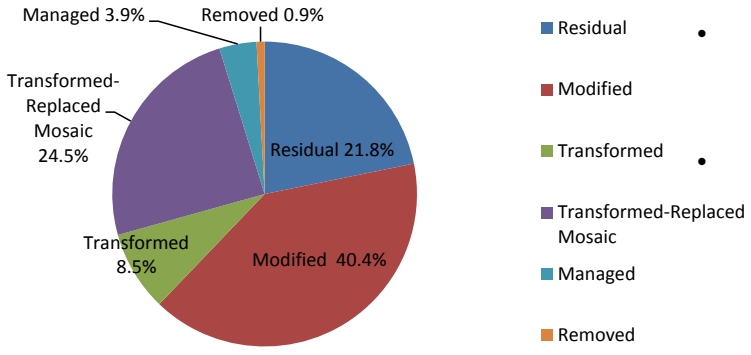


Figure 13: Vegetation condition in the Northern Rivers CMA Region
(source OEH SOC vegetation data)

In the region 21.8% of vegetation is classified as residual vegetation (i.e. relatively natural and undisturbed), and another 40.4% is modified (i.e. relatively intact but with some disturbance). The remaining 37.9% is significantly altered, replaced or removed. This gives the region a 'fair' rating for vegetation condition, which is the same rating given to NSW as a whole. To gain a better understanding of vegetation extent and condition at a regional and local level, other OEH datasets were analysed. Figure 14 shows the percentage of existing (or extant) vegetation in each LGA in the reporting region. Clarence Valley has the highest coverage of native vegetation at 75%, with Kempsey next at 73.8%, and Port Macquarie-Hastings at 73.1%. The LGAs with the least existing vegetation cover were Ballina (20.5%), Lismore (24.6%) and Byron (37%). The reasons for the low vegetation cover will be discussed later in this section.

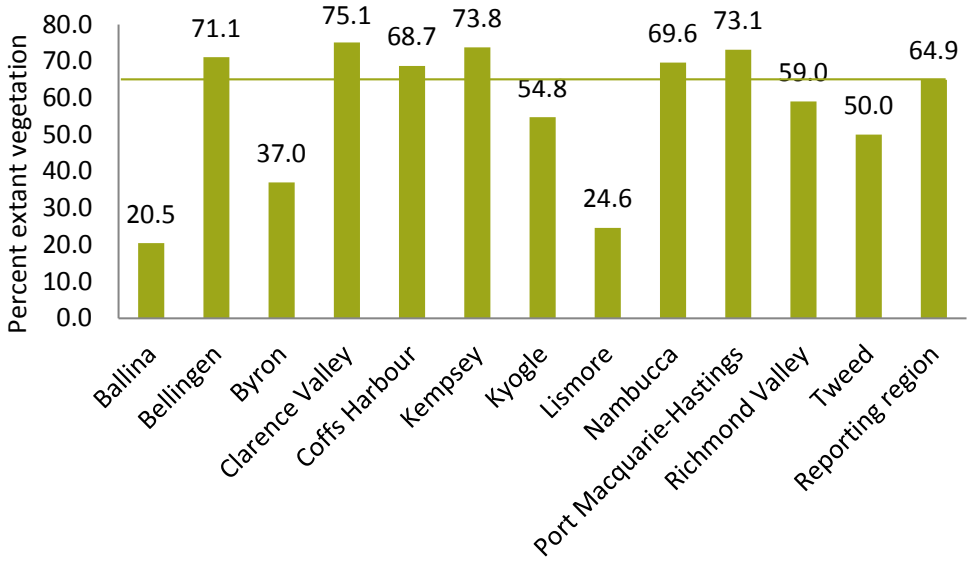


Figure 14: Percent extant vegetation in the reporting region
with regional average indicator line (Source: OEH)

Current vegetation extent does not give an indication of the quality of the vegetation as species habitat or the connectivity of the vegetation. To determine the area of effective species habitat, 'effective habitat area' was calculated using the OEH Biodiversity Forecasting Tool (BFT). Outputs from the BFT are numerous, and only two have been used for this condition assessment. The BFT uses a map of existing vegetation communities, an estimate of the pre-1750 extent of these communities, a map of current vegetation condition, and a map of threats across the CMA Region, and uses these map values to estimate effective habitat area, habitat connectivity, and many other outputs and measures. The BFT takes into account urban and cleared areas and is considered a 'true' value of effective habitat (DECCW 2010d). Effective habitat area (EHA) is shown in Figure 15, with LGAs ranked from 'poor' (red) to 'very good' (dark blue). The heavily cleared northern LGAs of Lismore, Ballina and Byron have the poorest effective habitat area of the CMA Region, with the adjacent LGAs of Tweed, Richmond Valley and Kyogle only having a slightly higher EHA. The southern LGAs all had 'good' EHA, however, the LGAs with the best EHA (Greater Taree and Glen Innes Severn) are outside the reporting region. The effective habitat areas are summarised in Figure 16.

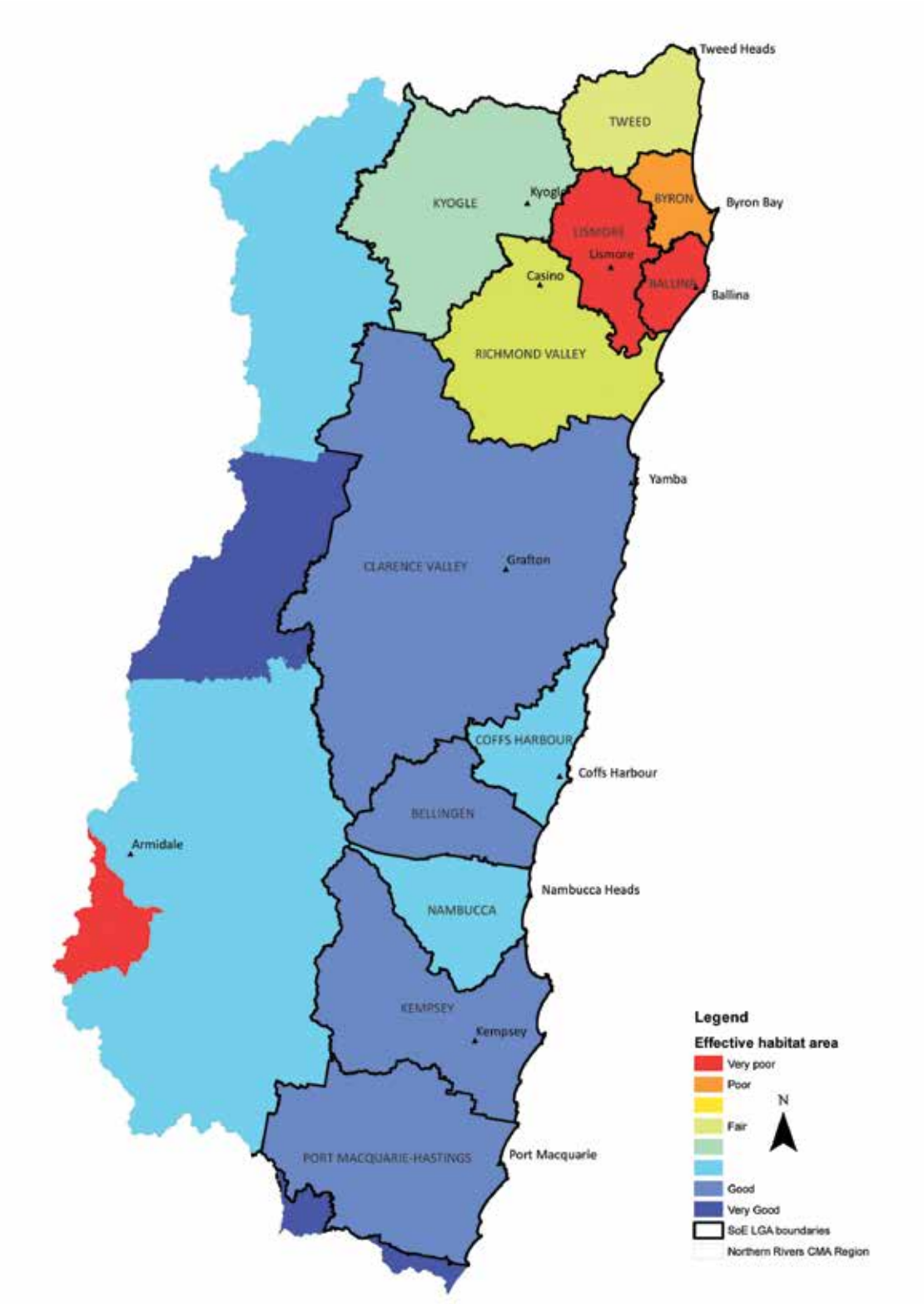


Figure 15: Effective habitat area in the Northern Rivers CMA Region by LGA

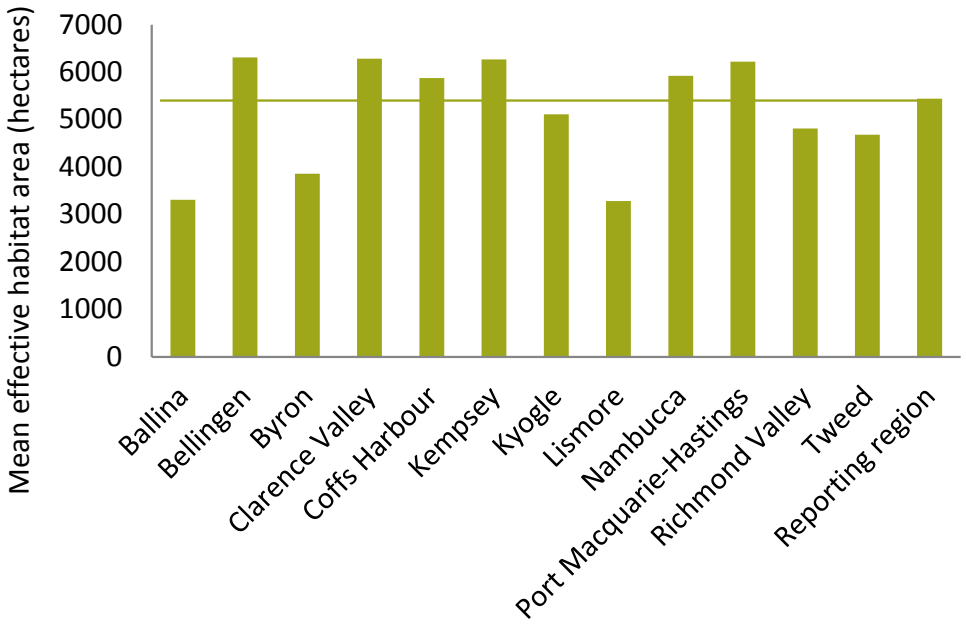


Figure 16: Mean effective habitat area in the reporting region
with regional average indicator line (Source: OEH BFT)

Habitat connectivity is another measure of vegetation condition, and can assist with determining status of species. Poor habitat connectivity impacts species by limiting their dispersal and restricting population structure and genetic flow between populations. For successful species population expansion and diversity, habitat connectivity must be on a scale that is sufficient to permit gene exchange and range expansion, support trophic (food-web) relationships, accommodate disturbance processes such as climate change, and support river flows that maintain the ecology (hydro-ecological flows) (Whitten et al. 2011). Again using the BFT, habitat connectivity was determined by assessing the cohesiveness (togetherness) of the vegetation. Figure 17 shows habitat connectivity for the Northern Rivers CMA Region and the LGAs within it. Unsurprisingly, the northern LGAs of Lismore, Ballina, Byron and Tweed have the lowest habitat connectivity, indicated by the pale areas on the map. The dark red areas indicate good to excellent habitat connectivity, and are generally within national parks and state forest. Clarence Valley LGA has the best coastal connected habitat, with Yuraygir and Bundjalung national parks covering the majority of the coastline.

Photo Golden Whistler Photo by Walter Bailey

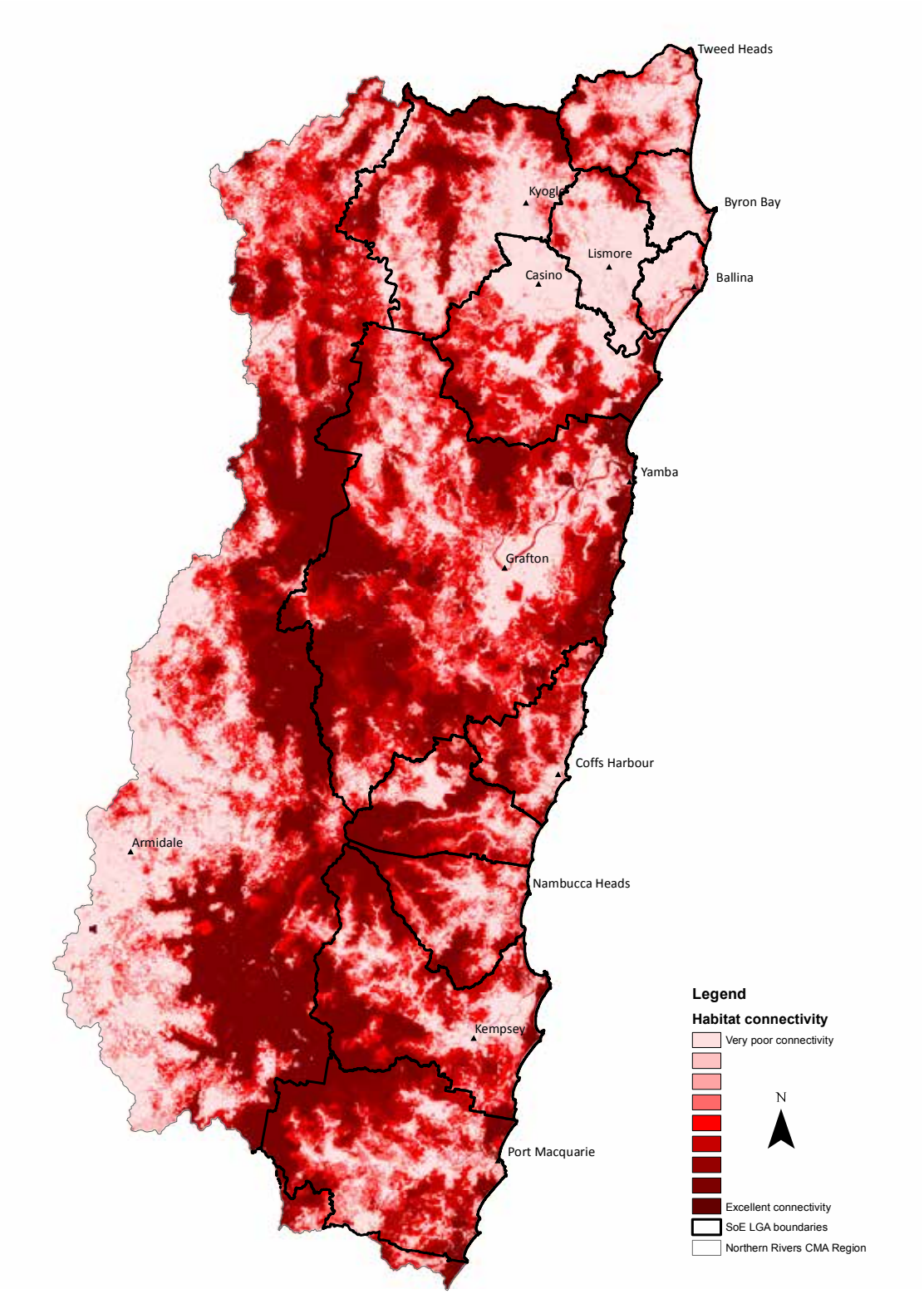


Figure 17: Habitat connectivity in the Northern Rivers CMA Region

2.1.2 Net vegetation change – reduction in woody vegetation

The greatest pressure on vegetation in the Northern Rivers CMA Region is land clearing and the fragmentation of remaining vegetation (DECCW 2009b). As shown in the habitat connectivity and effective habitat area maps previously, the LGAs of Ballina, Byron, Lismore and Tweed have been subject to more historical clearing than other LGAs in the reporting region. This area used to be covered by what is known as the Big Scrub, which was once the largest continuous tract of subtropical rainforest in Australia, covering 75,000 hectares of the rich basalt soils to the east and north of Lismore. From the 1860s onwards arable land including parts of the Big Scrub was heavily cleared for agriculture and timber, and by 1900 was essentially gone. The Big Scrub remnants are now protected within nature reserves, however, their small size, fragmentation and isolation makes them vulnerable to further degradation from invasive species, visitor impacts and fire (NPWS 1997).

Ideally, protection of adjacent vegetation on private land would ensure these remnants remain in some connected state. Native vegetation clearing is listed as a key threatening process at state and national levels, and is considered to be the single greatest threat to biodiversity in NSW (DECCW 2009b).

To monitor the reduction in area of vegetation, annual change in woody vegetation is assessed using Landsat remote sensing data analysed with SLATS methodology (Statewide Landcover and Trees Study) developed in Queensland (DERM 2012). This methodology detects woody vegetation, such as forest, that is over 2 metres high with more than 20% canopy cover. Records of woody vegetation change (i.e. alteration/removal) in NSW began in 1988 and are kept by OEH who reports annually on vegetation change in NSW (OEH 2012a). Figure 18 shows data for vegetation loss by type in the Northern Rivers CMA Region, and then by individual LGA in Figure 19.

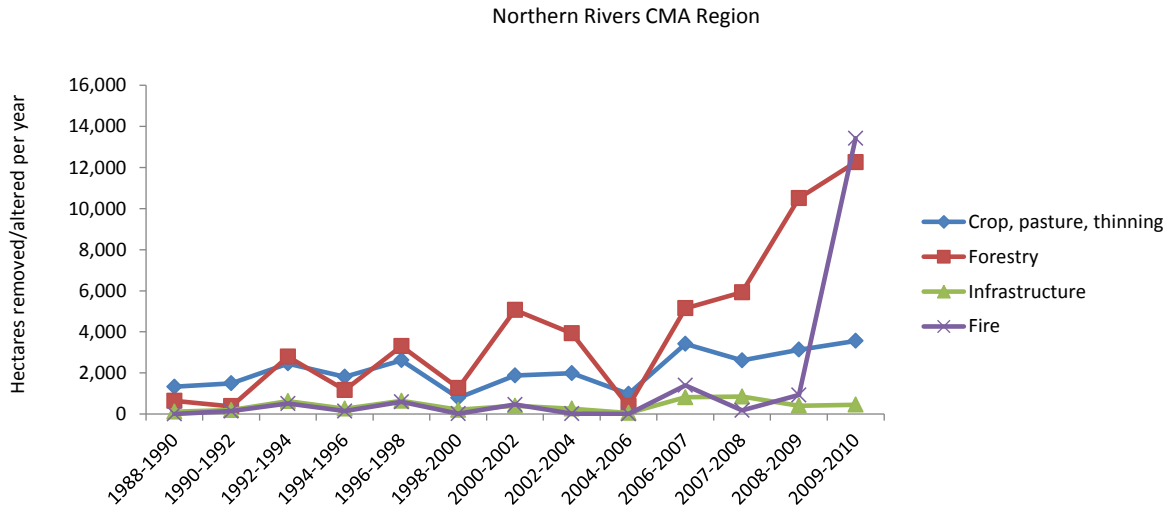


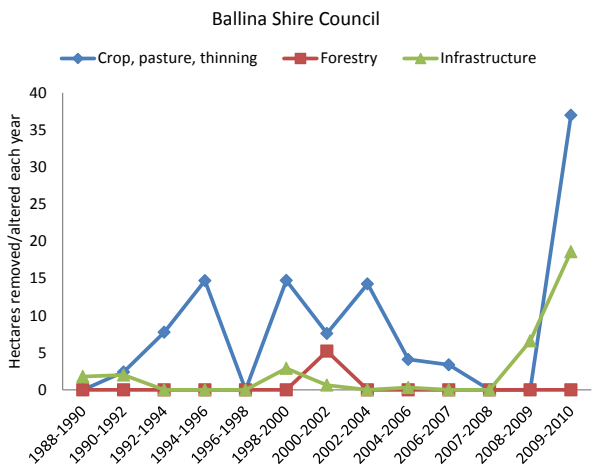
Figure 18: Change in woody vegetation in the Northern Rivers CMA region from 1988 to 2010 (Source: OEH)

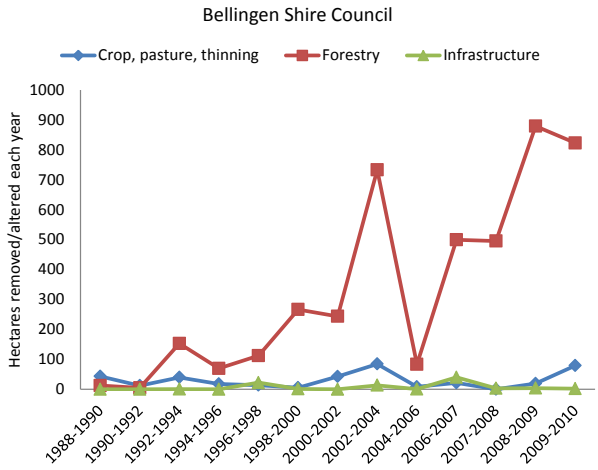
Categories of change in woody vegetation are:

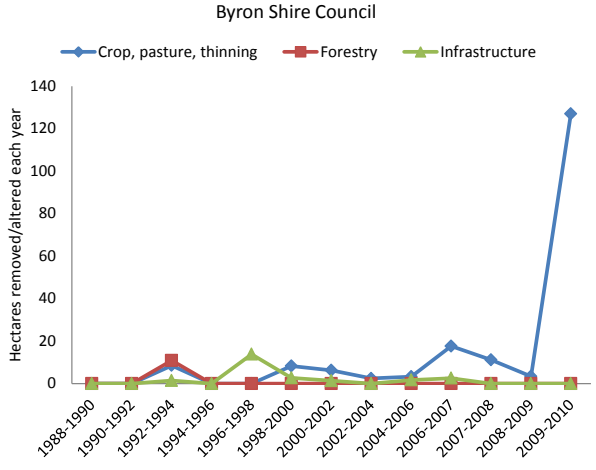
- crop, pasture, thinning: generally on private agricultural land and for agricultural purposes
- forestry: includes Forest NSW operations, plantation forests and private native forestry. Note that clearing for forestry relates to timber harvesting, and is subject to regulatory controls both on public and private land to ensure sustain able operations and appropriate ongoing management for natural resource outcomes and future timber production
- infrastructure: includes roadworks, power lines, fire breaks, fencing and mining
- fire: includes recent fires only where fire scar is visible and vegetation loss is temporary.

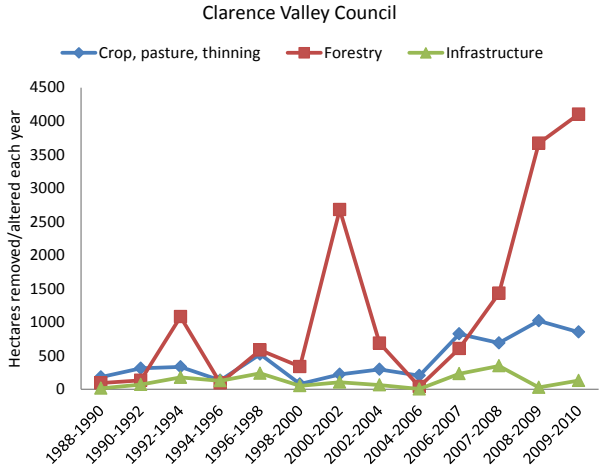
At a regional level, approximately 100,000 hectares of woody vegetation (2.2% of the CMA Region) has been removed or fire-affected since 1988. Forest harvesting in state forests and approved private plantations and private forestry agreements account for 50% of the area; vegetation removal for agriculture accounts for 27% of the area; fire accounts for 17% of the area, with the 2009 fires affecting substantial areas; and infrastructure works accounting for only 5% of the area. The SLATS methodology only measures changes in woody vegetation and does not take into account regrowth, replanting, restoration or natural regeneration after fire or forestry operations. It is also unable to distinguish between beneficial clearing, such as removal of non-native vegetation (e.g. weeds species such as Camphor laurel), and other types of clearing. So these clearing figures need to be interpreted along with the figures in Section 2.3.1 which indicate the area of land under protection at state, regional and local levels exceeds 23% of the CMA Region. Woody vegetation removal data by LGA is presented in Figure 19, but the fire data has been removed from the LGA graphs because it dominates and makes the other categories difficult to display.

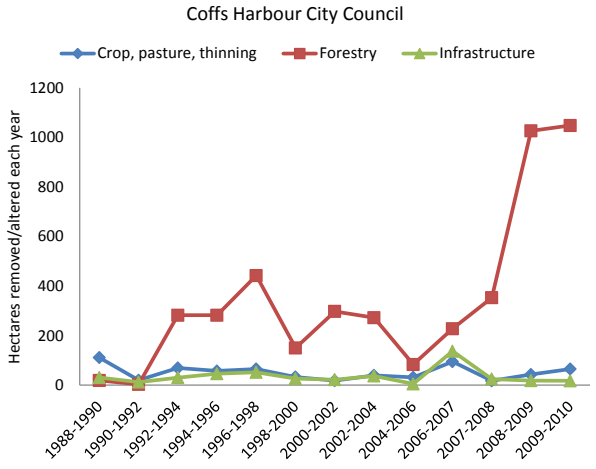
Photo: Washpool, NSW
Photo by: Shane Ruming











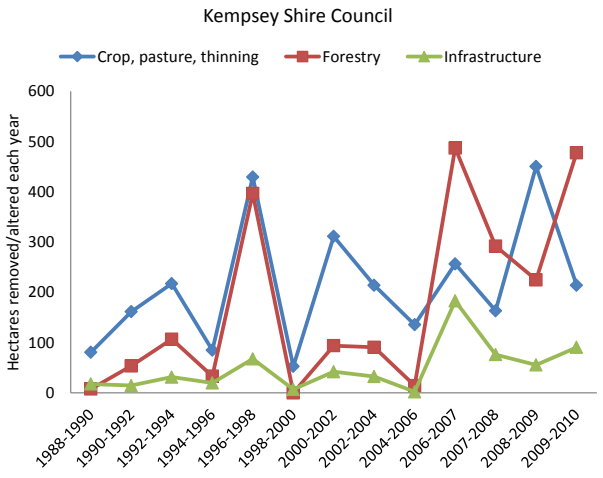


Figure 19: Woody vegetation clearing in the reporting region between 1988 and 2010

Figure 19: Woody vegetation clearing in the reporting region between 1988 and 2010

Figure 20 shows the percent of each LGA cleared since 1988 using the NSW woody vegetation change data. The LGAs with the highest percentage of area cleared also have the highest area of state forest, so the trend in forestry harvesting correlates with the area of state forest within each LGA.

The LGAs with the lowest clearing rates are those with little or no state forest. Clearing within the reporting region and the CMA Region as a whole is generally low and mostly confined to state forest harvesting operations.

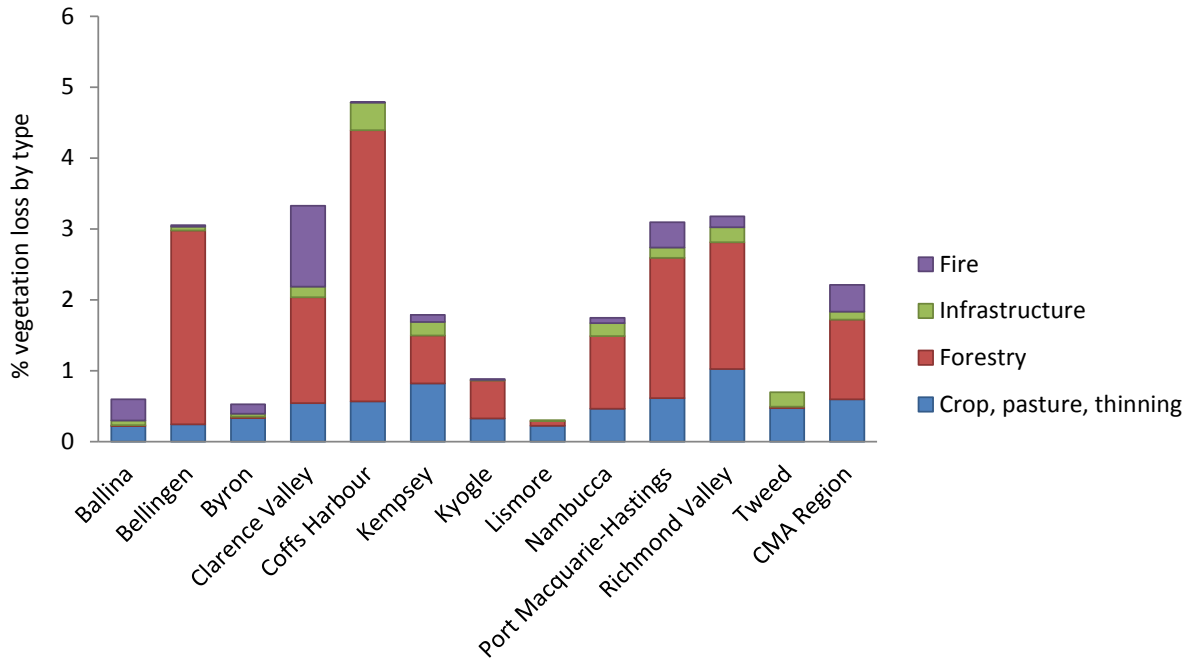


Figure 20: Percent of vegetation cleared since 1988 (Source: OEH)

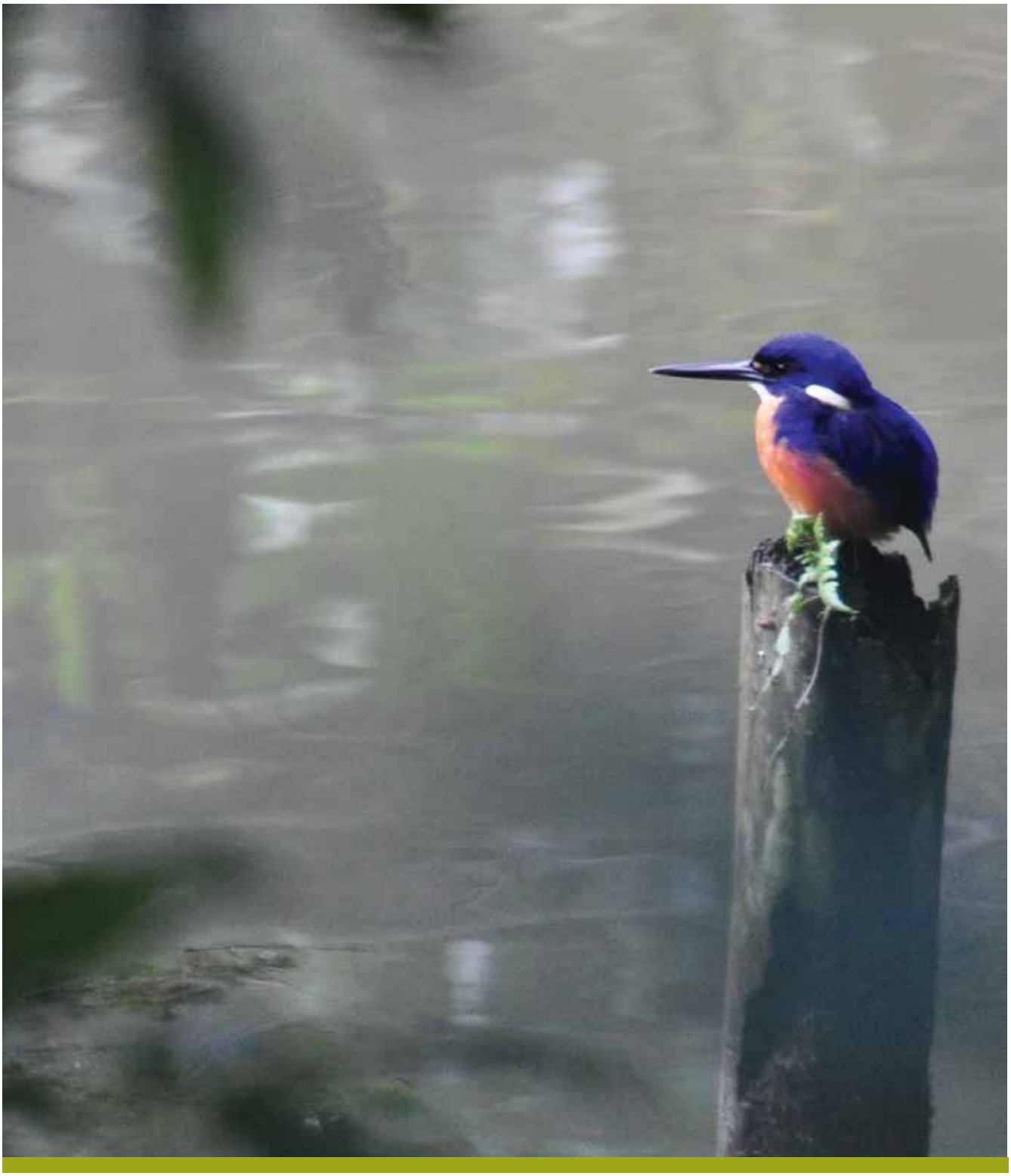
Clearing for forestry can occur on private land under private native forestry provisions. Private native forestry operations are subject to approval under the Native Vegetation Act 2003, require a property vegetation plan to be prepared, and must adhere to the Private Native Forestry Code of Practice for Northern NSW (DECC 2008a). In the NSW Woody Vegetation Change 2006 to 2007 report (DECC 2008b), private native forestry in the north coast region was identified as increasing significantly. The NSW Annual Report on Native Vegetation 2010 'Private Native Forestry Report Card' (OEH 2012a) stated over 71% of all private native forestry property vegetation plans in NSW were in northern NSW. During consultation with councils in the reporting region in 2012, a number reported that they considered private native forestry to be the biggest threat to biodiversity. Reasons cited included: failure to consider the land zoning under the relevant local environment plan (LEP), no account taken of recent vegetation information gathered by councils (particularly regarding threatened flora and fauna), and no requirement for approval from the relevant council. A review of the Private Native Forestry Code of Practice was underway at the time this report was being prepared, with a number of LGAs making submissions to this review.

2.1.3 Management of key habitats and priority areas

To ensure remaining vegetation, habitats, species and habitat connectivity are maintained or improved, a number of biodiversity plans and strategies are in place at national, state, regional and local levels. These are listed in Table 10. These plans and strategies all relate to each other and guide natural resource management at each government level.

Table 10: Biodiversity plans and strategies

Government level	Plan	Agency
National	*Australia's Biodiversity Conservation Strategy 2010–2020*	DSEWPC
National	*Australia's Native Vegetation Framework (draft)*	DSEWPC
National	*National Wildlife Corridors Plan 2012 (draft)*	DSEWPC
National	*Australian Weeds Strategy*	DSEWPC/DAFF
State	*NSW 2021:A Plan to make NSW number 1*	NSW Government
State	*NSW Natural Resources, Monitoring Evaluation And Reporting Strategy 2010–2015*	OEH
State	*Draft NSW Biodiversity Strategy 2010–2015*	OEH/DPI
State	*NSW Invasive Species Plan 2008–2015*	DPI
State	*Draft NSW Biosecurity Strategy*	DPI
State	Threat abatement plans	OEH/DPI
State	Threatened species recovery plans	OEH/DPI
State	State environmental planning policies (SEPPs)	DOP
Regional	*Far North Coast Regional Conservation Plan*	OEH
Regional	*Draft Mid North Coast Regional Conservation Plan*	OEH
Regional	*Northern Rivers Regional Biodiversity Management Plan*	OEH
Regional	*Border Ranges Rainforest Biodiversity Management Plan*	OEH
Regional	*Lord Howe Island Biodiversity Management Plan*	OEH
Regional	*Northern Rivers Catchment Action Plan*	NRCMA
Local	Local environment plans	Local Government
Local	Development control plans	Local Government
Local	Coastal zone management plans	Local Government
Local	Biodiversity plans	Local Government
Local	Koala plans of management	Local Government
Local	Vegetation plans and strategies	Local Government
Local	Weed action plans or programs	Local Government



At the local government level, each council within the reporting region has a number of strategies, plans and programs that guide biodiversity management. These are listed in Table 11.

Photo: Azure Kingfisher Photo by: Walter Bailey

Table 11: LGA-level biodiversity plans (Source: Councils)

Local government area	Plans, strategies or projects current in 2011-12
Ballina	Roadside vegetation management plan
	Koala Plan of Management (draft)
	Bushland management plans (site specific)
	Coastal Zone Management Plan for the Richmond River
Bellingen	Bellingen Weed Action Program
	Dangar Falls Biodiversity Project
	Bellingen Coastal Processes and Hazards Definition Study
	Bellinger River Estuary Action Plan
	Bellinger River Health Plan
	Bellinger and Kalang Rivers Estuary Management Plan
	Our Living Coast: Council Action Learning — revegetating urban sites
	Our Living Coast: Bellingen Island Bush Regeneration
Byron	Byron Biodiversity Conservation Strategy
	Council bush regeneration works program
	Bush Futures Project
	Koala Plan of Management
	Roadside Vegetation Survey
	Byron Shire Coastal Zone Management Plan
	Brunswick Estuary Coastal Zone Management Plan
Clarence Valley	Biodiversity Management Strategy
	Clarence Estuary Management Plan
	Clarence Riparian Strategy
	Koala Management Plan (in development)
	Wooloweyah Lagoon Coastal Zone Management Plan
	Wooli Estuary Management Plan
Coffs Harbour	Coffs Harbours Biodiversity Action Strategy
	Biodiversity Monitoring Plan
	Jaliigirr project
	Class 5 Vegetation Layer (Verification Project) draft
	Revised Koala Plan of Management (Northern Precinct)
	Vegetation Management Plan (Waste Facility Conservation Area Restoration)
	Implementation of the Vertebrate Pest Management Plan
	Biodiversity guideline development
	Corridors Footprint Landscape Linkages
	Ecohealth monitoring program
Kempsey	Macleay River Estuary Coastal Zone Management Plan
	Kempsey Shire Coastal Hazard & Definition Study
	Upper Belmore River Riparian Rehabilitation Implementation Strategy
	Brighton Park Stormwater Management Strategy
	Saltwater Creek Foreshore Rehabilitation Works Strategy
	Korogoro Creek South Bank Foreshore Rehabilitation Project Overview
Kyogle	No plans presently
Lismore	Richmond River Coastal Zone Management Plan
	Koala Plan of Management of South-east Lismore
	Draft Biodiversity Management Strategy — Stage 1 vegetation and key habitats Mapping
	Roadside vegetation management plan
	Site-specific vegetation management plans
	Wilsons River Reach Plan
Nambucca	Our Living Coast: Bowraville Grey-headed Flying Fox Project
	Our Living Coast: Stormwater Turtle Project
	Our Living Coast: Wellington Rock Project

Table 11: Continued

Local government area	Plans, strategies or projects current in 2011-12
Port Macquarie-Hastings	Comboyne Plateau NRM plan and Subcatchment plan
	Vegetation and Koala Habitat Mapping
	Riparian (fresh and estuarine) management
	Public bushland management programme / invasive species plan
	Coastal zone management
	Lake Innes Reversion Project stage 1
	Ecohealth monitoring
	Kooloonbung Creek Plan of Management
	Maria River Wilderness Project
Richmond Valley	Evans River Estuary Management Study & Plan
	Richmond Valley Koala Habitat Atlas
	Salty Lagoon Channel Project
	Coastal Zone Management Plan for Evan Head and coastline (in progress)
	Richmond River Coastal Zone Management Plan
Tweed	Tweed Vegetation Management Strategy - Biodiversity Grants
	River Health Grants
	Koala Plan of Management
	Roadside Vegetation Management Plan
	Recovery of Threatened Species in Priority Implementation Areas
	Protection and Restoration of Pottsville wetlands
	Restoring Littoral Rainforest between Fingal Head and Wooyung
	Tweed Byron Bush Futures Project
Far North Coast Weeds	Administration of the *Noxious Weeds Act 1993*
	Local weed management plans
	Removal of Noxious Weeds (Trees) policy
Richmond River County Council	McAnelly Riparian Restoration Plan
	Richardsons Riparian Restoration Plan
	Woodburn Riparian Restoration Plan
	Swan Bay Management Plan
	Kilgin Koala Planting & Remnant Restoration Management Plan
	Amphletts Lagoon Management Plan
	Bora Creek Management Plan
	Mynumia Lagoon Management Plan
	Seelim Creek Management Plan
	Gas Works Creek Management Plan
	Tuckean Swamp Land & Water Management Plan
	Coastal Zone Management Plan for the Richmond River
Rous Water	Wilsons River Catchment Management Plan

The outputs from these plans and projects will be detailed in other sections.

2.2 Native vegetation restoration

INDICATORS: Habitat areas restored (RESPONSE)
Environmental volunteers working on private and public land (RESPONSE)
Data: Data source: Councils, Northern Rivers CMA, Landcare
Data quality: Medium
Key issue: Volunteer hours underestimated as not always reported

Restoration of native vegetation has been shown to be particularly effective when sites are of a manageable size, objectives are clear, action plans are simple, and follow-up is timely and regular (Sleeman 2010). There is a general lack of comprehensive evaluation of restoration projects, but where evaluation has occurred, results indicate that restoration of degraded areas does improve ecosystem services, however, restored sites remain of a lower habitat and vegetation quality than un-degraded sites or areas (Suding 2011).

As shown previously in Tables 10 and 11, the Northern Rivers CMA Region has a comprehensive suite of strategies, plans and programs at state and local level that involve native vegetation restoration. Some of these programs are run by state agencies such as OEH, Northern Rivers CMA and DPI and their various divisions, and many are run by local government. Landholders make a large contribution to restoration, actively restoring their properties and often working with involved agencies to monitor the success or progress of their projects. In 2011–12,, 345 landholders were involved in implementing natural resource management knowledge and skills on their properties.

Also assisting restoration efforts is the vast reserve of volunteers who provide a free but highly valued contribution to habitat restoration. Groups such as Landcare, Dunecare, Rivercare, EnviTE and Green Corps have assisted many councils, the Northern Rivers CMA, National Parks and Wildlife Service and Fisheries NSW to restore both land and aquatic habitats. There are 483 Landcare groups in the Northern Rivers CMA Region alone, and many undertake regular restoration work without documenting hours or detailing areas restored, so the figures in the tables will vastly underestimate the work volunteers provide. Figures indicate at least 30,000 volunteer hours were given during 2011–12.

Grant funding is also essential for habitat restoration, with much of the work undertaken having been funded by various sources. Table 12 shows the area of habitat restored for council-run projects in 2011–12, the funding contributions, and the number of volunteer hours contributed where known. Riparian and wetland habitats are not included in the figures below as these are reported in Theme 4: Water. Note that councils vary in the way they capture this data. Many do not routinely report this information, so not all activities have been reported here and this is considered to be an underestimate of restoration work conducted in 2011–12,.

Table 12: Habitat restoration and volunteer hours 2011–12 (Source: Councils; Northern Rivers CMA)

LGA or County Council	Area restored (ha)	Trees planted	Land type	Activity	Funding	Volunteer hours *
Ballina	102	1,200	Private and public land	Weed removal and planting	Council, NRCMA, Environmental Trust, OEH	500
Byron	73	800	Public land	Primarily weed removal, some planting	Council, Environmental Trust, GreenCorps	unknown
Bellingen	4	1,200	Public land	Weed removal and planting	Council, Environmental Trust	unknown
Clarence Valley	70	1,160	Private and public land	Primarily weed removal, some planting	Council, Landcare	5,881
Coffs Harbour	178		Public land	Primarily weed removal, some planting	Council	unknown
Kempsey	75		Public land	Weed removal	Council	unknown
Kyogle	3	300	Public land	Primarily weed removal, some planting	Council, Environmental Trust, GreenCorps	4,300
Lismore	36	570	Private and public land	Weed removal and planting	Council, DPI-Fisheries	2,748
Nambucca	unknown			Dunecare		unknown
Port Macquarie-Hastings	over 22		Private and public land	Bush regeneration	Landcare	9,139
Tweed	243	800	Private and public land	Weed removal and planting	Council, NRCMA, Caring for Country	11,333
Richmond River County Council	0.2	250	Private land	Planting	Council	12
Northern Rivers CMA Projects^	934	2,400		Weed removal and planting		3,472

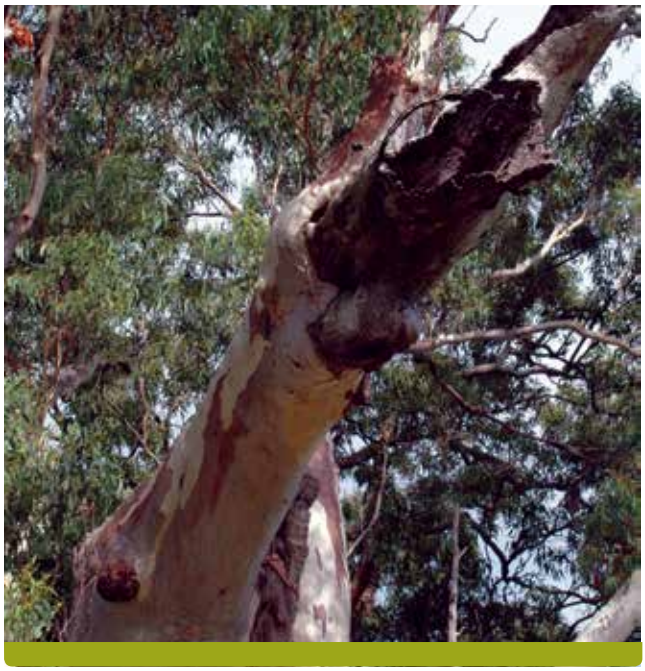
* Volunteer numbers are substantially underestimated as not all volunteer groups report hours

^ Total not given as the Northern Rivers CMA figures include work reported on by councils funded by the NRCMA

2.3 Conservation: reserves and agreements

INDICATOR: Actions to protect native vegetation (RESPONSE)
Data: Data source: OEH, DPI Data quality: High
INDICATOR: Council land use zoning (LEPs) (RESPONSE)
Data: Data source: Councils Data quality: High
INDICATOR: Vegetation protected and rehabilitated under private agreements (CMA and OEH)
Data: Data source: Northern Rivers CMA, OEHData quality: Medium

Biodiversity protection and conservation is achieved at a regional level through the national parks system, at a local level through council land zoning, and at the landholder level through agreements with individual landholders on private land.



2.3.1 Protection of native vegetation

In the CMA Region in 2012, 22% of the Region was protected in national parks, nature reserves and state conservation areas. State forests covered 12.5% of the Region. Over the past four years (since the 2009 comprehensive SoE report), the area of land protected in national parks and nature reserves has increased by 11,400 hectares, or 1% in the CMA Region. The breakdown of land in the national park estate and state forests by LGA is detailed in Table 13.

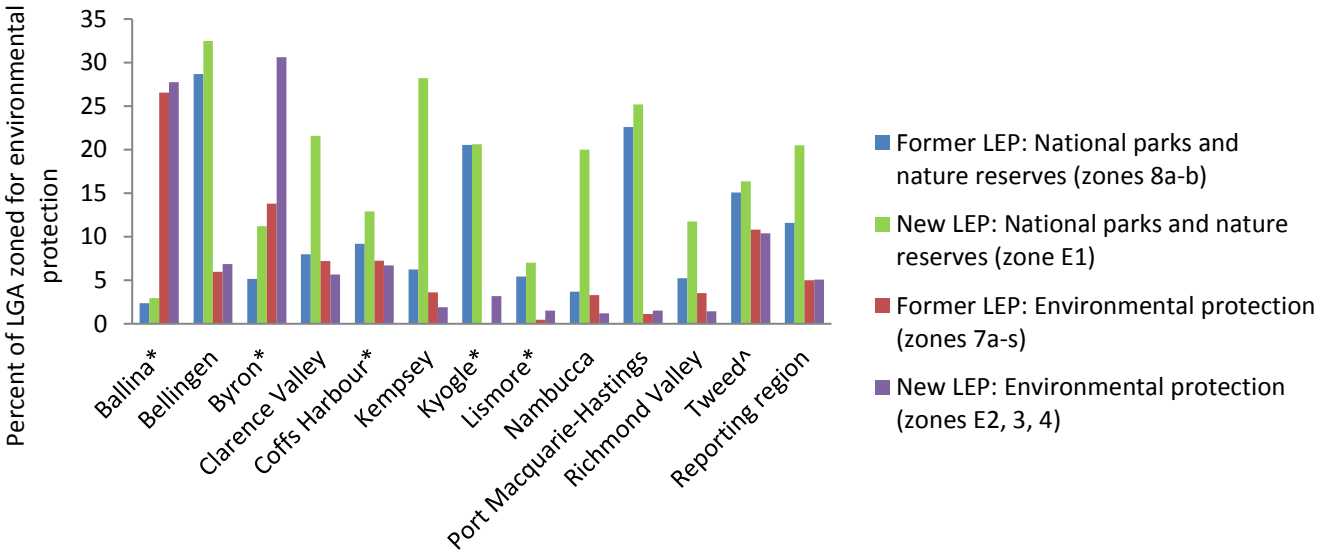
Photo this page by: Nigel Cotsell
Photo previous page: Swamp sclerophyll forest
Photo by Shane Ruming

Table 13: Area of national park estate and state forest in 2012 (Source: OEH; DPI)

Local Government Area	Total area (ha)	National Parks Estate (ha)	% National Parks Estate	State Forest (ha)	% State Forest
Ballina	49,298	1,422	2.9	0	0.0
Bellingen	160,152	51,762	32.3	34,059	21.3
Byron	56,920	6,373	11.2	0	0.0
Clarence Valley	1,044,795	223,467	21.4	195,725	18.7
Coffs Harbour	117,392	14,597	12.4	40,148	34.2
Kempsey	337,419	95,059	28.2	24,689	7.3
Kyogle	360,204	73,616	20.4	41,574	11.5
Lismore	129,341	9,061	7.0	1,097	0.8
Nambucca	149,134	29,539	19.8	32,127	21.5
Port Macquarie-Hastings	356,949	82,014	23.0	73,710	20.7
Richmond Valley	305,783	35,111	11.5	45,702	14.9
Tweed	132,384	21,356	16.1	0	0.0
CMA Region	5,026,315	1,102,595	21.9	626,046	12.5

2.3.2 Council land-use zoning (LEPs)

In council areas, land zoning is governed by the local environment plan (LEP) which includes areas of national park and nature reserve, areas of environmental protection, and areas where certain activities are not permitted due to environmental impacts. The majority of LGAs in the Northern Rivers CMA Region have recently prepared new LEPs according to the NSW Government's requirement for all councils to prepare a single LEP which conforms to the format and content of the new Standard Instrument LEP. Most LGAs in the reporting region either have approved new LEPs or draft LEPs. Figure 21 and Table 14 show the area under environmental protection in both the previous LEPs and new LEPs. Note that many LEPs are in draft form and may change, so the areas reported here may not be accurate once LEPs are finalised.



* Indicates the LEP is in draft form and zone areas may change

^Indicates figures unavailable so former LEP areas used to calculate area under environmental protection

Figure 21: Percent of LGA zoned for environmental protection – a comparison of former LEPs with new LEPs (Source: Councils)

The figures show that there has been an increase of almost 293,000 hectares across the reporting region for land protected under LEPs. This includes 288,382 hectares added to the national park estate, and brings the area under protection in the reporting region to 25.6%.

Table 14: Percent of LGA zoned for environmental protection – a comparison of former and new LEPs (Source: Councils)

	Former LEP				New LEP			
Local Government Area	Area national parks estate (ha)	% LGA	Area environmental protection (ha)	% LGA	Area national parks estate (ha)	% LGA	Area environmental protection (ha)	% LGA
Ballina*	1,118	2.4	12,505	26.6	1,452	3.0	13,649	27.7
Bellingen	45,899	28.7	9,533	6.0	51,933	32.5	20,516	6.9
Byron*	2,913	5.2	7,779	13.8	6,358	11.3	17,287	30.6
Clarence Valley	83,368	8.0	75,088	7.2	225,043	21.6	58,971	5.7
Coffs Harbour*	10,771	9.2	8,520	7.3	15,100	12.9	7,855	6.7
Kempsey	21,115	6.3	12,221	3.6	95,220	28.2	6,458	1.9
Kyogle*	73,616	20.6	0	0.0	73,800	20.6	11,364	3.2
Lismore*	6,968	5.4	623	0.5	9,029	7.0	1,960	1.5
Nambucca	5,494	3.7	4,910	3.3	29,806	20.0	1,801	1.2
Hastings	82,638	22.6	4,211	1.2	92,738	25.2	5,615	1.5
Richmond Valley	15,948	5.2	10,810	3.6	35,906	11.8	4,369	1.4
Tweed^	19,023	15.1	13,613	10.8	21,356	16.3	13,613	10.4
Reporting region	368,871	11.6	159,813	5.0	657,741	20.5	163,458	5.1

* Indicates the LEP is still in draft form and zone areas may change

^ Indicated figures unavailable so former LEP areas used to calculate area under environmental protection

2.3.3 Land protected under Northern Rivers CMA incentives and other conservation agreements

At the landholder level, there are a number of different land conservation agreements that protect native vegetation on private land in the CMA Region. As of 30 June 2012, approximately 5,118 hectares of land was conserved under Northern Rivers CMA agreements and 38,386 hectares under agreements managed by OEH, totalling 43,504 hectares or nearly 1% of the CMA Region. Of these agreements, 9,759 hectares (22.4%) are protected in perpetuity. These are shown by agreement type in Table 15 below.

Table 15: Private land under conservation agreements (Source: NRCMA, OEH)

Land agreement type	Agency	Number of agreements	Area (ha)
Conservation and incentive property vegetation plans (in perpetuity)	NRCMA	39	1,546
Non-perpetual property vegetation plans	NRCMA	64	3,572
Conservation agreements in perpetuity	OEH	56	5,067
Registered property agreements in perpetuity	OEH	93	3,146
Wildlife refuges (not in perpetuity)	OEH	100	30,173
Total area of private land currently under protection		352	43,504
Total area of private land currently under protection in perpetuity		188	9,759

2.4 Native flora and fauna

INDICATORS: Number of endangered and vulnerable species, populations, and ecological communities (CONDITION)
Key threatening processes (PRESSURE)
Data: Data source: OEH, DPI Data quality: Medium to high

The Northern Rivers CMA Region of NSW has very high species diversity. It also contains a number of species found nowhere else in Australia, and others which due to their diminished range are now only found in isolated pockets in our Region. For example, Mitchell's rainforest snail is only found in the northern part of the CMA Region between Ballina and Tweed Heads; Coastal Fontainea shrub (Fontainea oraria) is now found only near Lennox Head headland; and the marine brown alga Nereia lophocladia is only known from waters off Coffs Harbour. The CMA Region supports over 40% of NSW threatened species and one fifth of the State's threatened ecological communities, despite the Region occupying only 6.3% of the State (DECCW 2010b).

The current status of native flora and fauna in the reporting region is discussed in this section along with key threatening processes impacting these species.

Of the 1,182 species listed as vulnerable, endangered, critically endangered or presumed extinct in NSW, 448 species (or 38%) are found in the CMA Region, and some LGAs within the reporting region support a very high number of these species. There are 41 listed key threatening processes that are relevant to the CMA Region, and 20 threat abatement strategies and 29 recovery strategies. These are summarised in Table 16 and can be accessed from NSW BioNet at www.bionet.nsw.gov.au.

Photo: Little Tern Photo by: John Turbill

Table 16: Number and status of threatened species
(Source: BioNet online database at www.bionet.nsw.gov.au)

	CMA Region	Ballina	Bellingen	Byron	Clarence Valley	Coffs Harbour	Kempsey	Kyogle	Lismore	Nambucca	Port Macquarie-Hastings	Richmond Valley	Tweed
FLORA													
Endangered	140	78	31	81	89	63	36	95	77	29	29	94	69
Extinct	4	2	0	1	1	0			1	0	0	0	0
Critically endangered	5	1	0	1	1	0	1	1	1	1	2	1	0
Vulnerable	94	55	22	55	62	43	31	58	55	26	28	58	38
Endangered population	2	0	0	0	0	1	0	0	0	1	0	0	
Total flora	245	136	53	138	153	107	68	154	134	57	59	153	107
FAUNA													
Endangered	43	31	24	31	36	27	25	29	25	24	24	33	29
Extinct	0	0	0	0	0	0							
Critically endangered	9	6	4	6	7	6	3	6	6	3	3	6	6
Vulnerable	123	108	100	107	112	108	105	83	87	101	103	108	102
Endangered population	3	1	2	2	2	1	2	1	1	1	2	1	1
Endangered ecological community	18	10	15	11	17	13	15	13	10	12	14	13	11
Total Fauna	196	156	145	157	174	155	150	132	129	141	146	161	149
FISH													
Extinct	1												
Critically endangered	1	1	1	1	1	1	1	0	0	1	1	1	1
Endangered	2				1							1	
Vulnerable	2	2	2	2	2	2	2			2	2	2	2
Marine flora critcally endangered	1					1							
Total aquatic species	7	3	3	3	4	4	3	0	0	3	3	4	3
TOTAL all species	*448*	*295*	*201*	*298*	*331*	*266*	*221*	*286*	*263*	*201*	*208*	*318*	*259*
Key threatening processes	35	34	35	34	35	35	35	32	32	35	35	34	34
Aquatic key threatening processes	6	6	6	6	6	6	6	5	5	6	6	6	6

Key changes in the past year have been the listing of the koala as vulnerable at a national level, and the addition of the fungal plant disease, myrtle rust, as a key threatening process. Previously, all NSW-listed threatened species and communities were required to have a recovery plan prepared for them by either OEH or DPI. Preparation of individual recovery plans is no longer mandatory and recovery now incorporates a recovery planning approach into strategic, landscape-based biodiversity management that integrates prioritised species recovery with threat abatement (OEH 2012b). This means that management of a threatened species involves a suite of actions that may include actions such as habitat assessment, threat management, population monitoring, education, landholder involvement and so on that are relevant for all threatened species.

2.5 Invasive species

INDICATORS: Extent of invasive weed species (CONDITION/PRESSURE)
Extent of invasive weed control (RESPONSE)
Data: Data source: Councils, county councils
Data quality: Low to medium
INDICATORS Extent of pest fauna species (CONDITION/PRESSURE)
Number of pest fauna control programs (RESPONSE)

Whilst having some of the highest biodiversity in the country, the Northern Rivers CMA Region also has some of the highest numbers of invasive species, both weeds and vertebrate pests. In recent years, cane toads have progressed further south, the Indian myna has become more prolific, and at national level this year 12 new weeds have been added to the list of weeds of national significance.

Control of invasive species is critical to sustaining the native biodiversity of the CMA Region. For example, the introduced tree camphor laurel has been found to impact aquatic biodiversity by reducing the number of aquatic invertebrates (water bugs) in streams containing more than 30% camphor laurel leaf litter. This in turn reduces the available food for fish, amphibians and other stream life, thus reducing the species richness and diversity in those streams (Davies & Boulton 2009). The successful control of predators such as rats and foxes has improved the reproductive success of endangered shorebirds such as little tern and muttonbird (pers comm A Walton OEH 2012).

Within the CMA Region, there are a number of different agencies and groups responsible for the control of invasive species. Nationally, the Australian Weeds Committee coordinates the control efforts for the 32 most damaging invasive plant species, and vertebrate pest control is guided by the Australian Pest Animal Strategy. At state level, the Department of Primary Industries (DPI) implements the NSW Invasive Species Plan 2008–2015, and oversees the work of the Livestock Pest and Health Authority (now incorporated under Land and Soils Services within DPI) which assists private landholders with vertebrate pest control on properties. DPI also coordinates regional weeds advisory committees who work with local councils and county councils for invasive species control. Regionally, the National Parks and Wildlife Service (within OEH), Department of Lands, and Forests NSW (both within DPI) all have their own invasive species control programs for public lands. Local councils assist with pest control outside of national parks, state forests and other Crown lands, and also assist local landholders and residents with pest control.

A summary of local programs for invasive species control is presented in the following tables, along with some distribution data from state level.

2.5.1 Invasive weed species

Far North Coast Weeds is a local county council that is responsible for administering the Noxious Weeds Act 1993. It includes the LGAs of Tweed, Byron, Ballina, Lismore, Richmond Valley and Kyogle, and has developed roadside weed management plans, mapped the density and distribution of roadside noxious weeds, and carried out control works on declared noxious weeds (FNCW 2012). All other LGAs operate under the same plan for noxious weed control, and there are two regional reporting bodies — North Coast Weeds Advisory Committee and the Mid North Coast Weeds Advisory Committee — which oversee the implementation of the Weeds Action Plan in the reporting region and report to DPI. The figures reported here (see Table 17) only apply to weed control conducted by councils and county councils under the Weeds Action Plan, and do not include specific habitat restoration projects that involve weed removal, or the work private landholders do to control weeds.

Table 17: Weeds Action Plan reporting for the CMA Region for 2011–12
(Source: Councils and weeds advisory committies)

		Far North Coast Weeds	Coffs Harbour	Clarence Valley	Bellingen	Nambucca	Kempsey	Port Macquarie-Hastings	TOTAL for 2011-12
Extent of area protected (ha)				2,350,000			175	1,505	2,351,680 ha
Regional High Risk sites identified and documented	High Risk sites identified	750	385	279	194	0	105	247	1,960
	High Risk sites treated (Ha)	111	440	0	25	136	1,115	4,670	6,497 ha
Management of High Risk pathways	Pathways identified (km)	16,063	862	3,003	1,755	545	4,386	1,378	27,992 km
	Pathways treated (km)	4,047	0	977	1,434	247	708	708	8,122 km
Impacts reduced at priority sites	Priority sites identified	1,011	412	0	25	0	85	762	2,295
	Evidence of reduced weed impacts (Ha)	102	112	6,879	15	0	175	1,524	8807 ha

Note: Far North Coast Weeds covers the LGA's of Tweed, Byron, Ballina, Lismore, Richmond Valley and Kyogle

In the reporting region, over 2.3 million hectares of land is under active weed control by councils and county councils. In 2011–12, over 45% of high risk pathways (i.e. areas considered to be able to transport weeds and weed propagules easily) were treated, along with 44% of regional high risk sites.

2.5.2 Invasive fauna species

Vertebrate pests in the CMA Region — including rabbits, foxes, goats, cats, dogs, deer, cane toads, pigs and mosquito fish — are all listed as key threatening processes in NSW. This means they have a measureable impact on threatened species populations and their habitats.

Information collected by DPI Vertebrate Pest Research Unit on vertebrate pests in the CMA Region is provided in Table 18.

Photo: Cane Toad
Photo by: Nigel Cotsell

Table 18: Vertebrate pest species found in the Northern Rivers CMA Region (Source: DPI)

Pest	Density	Location
Cane toads	Medium to high	Clarence River to Tweed
	Low	Port Macquarie
Pigs	Low to medium	Coastal areas mainly around Clarence and Kempsey
	Medium to high	Tablelands areas
Horses	Low to medium	Clarence Valley, Coffs Harbour and tablelands areas
Goats	Generally low	Mostly confined to the tablelands region
Foxes	Presence	All of CMA Region
Dogs	Medium to high	80% of the CMA Region, away from the coastal strip
	Low	Along the coastal strip
	Absent	Ballina & Byron LGAs & coastal Tweed
Deer	Low to medium	Southern, central section of CMA Region, predominantly near state forest and national park areas
Cats	Presence	All of CMA Region
Freshwater fish pest species		
Eastern gambusia (Mosquito fish)	Presence	All of CMA Region freshwater river reaches
Carp	Presence	All of CMA Region freshwater river reaches
Redfin	Presence	All of CMA Region freshwater river reaches
Banded grunter	Presence	Clarence River system freshwater river reaches
Goldfish	Presence	Lowland freshwater rivers throughout CMA Region

Each Council within the reporting area has some type of program or service to assist in vertebrate pest control. These are listed below in Table 19.

Table 19: Pest control programs in the reporting region (Source: Councils)

Local Government Area	Vertebrate pest control program
Ballina	Indian myna trap loan
Bellingen	Indian myna trap loan
Byron	Cane Toad Musters
	Exclusion fencing for cane toads
	Community education
	Indian myna trap loan
	Feral animal trapping (wild dogs, foxes, cats)
Clarence Valley	Indian myna trap loan
	Cane toad control (seek & hand removal)
	Wild dog, fox control (Baited)
	Pig control
	Feral horse control
	Wild cat control
	Fox
	Sand-pad monitoring
Coffs Harbour	Indian myna control program
	Cane toad program (education program delivery & cane toad record/sighting follow up field work)
	Fox trapping program (Urban)
	Vertebrate monitoring, baseline data program (Airport & Coffs Coast State Park)
	Operational plan development for council-managed high conservation lands (high priority lands in the Coffs Harbour Vertebrate Pest Management Strategy)
	Threatened species threat abatement programs (little tern protection at Hearnes Lake)
	Wild horse program
Kempsey	Feral cat trap loan
Kyogle	Indian myna trapping program
Lismore	Indian myna trap loan
	Cane toad control research project — Sydney University
	Feral cat trap loan
Nambucca	Indian myna project
Port Macquarie-Hastings	Indian myna program
	Feral deer program
Richmond Valley	Indian myna trap loan
	Annual carp muster which is undertaken by the Casino RSM Social Fishing Club
Tweed	Indian myna trap loan
	Cane toad control program — musters and breeding habitat exclusion
	Wild dog and fox control
	Rabbit trap loan
	Rooster removal from threatened snail habitat

At this time, there is little local-level (i.e. LGA-level) information on the abundance and distribution of vertebrate pests in the CMA Region. It is hoped by the next reporting period in 2016 there will be better local information on vertebrate pests.

Tree roots,
Photo by Nigel Blake

3

3. Land use and Soils

The landscape of the Northern Rivers CMA Region has been significantly altered since European settlement. The large-scale clearing of forests for timber and agriculture in the Region in the late 1800s and early 1900s created a vastly different landscape to the original native vegetation, and more recent coastal urban and infrastructure expansion has increasingly applied pressure to our soil resources either through increasing soil loss or removing fertile land and soils from agricultural production. Soils are non-renewable, and some consider that declining land and soil condition is the greatest ecological threat facing Australia (e.g. Chapman et al. 2011), as it impacts ecological functioning and can be irreversible. Soil security is fundamental to food production and livestock health. Where soil is managed continually beyond its capability it has had detrimental effects on the socio-economic well-being of communities. Fortunately, in the CMA Region, soil and land condition are rated as fair to good, although erosion and acid sulfate soils are rated as poor in this Region, and the recent years of high rainfall has exacerbated soil loss.

The Natural Resources Commission has two state-wide targets for soil and land:

- by 2015 there is an improvement in soil condition
- by 2015 there is an increase in the area of land that is managed within its capability.

These two targets have been used for this report and are discussed below.

The pressures acting on soil condition primarily relate to land management practices, so these two indicators are discussed together, with acid sulfate soils discussed separately as they are a major soil issue for this Region.

3.1 Soil condition

INDICATOR: Soil condition (CONDITION)
Data source: OEH
Data quality: Medium to high

Soil condition in the CMA Region was assessed using data collected as part of the 'NSW Natural Resources Monitoring, Evaluation and Reporting Strategy' (NSW MER Strategy) and analysed by OEH in 2012, expanding on monitoring conducted for the State of the Catchments 2010 report (DECCW 2010b). The CMA Region has been divided into 10 soil monitoring units (SMUs) which cover approximately 21% of the CMA Region and monitoring sites are located within each SMV. (see Figure 22). The data in Table 20 shows the current condition of soils in the 10 soil management units. The condition of each SMU was determined through omparison of test sites with a reference site (considered to be in ideal condition) within the same SMU.

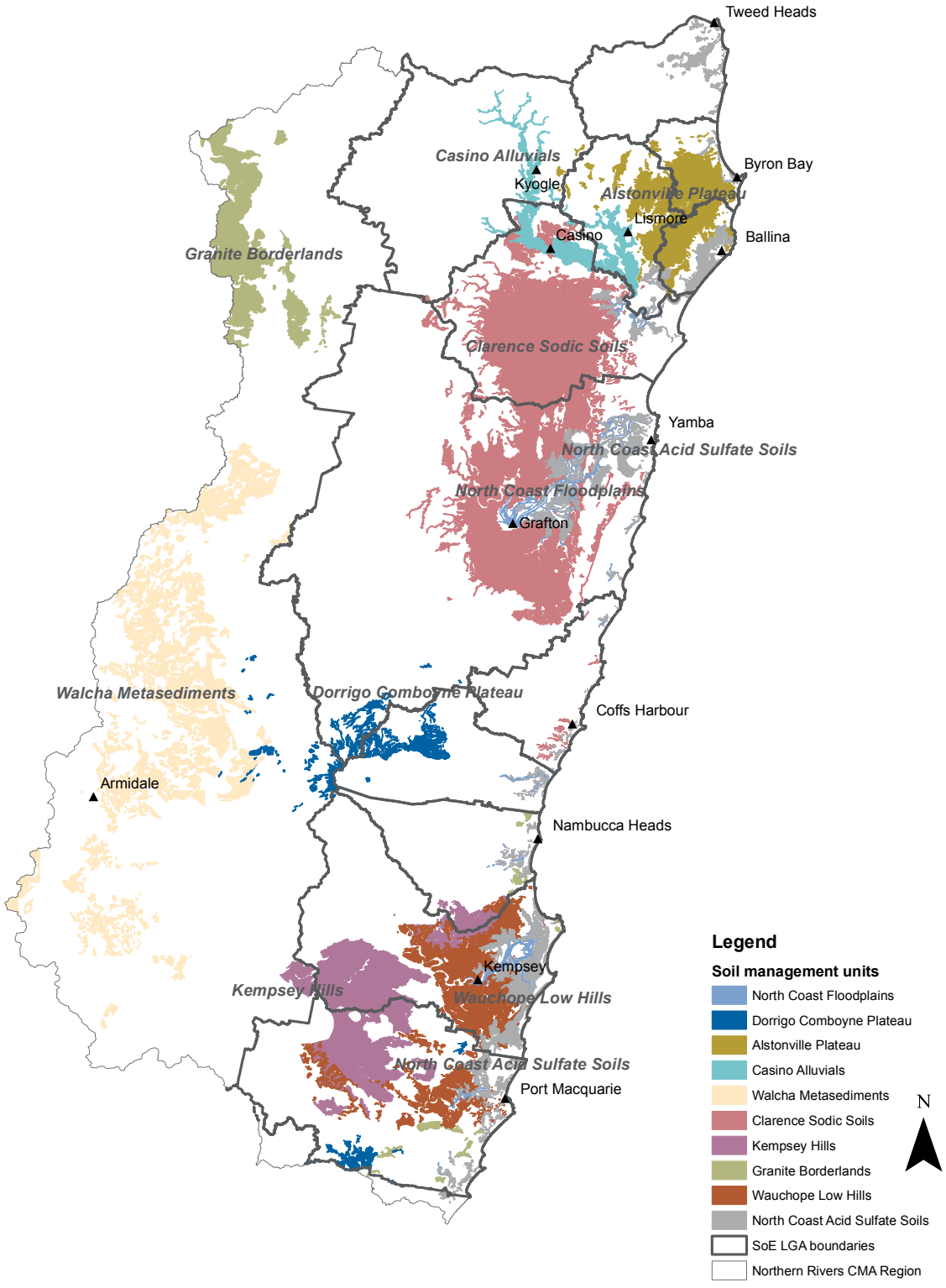


Figure 22: Soil management units in the Northern Rivers CMA Region (Source: OEH)

Legend for tables

4.6 – 5.0	Very good	No loss of soil function. Either no deterioration or an improvement on reference condition.
3.6 – 4.5	Good	Slight loss of soil function. Noticeable but not significant deterioration against reference condition.
2.6 – 3.5	Fair	Noticeable loss of soil function. Noticeable deterioration against reference condition.
1.6 – 2.5	Poor	Significant loss of soil function. Considerable deterioration against reference condition.
<1.5	Very poor	Profound loss of soil function. Severe deterioration against reference condition.

Table20: Soil management unit condition by indicator for 2012 (Source: OEH)

Soil management unit	Sheet erosion	Gully erosion	Wind erosion	Acidity	Organic carbon	Soil Structure	Acid sulfate soils	Soil salinity
North Coast Floodplains	3.6	5.0	5.0	3.6	1.1	4.0		4.4
Dorrigo-Comboyne Plateau	2.7	4.0	5.0	no data	no data	no data		5.0
Alstonville Plateau	2.2	4.0	5.0	3.9	4.0	4.6		5.0
Casino Alluvials	2.4	4.0	3.1	3.9	3.2	3.1		4.1
Walcha Metasediments	2.9	3.5	5.0	3.7	2.1	3.4		3.0
Clarence Sodic Soils	2.9	2	4.0	3.1	2.6	3.7		4.2
Kempsey Hills	2.5	2.5	5.0	2.7	2.7	4.0		5.0
Granite Borderlands	2.8	3.0	3.0	3.5	2.8	4.1		3.8
Wauchope Low Hills	2.4	4.0	5.0	3.9	3.5	4.3		4.7
North Coast Acid Sulfate Soils	3.7	5.0	5.0	2.2	3.3	5.0	3.0	5.0

Each SMU varied in its condition for each indicator. Generally, all SMUs averaged as fair to good for overall soil condition; however, sheet erosion is an issue for most SMUs, followed by organic carbon depletion, which is an issue for most SMUs, particularly coastal floodplains. The reduction in soil carbon is of particular concern and will require response from a range of landowners and stakeholders. There is a slight decline for acidity, the indicators of soil structure and acid sulphate soils are improving, and the others remain steady. Wind erosion, soil salinity and soil structure are the best of the indicators, showing these are less of an issue for land management in the CMA Region. However, continued good land management practices are needed to maintain this good status (Chapman et al. 2011). These indicators will continue to be regularly monitored as part of the NSW MER program. The indicators also respond well to land management practices, which are discussed next.

3.2 Land management within capability

INDICATOR: Land managed within its capability (PRESSURE)
Data source: OEH Data quality: Medium to high

Land management practices are the primary pressure on soil condition (Chapman et al. 2011). Fortunately, this means that soil condition can be improved through changes in land management, with the associated benefits of increased agricultural productivity and better ecological functioning.

Land management within capability is also being monitored as part of the NSW MER Strategy. This involves assessing how well land types are being managed and whether the land can be maintained in good condition under these management practices.

For example, different levels of tilling, fertiliser use, length of time land is left fallow, and amount of vegetation or ground cover all affect how well the land and soil cope. Some practices will degrade land and soil faster than others.

The land management information reported here was gathered by OEH under its MER program, and includes data gathered from landholders themselves, from actual site soil samples and land assessment, and expert knowledge (Chapman et al. 2011). This information was then used to derive a score, or index, shown in Table 21 below.

Table 21: Land management within capability for SMUs in Northern Rivers Region CMA in 2012 (Source: OEH)

Soil management unit	Sheet erosion	Gully erosion	Wind erosion	Acidification	Organic carbon decline	Soil Structure decline	Acid sulfate soils	Salinity/water logging
North Coast Floodplains	4.1	4.1	4.1	3.0	4.4	4.4		4.9
Dorrigo-Comboyne Plateau	2.9	2.9	4.4	3.3	5.0	5.0		5.0
Alstonville Plateau	2.8	2.9	4.2	3.3	4.8	5.0		5.0
Casino Alluvials	4.7	4.7	4.8	3.2	4.2	4.2		4.6
Walcha Metasediments	2.8	2.8	4.0	2.9	3.1	3.1		3.8
Clarence Sodic Soils	3.8	3.8	4.7	2.2	3.2	3.3		1.7
Kempsey Hills	1.7	1.7	4.7	3.7	4.7	4.7		4.7
Granite Borderlands	4.5	4.7	4.6	3.0	4.6	4.4		5.0
Wauchope Low Hills	3.0	3.0	4.5	3.0	4.1	4.1		4.9
North Coast Acid Sulfate Soils	4.9	4.9	2.6	2.3	1.4	1.7	3.7	1.0

The data indicates that for the CMA Region, land management is generally 'fair' to 'good'. Erosion and acidity are the primary issues affecting land management in the Region, with salinity or waterlogging affecting Clarence Sodic Soils.

Acid sulfate soils (ASS) require ongoing management as they are the poorest performing soil management unit in the region. Remediation of ASS is discussed in section 3.4.

3.3 Funded land and soils management activities

INDICATOR: State- and federally-funded soil and land management activities (RESPONSE)
Data source: Northern Rivers CMA Data quality: Medium

In 2011–12 soil improvements and erosion controls were implemented on 4,655 hectares of land, and 1,680 hectares were managed for sustainable land management across the CMA Region. Improvements to acid sulfate soils are not included here as they are detailed in section 3.4.

3.4 Acid sulfate soils

INDICATOR: Extent of acid sulfate soils: hotspots and drainage density (PRESSURE)
Data source: Former Department of Land and Water Conservation
Data quality: High
INDICATOR: Area of remediated acid sulfate soils, drains and associated wetlands (RESPONSE)
Data source: Councils, county councils, Northern Rivers CMA
Data quality: Medium

Acid sulfate soils (ASS) are naturally occurring soils that contain iron sulfides. In the CMA Region, the acid sulfate soils of most concern are those which formed within the past 10,000 years, after the last major sea level rise. When the sea level rose and inundated land, sulfate in the sea water mixed with land sediments containing iron oxides and organic matter. The resulting chemical reaction produced large quantities of iron sulphides in the waterlogged sediments. Generally lying under alluvial soils, ASS are harmless if left alone and inundated, but when disturbed they react with oxygen to release sulfuric acid into the surrounding environment. This acid also dissolves and then transports heavy metals including iron and aluminium. This toxic combination severely affects vegetation, fish and other aquatic life (invertebrates and aquatic vegetation), and reduces the condition and productivity of the soil it comes into contact with (Johnston et al. 2003). It also corrodes and decreases the lifespan of any concrete and steel infrastructure it encounters.

In the CMA Region, ASS are found in all coastal council areas from Port Macquarie-Hastings north to Tweed. Urbanisation, agriculture and development have disturbed many areas of ASS. In particular, the broadscale excavation of flood mitigation drainage systems across the coastal floodplains has exacerbated ASS issues by increasing oxidisation of these soils. Much remediation work is now focusing on restoring higher groundwater levels in key drainage systems to minimise the potential for further oxidation and export of acidic contents.

ASS have been comprehensively mapped for the CMA Region, and best practice remediation techniques employed.
At a state level, DPI and the CMA are involved in remediation works and funding remediation programs. At a local level, councils have their own restoration programs which complement the state-level programs and are often funded by state agencies.The current state of ASS in the CMA Region and by each LGA is detailed in Table 22.

Table 22: Acid sulfate soils in the Northern Rivers CMA Region – status and remediation
(Source: Councils)

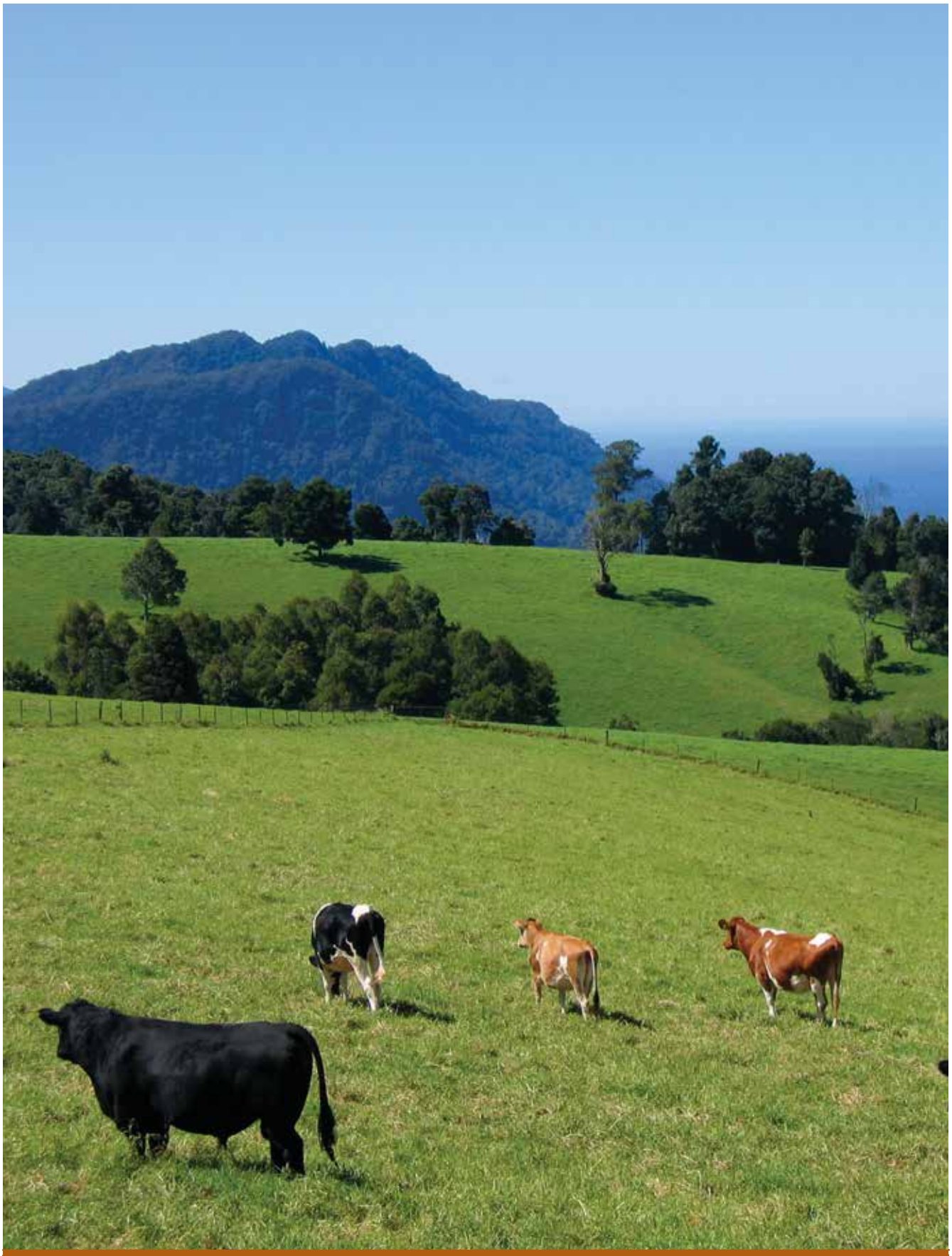
	Bellingen	Byron	Clarence Valley	Coffs Harbour	Kempsey	Nambucca	Port Macquarie-Hastings	Richmond River County Council *	Tweed	CMA Region
Total area identified high risk ASS (ha)	4,243	1,518	67,109	4,707	41,791	4,542	19,513	36,421	13,714	194,657
Total area identified low risk ASS (ha)	772	6,371	14,978	4,431	9,261	2,111	6,874	33,988	6,118	85,702
Total area of ASS hot spots (ha)	0	1,265	10,001	0	15,781	0	3,711	15,139	3,618	49,514
Area of ASS remediated (ha)	0	0	5,100	0	40	0	5,122	3,939	4,320	18,521
Area of associated wetland remediated (ha)	0	0	1,184	0	40	0	942	63	120	2,349
Number of drains remediated	0	0	129	0	2	0	57	29	72	289
Length of drains remediated (km)	0	0	85	0	0.6	0	145	109.7	82	422.3

In the CMA Region, just over 280,000 hectares of acid sulfate soils have been identified. Of these, 70% are considered high risk and 30% low risk. Nearly 50,000 hectares of land is considered to contain ASS hot spots, which mean they are considered to be priorities for remediation works. Drainage channels (both natural creeks and streams, and channels constructed for agriculture) increase the transport of ASS into river systems. All 4,546 km of ASS drains have been mapped for the CMA Region. Drained wetlands often adjoin or overlay areas of ASS and remediation of these wetlands is critical to maintain their important ecosystem functions.

Many councils are actively remediating ASS in their areas, with 18,521 hectares of land, 422 km of drainage, and 2,349 hectares of adjoining wetland remediated in the region. Management plans and agreements are in place for remediated areas to guide ongoing maintenance. Management of ASS is generally covered under each council's LEP and associated development control plans which specify what activities can be undertaken on identified ASS.

An exception is the NSW sugar cane industry which has a self-regulation process for ASS management. Cane farmers that clean or excavate drains on their farms are required to keep records of such works and apply lime at recommended rates to neutralise any potential acidity. An audit of 30 cane farms (10 each in the Tweed, Richmond and Clarence) to check compliance with this policy is carried out annually by industry, local and state government staff.

Photo on following page by Mark Asquith



Anemones and fish at Anemone Bay, NSW
Photo by Hamish Malcolm

4

4. Water

The Northern Rivers CMA Region has some of the largest river systems in the State. The Clarence River system is the largest coastal river system in NSW, the Richmond River drains the largest coastal floodplain in NSW, and the Region has the highest rainfall in the State.

Along the CMA Region's coast there two main estuary types: wave-dominated barrier estuaries and intermittently closed or open lakes and lagoons (ICOLLS). Groundwater is also a feature of the CMA Region, with a number of groundwater sources many of which supply both urban and rural areas with water. The marine environment adjacent to the mainland park of the CMA Region is incredibly diverse and includes two marine parks and an aquatic reserve. We are dependent on these river and estuary systems for our water supply, our recreation (swimming, fishing), and for some, our livelihood (oyster production, commercial fishing, tourism). Our rivers, creeks and estuaries are subject to increasing pressures from agriculture, land modification, urban expansion and associated pollution and alterations. Fortunately some rivers and estuaries are contained within the national park estate, thus removing them from urban pressures, but others are highly impacted by pollution and alteration. Maintaining clean, healthy waterways is critical to sustain our current lifestyle, so monitoring and appropriate management are vital.

In this section, the current condition of rivers and estuaries, wetlands, groundwater and the near-shore marine environment are detailed, along with key pressures and major responses.

Photo by: Nigel Blake

4.1 Estuarine and freshwater rivers

INDICATORS: Water quality, macro invertebrates and fish assemblages (CONDITION)
Presence of riparian vegetation(CONDITION)
Data sources: Water quality: Ecosystem health programs, Data quality:High
Macroinvertebrates: OEH, Ecosystem health programs
Data quality:High (Macroinvertebrates)
Fish assemblages: DPIData quality:High
Riparian vegetation: NSW Office of Water, councils, ecosystem health programs. Data quality:Low to medium

Estuarine and freshwater river condition is generally assessed using a number of indicators, including:

- water quality, particularly chlorophyll-a, turbiditytotal nitrogen, total phosphorous and dissolved oxygen
- macroinvertebrate levels — i.e. the type and number of water bugs
- riparian/riverbank vegetation
- fish condition — i.e. the number, type and age of fish species.

The CMA-led Ecohealth program uses all these indicators when assessing river health. Unfortunately, very few river systems in the CMA Region have had this comprehensive condition assessment conducted as it is resource intensive, time consuming and costly, but it does provide extensive information on river and estuary health.

The majority of councils in the CMA Region carry out standard basic water quality testing as part of their licence conditions for operating waste water treatment plants (WWTP). This means any council that has a WWTP discharging treated effluent into rivers must test the water quality to ensure there is minimal impact. In the absence of comprehensive assessment, this is often the only information available for river and estuary condition. OEH and DPI have conducted some monitoring of water quality, macroinvertebrates, fish condition, and riparian vegetation as part of the NSW MER Strategy, but these monitoring sites do not comprehensively cover the CMA Region, so additional local assessments are required.

These circumstances have resulted in a limited regional coverage for waterway condition, particularly freshwater river reaches. Although limited, the available data for both local and state-wide monitoring is reported here. Further assessment of water quality, wetlands and riparian vegetation is being piloted through a national 'Framework for the assessment of river and wetland health' (FARWH). This program aims to report on river and wetland condition at a national and regional scale, with targeted sites for field assessments (Alluvium Consulting 2011). It is hoped this information will be available for the next regional SoE report in 2016.

4.1.1 Comprehensive river health assessment

Only four LGAs within the reporting region have conducted comprehensive ecosystem health assessments for rivers and estuaries. At the time of this report, Bellingen, Port Macquarie-Hastings and Coffs Harbour councils had completed comprehensive Ecohealth assessments, and Clarence Valley Council have just commenced the program. Tweed Shire Council ran the South East Queensland Catchments (SEQ Catchments) version of the program in 2008, and all other councils within the CMA Region are hoping to have a comprehensive assessment completed by the next SoE report in 2016. The program is intensive and costly, but is only designed to be conducted every 4–5 years. As it is unlikely all councils will be able to complete the CMA-funded program by

the next SoE report, some are looking at gaining grant funding to run the SEQ Catchments version of the program in order to have one comprehensive assessment completed by 2016. Ecohealth and the SEQ Catchments program both assess water quality, riparian vegetation, macroinvertebrates and fish condition in estuaries and freshwater reaches of rivers and creeks. Combined, these indicators give an overall score for river and estuary condition. Scores are summarised in Table 23 for the four LGAs who have undertaken this comprehensive assessment (for full details of results, see Ryder et al. 2011, 2012a, 2012b; IWC 2009).

Table 23: Results from comprehensive ecosystem health assessments in the reporting region (Source: Ryder et al. 2011, 2012a, 2012b; IWC 2009)

	Water quality	Macro invertebrates	Riparian vegetation	Fish condition	Plankton	Total
Coffs Harbour LGA 2011-12						
Overall score	C	D-	C+			C-
Estuaries	C-					C-
Freshwater	B-	D-	C+			C
Port Macquarie - Hastings LGA 2011-12						
Hastings	C+	C+	C-	B+	B	B-
Camden Haven	C	C-	C	B-	B	C+
Lake Innes	C-		A-		B+	B
Estuaries						
Hastings	C-	B	D			C
Camden Haven	C	B	C+			C+
Freshwater						
Hastings	B-	C+	C-	B+		B-
Camden Haven	C+	C-	C	B-		C+
Bellingen LGA 2009-10						
Bellinger River	B	C+	C+	C-		B-
Kalang River	B-	C-	C+	C-		C+
Estuaries						
Bellinger River	B-		C+			C+
Kalang River	C		C+			C+
Freshwater						
Bellinger River	A-	C+	C+			B-
Kalang River	B+	C-	D			C+
Tweed LGA overall 2007-08 (SEQ program)*						
Estuary						C
Freshwater						D+

Grade	Result	Description
A	Excellent	Conditions meet all measured ecosystem health values; habitats are in near-pristine condition
B	Good	Conditions meet most measured ecosystem health values; most habitats are intact
C	Fair	Conditions meet some of the measured ecosystem health values; habitats are mildly impacted
D	Poor	Conditions do not meet most measured ecosystem health values; habitats are moderately impacted
E	Very poor	Conditions do not meet any measured ecosystem health values; habitats are severely impacted

Results indicate that for most of the four assessed LGAs, waterway condition is 'fair', with mildly impacted ecosystems and habitats. The freshwater reaches of the Bellinger and Hastings rivers were rated in 'good' condition (most ecosystems and habitats are intact for most aspects assessed), as was Lake Innes, a coastal lake or ICOLL. These high-scoring locations were all surrounded by forest.

Poorest water quality was found across all systems at the sites closest to the tidal limit (where freshwater meets salty water) indicating this zone acts as a deposit point for both freshwater and estuarine contaminants and sediments. High nutrient and sediment loads were strongly linked to high rainfall for those systems assessed during 2011, reflecting the influence of the La Niña cycle. However, in the Coffs Harbour systems, water quality issues were identified in both high and low flow conditions. In the Tweed, freshwater reaches scored poorly with a 'D+', with elevated nutrients due to onsite sewage management systems and livestock, high silt loads from inadequate or absent riparian vegetation, and many road crossings preventing fish movements. Tweed estuaries were in slightly better condition scoring a 'C', with better water quality in dry times, and good riparian vegetation. Nutrient loads were identified near waste water treatment plants. Macroinvertebrates scores were acceptable for 66% of sites, but were very poor at 13% of sites.

Port Macquarie – Hastings Council included zooplankton sampling in their recent Ecohealth program as it is a simple and useful measure of water quality, with results indicating a rating of 'good' across all 9 waterways sampled (Suthers et al. 2012).

Photo: Tarwhine
Photo by: Brett Vercoe

4.1.2 Water quality

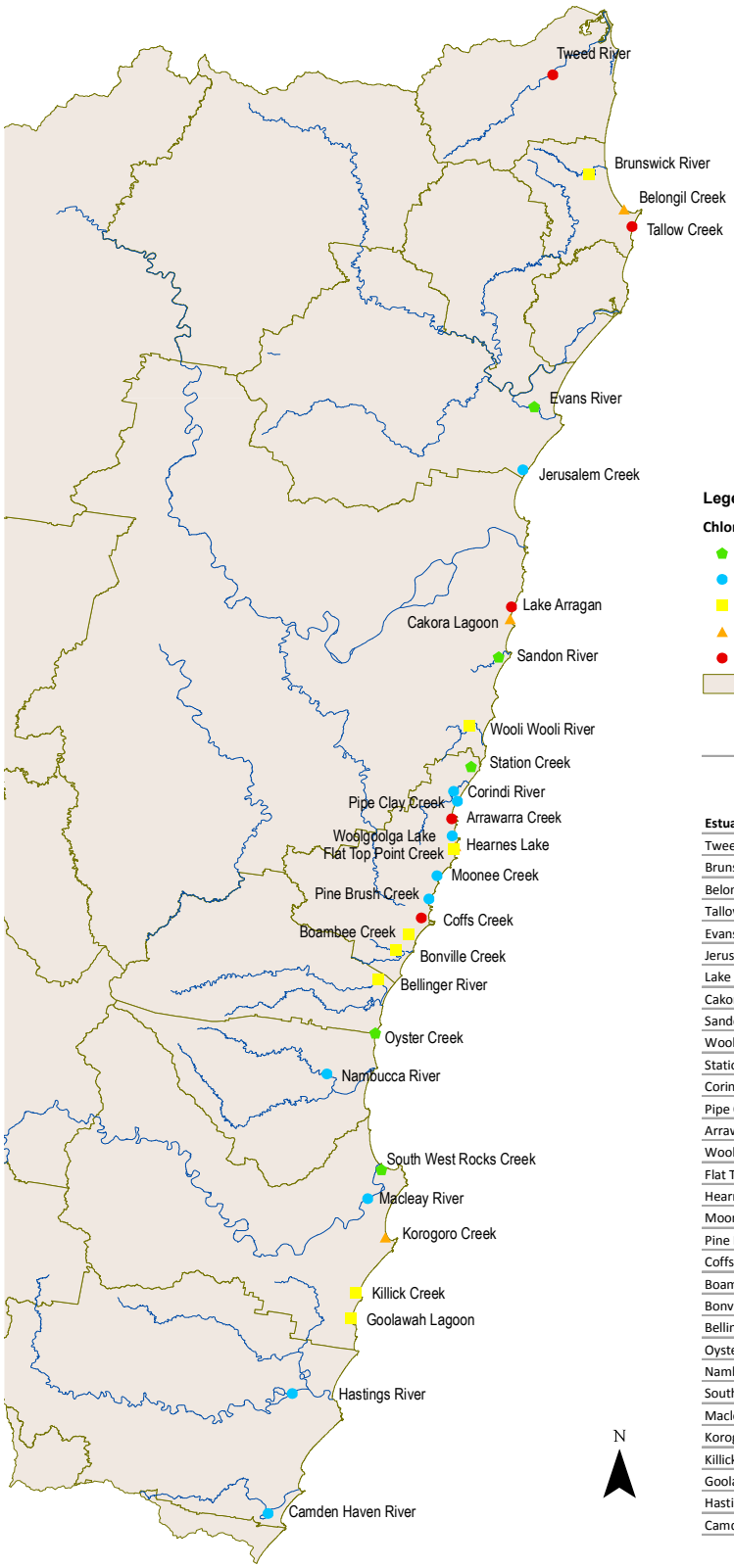
There is limited water quality data for the reporting region as a whole due to the absence of a standardised, simple and cost-effective method for regular water quality monitoring. Every LGA in the reporting region has some basic water quality data as a result of the requirement to test water quality adjacent to sewerage treatment plant discharge points.
NSW monitoring to date covers estuarine sites in the CMA Region, but there is a lack of freshwater monitoring. Available water quality data for rivers is summarised here. As part of the NSW MER program, water quality was monitored at 32 estuaries, lakes and lagoons along the coast of the Northern Rivers CMA Region between 2009 and 2010 by OEH. Turbidity and chlorophyll-a were the key measures used to determine water quality, as they indicate levels of nutrients, sediments and other contaminants in waterways that may lead to algal blooms, impacting aquatic and human health. Increases in turbidity and chlorophyll-a levels are normal after heavy rains and in summer with warmer water temperatures. However increased levels that persist over time indicate poor water quality (OzCoasts 2012). Acceptable levels are set nationally under the ANZECC guidelines, and have been modified for regional use by the Ecohealth program (see Ryder et al. 2012b).

Results indicate that 15.6 percent of estuaries are in 'very good' condition for chlorophyll-a and almost 47% of estuaries are in 'very good' condition for turbidity, meaning less than 10% of samples exceeded the guideline limits. Thirty-one percent of estuaries were rated as 'good' for chlorophyll-a and 37.5% for turbidity, meaning less than 50% of samples exceeded the guideline limits. Twenty-eight % of estuaries received a 'poor' or 'very poor' rating for chlorophyll-a and 6.25% for turbidity (see Table 24).

The poorest performing estuaries were Tweed River, Coffs Creek, Arrawarra Creek, Tallow Creek, Cakora Lagoon, Belongil Creek and Lake Arragan. Results indicate that nutrient loads in the region's estuaries are of concern and are impacting water quality in many estuaries. The poorest location for turbidity was Coffs Creek, where 80% of samples exceeded the guideline, with Arrawarra Creek, Cakora Lagoon, Lake Arragan and Flat Top Point Creek receiving ratings of 'fair', meaning 50-75% of samples exceeded the guidelines. The cleanest estuaries were Station Creek, Sandon River, South West Rocks Creek, Oyster Creek and Evans River (see Figure 23).

Table 24: Water quality ratings in CMA Region estuaries for chlorophyll-a and turbidity for 2009 and 2010 (Source: OEH)

Rating	Rating guide	Chlorophyll-a %	Turbidity %
Very good	Less than 10% of samples exceeded the guidelines	15.6	46.9
Good	10-50% of samples exceeded the guidelines	31.3	37.5
Fair	50-75% of samples exceeded the guidelines	25.0	9.4
Poor	75-90% of samples exceeded the guidelines	12.5	6.3
Very poor	More than 90% of samples exceeded the guidelines	15.6	0



Estuary (north to south)	Chlorophyll-a: % samples exceeding guidline	Rating
Tweed River	100	very poor
Brunswick River	69	fair
Belongil Creek	75	poor
Tallow Creek	100	very poor
Evans River	8	very good
Jerusalem Creek	12	good
Lake Arragan	100	very poor
Cakora Lagoon	78	poor
Sandon River	8	very good
Wooli Wooli River	42	fair
Station Creek	8	very good
Corindi River	42	good
Pipe Clay Creek	33	good
Arrawarra Creek	100	very poor
Woolgoolga Lake	25	good
Flat Top Point Creek	83	poor
Hearnes Lake	67	fair
Moonee Creek	17	good
Pine Brush Creek	17	good
Coffs Creek	100	very poor
Boambee Creek	70	fair
Bonville Creek	70	fair
Bellinger River	56	fair
Oyster Creek	0	very good
Nambucca River	36	good
South West Rocks Creek	9	very good
Macleay River	42	good
Korogoro Creek	82	poor
Killick Creek	50	fair
Goolawah Lagoon	50	fair
Hastings River	38	good
Camden Haven River	17	good

Figure 23: Ratings for Chlorophyll-a in CMA Region estuaries in 2009 and 2010
(Source: OEH)

4.1.3 Aquatic macroinvertebrates

Aquatic macroinvertebrates, or water bugs, are a key indicator of river health. Certain types of water bugs are sensitive to pollution and others are pollution-tolerant. The numbers and different species of water bug can therefore indicate how clean a waterway is. Water bugs also provide a crucial role in the food chain as consumers of almost all types of organic matter (leaves, algae, wood, plants) and are a major food source for many other species such as frogs, fish, birds, turtles, platypus and water rats (Chessman 2003).

As such, a good macroinvertebrate population equals a healthy, pollution-free river with plenty of fish and other fauna. OEH has been monitoring macro-invertebrates as part of the NSW MER Strategy. Samples have been collected from 1994 to mid-2010 from all parts of the CMA Region. The samples collected are compared with the samples collected from reference sites and scored accordingly. The CMA Region–wide data from the program is displayed in Figure 24. Scores by LGA are shown in Table 25.

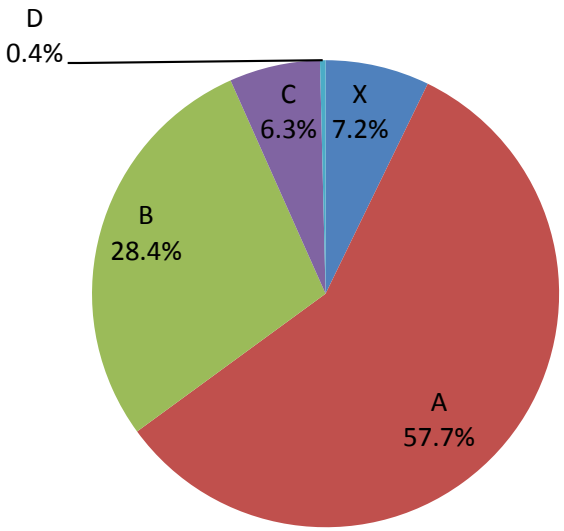


Figure 24: Macroinvertebrate health – percentage of sites in the Northern Rivers CMA Region in each health category, 1994 to mid-2010 (Source: OEH)

Key to scores:

Score	Key	Description
X	More biologically diverse than reference	More families found than expected. Potential biodiversity 'hot-spot' or mild organic enrichment.
A	Similar to reference condition	Expected number of families within the range found at 80% of the reference sites.
B	Significantly impaired	Fewer families than expected. Potential impact either on water and/or habitat quality resulting in a loss of families
C	Severely impaired	Many fewer families than expected. Loss of families from substantial impairment of expected biota caused by water and/or habitat quality.

Table 25: Macroinvertebrate health in the reporting region– percentage of sites in each health category (Source: OEH)

Local Government Area	X	A	B	C	D
Ballina		11.1%	50.0%	33.3%	5.6%
Bellingen	14.5%	58.7%	23.9%	2.9%	
Byron		24.1%	55.2%	20.7%	
Clarence Valley	3.6%	61.3%	25.8%	8.8%	0.5%
Coffs Harbour		28.3%	41.7%	28.3%	1.7%
Kempsey	13.4%	55.4%	29.5%	1.8%	
Kyogle	7.5%	61.2%	31.3%		
Lismore	6.8%	43.2%	38.6%	11.4%	
Nambucca	1.5%	40.3%	40.3%	16.4%	1.5%
Port Macquarie – Hastings	7.0%	63.1%	29.3%	0.6%	
Richmond Valley	3.4%	27.6%	58.6%	10.3%	
Tweed	4.7%	60.5%	25.6%	9.3%	
CMA Region	7.2%	57.7%	28.4%	6.3%	0.4%

Analysis of the data shows that generally the CMA Region is performing well for aquatic macroinvertebrates. Over 7% of all sites scored in the highest band (X), meaning these sites had more species diversity than expected and are in very good condition. The majority of the CMA Region scored an 'A', meaning 80% of the sites had the expected species families. Less than 10% of the Region scored 'C' or 'D' (severe to extreme impairment). When analysed, the sites with poor water quality as assessed by macroinvertebrates were located downstream from towns or agricultural areas.

Some macroinvertebrate data was collected for the Ecohealth programs and results are provided in Table 26.

Table 26: Macroinvertebrate scores from Ecohealth monitoring programs (Source: Ryder et al. 2011, 2012a, 2012b; IWC 2009)

Score	Key	Bellingen 2009-10	Coffs Harbour 2011	Port Macquarie-Hastings 2011	Tweed 2007-08
		Number of sites			
A	Excellent — near pristine condition				2
B	Good — most habitats and ecosystem processes intact	3	2	3	8
C	Fair — some habitat impacts but some ecosystem processes functional	5	1	8	3
D	Poor — many non-functional ecosystem processes and moderate habitat impacts	1	2	1	2
E or F	Fail — severely impacted habitats and ecosystem functions	1	5		

Results of the comprehensive ecosystem health assessments may differ from the NSW MER Strategy as they were all collected in a single year, whereas the state data has been collected over 18 years. For Bellingen, macroinvertebrate scores varied widely in the two main rivers. The poorest river was Spicketts Creek which scored consistently poorly indicating poor water quality and habitat condition (Ryder et al. 2011). Coffs Harbour macroinvertebrate scores were generally low, indicating degraded water quality and habitat in most river systems, with five locations scoring an 'E'. Port Macquarie-Hastings scores also indicate low to moderate long-term degradation of water quality and in-stream habitat (Ryder et al. 2012b). The highest scores were recorded in the most upstream river sections, suggesting better water quality and habitat and more sensitive surrounding land uses in these locations. In the Tweed, the macroinvertebrate scores were good for most locations. Only 2 of the 15 sites scored poorly, both on Duroby Creek (IWC 2009).

4.1.4 Fish condition

Fish condition (i.e. the number, variety and age of fish species in a river system) is an indicator of river health as it reflects disturbance (both natural and human), the presence of introduced fish species, and the number and type of fish species that would be expected in a river prior to European settlement (IWC 2009).

Fish condition monitoring has been conducted in the CMA Region as part of the NSW MER Strategy, and results are displayed in Figure 25. Results of the monitoring indicate that 'nativeness' (the number of native fish versus introduced or pest fish) is generally high, with pest species showing relatively little impact in the CMA Region. 'Expectedness' (the number and type of species expected to occur in a river) was variable, with the highland areas having the poorest expectedness across all river systems. So, although the fish found in the highland areas were native, there were far fewer species than expected. Best species occurrence or expectedness was found in the Clarence River (alpine and coastal plains regions), with good expectedness for the coastal plain for all other river systems. Recruitment (the number of fish determined to be smaller than an adult of its species) was generally poor across all rivers systems except in the slopes, where a score of 'fair' was achieved, however the alpine region scored 'very poor '(see figure 25; Gilligan in preparation). The low recruitment may have been related to the very wet years due to the La Niña conditions during sampling, and repeat surveys will determine the true recruitment pattern in the CMA region (Butler et al. 2012).

Generally, the coastal regions have better fish condition than the tablelands and highlands. Pest species impacts are low, but there are far fewer species in our rivers than expected, and fewer juveniles. Additional assessment of fish condition was conducted as part of the Ecohealth assessments. Fish condition in the Bellinger and Kalang rivers was assessed across 18 sites in 2009–10. Results indicated that fish communities in the freshwater reaches were good in the coastal plain, moderate in the lowlands, and poor in the slopes, upland and highland zones (Gilligan 2010). Only one introduced species was found (eastern mosquito fish *Gambusia holbrooki*), however, the number of native species was below expected levels with only 18 of 24 species found, and the 18 found were at fewer locations than expected indicating the number of fish species occurring in these rivers is poor.

Fish condition was also assessed in the Tweed, where 18 native species and two introduced species were found, however, the two introduced species made up 26% of the total catch. Two expected species were not found: olive perchlet and ornate rainbowfish. This indicates the Tweed system is moderately impacted by introduced species, and although most expected native species were found, their distribution was patchy. Duroby Creek was the poorest performing system (IWC 2009).

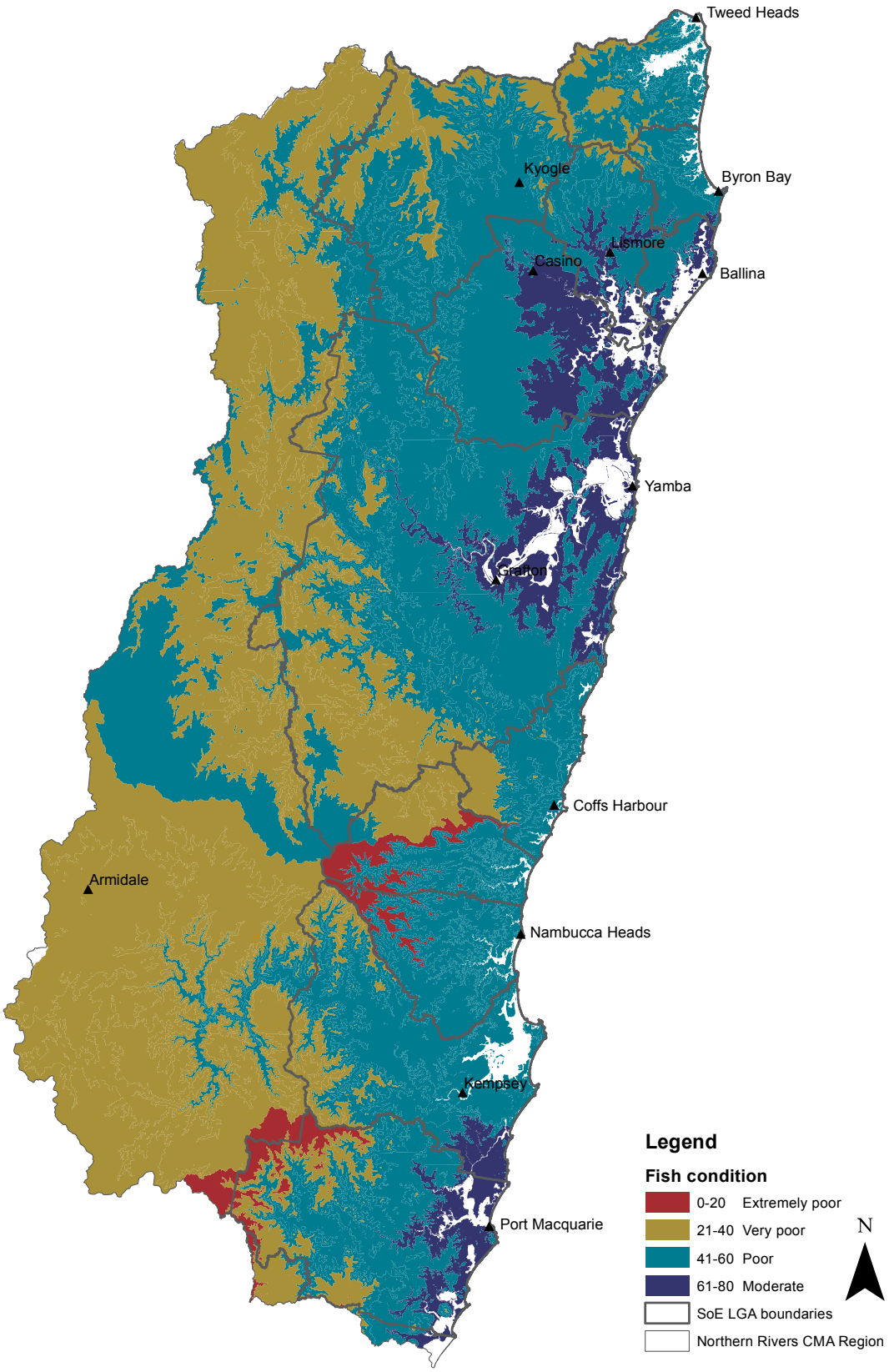


Figure 25: Freshwater fish condition for the CMA Region (Source: DPI)

4.1.5 Riparian vegetation

Riparian vegetation (i.e. vegetation lining rivers, creeks and estuaries) provides important ecosystem functions, such as reducing pollutants and sediment entering waterways, providing connected habitat for fauna, and stabilising river banks. Riparian vegetation in good condition influences biodiversity and system productivity. Riparian vegetation condition is used as an indicator of river and estuary health, however, there is little comprehensive data available for the CMA Region. Regionally, urbanisation and agriculture have impacted riparian vegetation, as vegetation is frequently removed or modified to provide stream access for people and livestock. Weeds are another major issue for riparian vegetation condition due to their impact on biodiversity (Davies & Boulton 2009). The biological importance of riparian vegetation makes it a high priority for assessment and restoration, and degradation of riparian vegetation has been listed as a key threatening process.

The NSW MER Strategy assessed riparian vegetation condition as part of its estuary condition monitoring program. Table 27 shows all assessed estuaries from north to south, and the percent of riparian vegetation disturbed. Results indicate that in many locations, 65 to 82% of riparian vegetation has been disturbed (Tweed, Macleay, Richmond, Clarence, Nambucca and Bellinger Rivers, and Woolgoolga Lake, Coffs Creek). Other locations including Salty Lagoon, Jerusalem Creek, Lake Arragan, Sandon River, Station Creek and Goolawah Lagoon have less than 1% disturbance, indicating these estuaries have maintained the important ecological functions of intact riparian vegetation, which include filtering runoff and improving water quality; protecting against bank erosion from wind, currents or boat wakes and providing a food source and habitat for estuarine-dependent fauna including mammals, reptiles and birds (Roper et al. 2011).

Table 27: Condition of riparian vegetation in estuaries of the CMA Region (Source: OEH)

Estuary (north to south)	% disturbed riparian vegetation	Estuary (north to south)	% disturbed riparian vegetation
Tweed River	81.8	Flat Top Point Creek	20.8
Cudgen Creek	48.0	Hearns Lake	31.1
Cudgera Creek	44.2	Moonee Creek	39.9
Mooball Creek	64.4	Pine Brush Creek	73.7
Brunswick River	56.1	Coffs Creek	66.3
Belongil Creek	46.7	Boambee Creek	35.8
Tallow Creek	40.5	Bonville Creek	40.5
Broken Head Creek	0.1	Bundageree Creek	5.0
Richmond River	74.9	Bellinger River	68.2
Salty Lagoon	0.0	Dalhousie Creek	17.5
Evans River	21.8	Oyster Creek	16.8
Jerusalem Creek	0.0	Deep Creek	50.3
Clarence River	67.6	Nambucca River	65.7
Lake Arragan	0.0	Macleay River	75.5
Cakora Lagoon	11.2	South West Rocks Creek	40.4
Sandon River	0.5	Saltwater Creek	12.6
Wooli Wooli River	4.8	Korogoro Creek	26.9
Station Creek	0.0	Killick Creek	24.5
Corindi River	16.8	Goolawah Lagoon	1.4
Pipe Clay Creek	20.0	Hastings River	55.8
Arrawarra Creek	30.4	Cathie Creek	9.1
Darkum Creek	50.9	Duchess Gully	22.1
Woolgoolga Lake	70.1	Camden Haven River	41.9

Riparian vegetation has also been assessed as part of the comprehensive ecosystem health assessments, and some councils have conducted comprehensive riparian vegetation condition assessments.

Results of ecosystem health assessments (see Table 23) indicate that riparian condition is only fair, and shows impacts and disturbance to habitats and ecosystem functions. Only one location scored an 'A' (excellent) — Lake Innes in Port Macquarie-Hastings LGA — and two locations scored a 'D' (poor) — the Kalang River in Bellingen LGA and the Hastings River estuary in Port Macquarie-Hastings LGA.

Ballina LGA mapping of riparian vegetation condition indicates that 42% remains highly vegetated, 15% has medium vegetation cover, 22% has no vegetation cover, and the remaining 21% was classified as low density vegetation or modified for horticulture (Moore 2003).

Clarence Valley LGA has also mapped riparian vegetation and prepared a riparian action strategy. Results of the mapping outside the floodplain region of the Clarence River indicates that approximately 85% of mapped riparian vegetation is in good condition, 13% is in moderate condition and 1.3% is degraded. Riparian vegetation condition within the floodplain area is less positive, with only 2% of riparian vegetation in good condition, 97.5% in moderate condition and 0.5% in poor condition.

Other LGAs are in various stages of assessing riparian vegetation condition, listed in table 28.

Table 28: Riparian assessment status by LGA (Source: Councils)

LGA	Riparian assessment status
Ballina	Specific riparian vegetation condition study conducted in 2003
Bellingen	Site assessments conducted as part of Ecohealth and by the CMA; comprehensive vegetation mapping commenced
Byron	Has conducted extensive vegetation mapping from which riparian vegetation condition information can be extracted
Clarence Valley	Desktop assessment of riparian condition and associated Riparian Action Strategy
Coffs Harbour	Has conducted extensive vegetation mapping from which riparian vegetation condition information can be extracted
Kempsey	No known mapping
Kyogle	No known mapping
Lismore	Has conducted extensive vegetation mapping from which riparian vegetation condition information can be extracted
Nambucca	Estuarine study completed
Port Macquarie – Hastings	Site assessments conducted as part of Ecohealth
Richmond Valley	Has mapped watercourses, wetlands and riparian vegetation, but no condition information
Tweed	Has assessed riparian vegetation as part of new CZMP but no condition information. Has implemented buffers: Minimum riparian buffer of 10m, Buffers of 30m in rural areas, 50m in urban development areas. Site assessments conducted as part of Ecosystem health monitoring program

Ideally, by the next comprehensive state of the environment report, due in 2016, all LGAs will have conducted a comprehensive assessment of riparian vegetation.

4.1.6 Waste water treatment plant and onsite sewage management system performance

INDICATOR: Waste water treatment plant (WWTP) and on-site sewage management system (OSMS) performance (PRESSURE and RESPONSE)
Data: Data source: Councils Data quality: Medium

Nutrient inputs into rivers and estuaries can severely impact river health and can also impact human health. In April 2006 the Bellinger River was closed to oyster harvesting by the NSW Food Authority, and the Kalang river is currently closed. Closures were in response to the presence of pollutants in the river, including faecal contaminants and a potentially toxic phytoplankton, that could be harmful to human health (Bellingen Shire Council 2010). As waste water treatment plants (WWTP) and on-site sewage management systems (OSMS) such as septics, composting toilets, are the primary source of contaminants, it is essential that they are functioning adequately. This will ensure a healthy river and estuary that is safe for aquatic biodiversity, water supply, swimming, fishing and oyster production. Many WWTPs discharge treated effluent into rivers and estuaries, so any malfunctions in operations can immediately impact water quality. Some OSMS are inappropriately located (e.g. too close to rivers and estuaries) and are known to impact water quality. The current functioning of WWTPs and OSMS by LGA is detailed in this section.

Waste water treatment plant performance

All LGAs in the reporting region manage more than one WWTP. They are all licensed by the Environment Protection Authority (EPA) and must supply regular information on any breaches or nutrient exceedences that occur. All WWTPs have strict water quality monitoring to rapidly identify breaches. Table 29 shows total discharge of treated effluent to waterways and total reused. Note that many LGAs have implemented effluent reuse schemes which reduce the amount of effluent discharged to waterways.

Table 29: Waste water treatment plant performance in the reporting region (Source: Councils)

Local Government Area	Total volume of wastewater treated (ML)	Volume of wastewater discharged to waterways (ML)	Volume of wastewater reused (ML)	% wastewater discharged to waterways	% wastewater reused
Ballina	4,545	4,392	153	96.6	3.4
Bellingen	764	764	0	100.0	0.0
Byron	3,789	3,259	530	86.0	14.0
Coffs Harbour	8,761	6,879	1,882	78.5	21.5
Clarence Valley	3,262	3,231	31	99.1	0.9
Kempsey	2,839	2,812	28	99.0	1.0
Kyogle	513	382	131	74.4	25.6
Lismore*	4,803	4,803	0	100.0	0.0
Nambucca^	1,646	1,405	241	85.4	14.6
Port Macquarie - Hastings	9,917	9,662	255	97.4	2.6
Richmond Valley	2,074	1,826	248	88.0	12.0
Tweed	8,546	7,079	1,467	82.8	17.2
Reporting region	51,458	46,494	4,964	90.4	9.6

* Water reuse is in place but is unmetred at this stage
^ Biosolids are reused

A number of councils have recently upgraded WWTP facilities to improve performance and most are reusing wastewater to some extent. Kyogle and Coffs Harbour councils reuse almost a quarter of their wastewater, and Tweed reuses 17%. Lismore has a significant reuse scheme but it is not yet metered, so a reuse volume could not be obtained. At a regional level, nearly 10% of all wastewater is reused. Increasing reuse of waste water will reduce the pressure on aquatic ecosystems as will improvements in waste water treatment technology.

On-site sewage management system performance

On-site sewage management systems (OSMS) include septics, aerated waste water treatment systems, reed beds, greywater systems and composting toilets. Many systems are old and do not function adequately. When situated too close to waterways, OSMS can release contaminants into the water and impact river and human health, and also groundwater health.

The status of OSMS in the reporting region is detailed in Table 30 below. The results indicate that for most LGAs, the failure rate of inspected OSMS is between 14% and 50%. An additional concern is the high estimated number of unregistered or illegal systems in place which are not monitored. At this point the impact of OSMS on waterways cannot be fully considered as we have neither the water quality data nor the OSMS location data to quantify the risks and impacts. The high rainfall received in the reporting year increased failure rates for OSMS as waterlogged ground results in issues such as non-functioning absorption trenches.

Table 30: Status of on-site sewage management systems in the reporting region
(Source: Councils)

Local Government Area	Total number of known OSMS	Number inspected in 2011–12	Number of failed OSMS	% failed	Estimated number of unregistered OSMS
Ballina	2,814	92	24	26	2,200
Bellingen	2,800	388	55	14	300
Byron	4,314	242	150	60	6,471
Coffs Harbour	5,392	910	350	38	unknown
Clarence Valley	7,857	569	85	15	25
Kempsey	4,675	897	219	24	500+
Kyogle	2,805	283	36	15	unknown
Lismore	3,441	600	162	27	97
Nambucca	2,976	755	31	4	100
Port Macquarie-Hastings	4,920	50	17	34	10,000
Richmond Valley	3,860	458	124	27	35
Tweed	7,021	480	27	6	unknown
Reporting region	52,875	5,724	1,280	22	approx 20,000

One issue currently for LGAs is a lack of funding to increase the number of OSMS inspections and to adequately document and map high risk systems. With the location of so many OSMS unknown, a comprehensive mapping and documentation system is required to allow identification of high risk systems and an adequate inspection program. Nambucca Council has established an OSMS database, a ratings system for all known OSMS, and a priority system for OSMS inspections, with high risk systems on an annual inspection timetable, medium risk on a three-year inspection cycle, and low risk systems on a seven-year cycle. Other councils are also implementing management plans for OSMS, but require additional resources due to the high number of OSMS in their respective LGAs. Some councils are recommending alternative systems to the traditional septic, such as aerated waste water treatment systems and composting toilets, which are better suited to certain soil types and reduce impacts. Many councils are also connecting houses in growing urban areas to the sewer, which will lead to a reduction in issues associated with OSMS and ideally improve water quality locally.

4.1.7 River restoration works and riparian vegetation restoration

INDICATORS: River rehabilitation works (RESPONSE)
Length of riparian vegetation restoration and recovery (RESPONSE)
Data source: Northern Rivers CMA, councils Data quality: Medium

Restoration of riverine and riparian habitat has great benefits for aquatic species and river health. The degradation of both aquatic habitat and riparian areas are classified as key threatening processes, and the Northern Rivers Catchment Action Plan (CAP; NRCMA 2005) has a target to rehabilitate 60% of stream lengths in priority subcatchments by 2016. River and riparian restoration works are conducted at state and local level, and works conducted within the CMA Region are reported below in Tables 31 and 32.

Table 31: River restoration works under Northern Rivers CMA projects for 2011–12
(Source: Northern Rivers CMA; Richmond River County Council)

Northern Rivers CMA projects	Measure
Bank stabilisation	2.5 km
Stream-bed stabilisation	1.7 km
Stream protected from livestock	10 km
Number of woody debris structures installed	9
Numbers of fish barriers removed or modified	3
Richmond River County Council projects	
Length of aquatic weed removal	7.6 km
Length of riparian weed control	3.2 km

Table 32 (and table 37 for wetlands restoration) shows the dependence on grant funding for habitat restoration projects, and the large volunteer contribution.
Many landholders also restore riparian vegetation on their own properties which is not reported here. Despite the degradation of streams and riparian vegetation being a key threatening process and a target under the Northern Rivers CAP, there is little resourcing or funding specifically targeting these processes. The lack of condition information, as detailed previously, highlights the need for increased resourcing and research into river and riparian vegetation restoration.

Table 32: Riparian vegetation restoration in the reporting region for 2011–12
(Source: Councils; NRCMA)

LGA	Area (ha)	Trees	Land type	Activity	Funding	Volunteer hours*
Ballina	27		Public land	Primarily weed removal, some planting and fencing	Council, Environmental Trust, Caring for Country	
Byron	28	800	Public land	Primarily weed removal, some planting	Council, NRCMA and Environmental Trust	
Bellingen	4	6,883	Private and public land	Weed removal and planting	Council, Environmental Trust, OEH	32
Clarence Valley	148	453	Private and public land	Primarily weed removal, some planting and fencing	Council, NRCMA, Caring for Country, landholders	2,803
Coffs Harbour	100	2,700	Private and public land	Weed removal and planting	Council, NRCMA, Environmental Trust, Federal Community Action Grant, Landcare, Transgrid, and private developer	1,750
Kempsey	1	1,850	Public land	Weed removal and planting	Council, NRCMA and Environmental Trust	94
Lismore	86	218	Private and public land	Primarily weed removal, some planting	Council, NRCMA	1,080
Nambucca	3		Public land	Weed removal and planting	Council, Environmental Trust	
Richmond Valley	1	310	Public land	Weed removal and planting	Council	
Tweed	68	800	Private and public land	Weed removal and planting	Council, Environmental Trust	1,750
Richmond River County Council	5	2,235	Private and public land	Weed removal and planting	Council, NewTrain, NRCMA, OEH and Environmental Trust	290
Rous Water	99	7,900	Public land	Weed removal and planting	Rous Water	
NRCMA Projects^	147			Weed removal and planting	Northern Rivers CMA	

* Volunteer hours are substantially underestimated as not all volunteer groups report hours.
^ Total not given as the Northern Rivers CMA figures include the work reported by councils funded by the NRCMA

4.1.8 Stormwater improvement works and water sensitive urban design (WSUD)

INDICATOR: Stormwater improvement works and WSUD plans (RESPONSE)
Data: Data source: Councils Data quality: High

Stormwater is a diffuse source of pollutants entering rivers and estuaries. Stormwater includes run-off after heavy rains, and often contains soil sediments, nutrients from fertilisers and manure, oil and grease, rubbish, and on occasion, sewage. This large pollution load can have a significant impact on water quality in our waterways. To better manage stormwater and reduce impacts, councils are developing water sensitive urban design (WSUD) plans. These plans provide specific guidance for urban settings on the methods to reduce pollutants and sediments entering waterways, for example, through use of vegetated buffers, stormwater reuse, stormwater retention and evaporation, and stormwater treatment systems. The aim is not only to reduce pollutant loads, but also to reduce the traditional use of pipes and waterway modifications to dispose of stormwater.

Table 33 details what policies and plans are in place for the councils in the reporting region to better manage stormwater.

Table 33: Stormwater management plans in the reporting region (Source: Councils)

LGA	Stormwater plans in place
Ballina	Stormwater management plan (under revision), stormwater quality improvement devices (SQIDs) plan
Bellingen	Stormwater Management Plan and Water Quality Urban Design (WSUD)
Byron	Adopted engineering specification (Northern Rivers Local Government Handbook of Stormwater Drainage Design) advising WSUD components to be designed to Brisbane City Council standards
Clarence Valley	No specific plans
Coffs Harbour	'Coffs Harbour City Council Water Sensitive Urban Design (WSUD) Policy' (2009) (under revision)
Kempsey	Location-specific stormwater improvement projects
Kyogle	No specific plans
Lismore	Urban stormwater management plan 2007 and WSUD Development control plan
Nambucca	Included in 2010 LEP
Port Macquarie-Hastings	'Hastings Urban Stormwater Management Plan' 2000 (LGA wide)
Richmond Valley	WSUD policy
Tweed	Tweed urban stormwater quality management plan 2012, Tweed development control plan section 5A – subdivision manual section 7D - stormwater quality

Information received from councils indicates that 7 of the 12 councils in the reporting region have dedicated stormwater management plans for their areas, and many have no specific stormwater provisions.

Table 34 below shows the costs involved with maintenance and construction of stormwater infrastructure, which is why WSUD policies (such as Coffs Harbour) put the onus on property developers to implement WSUD in their developments, and why council rates often include a stormwater levy. The maintenance of good riparian vegetation along waterways and community education also play a large role in reducing the impacts of stormwater.

Table 34: Stormwater improvement works in the reporting region in 2011-12 (Source: Councils)

Local Government Area	Improvement works for 2011–12	Cost
Ballina	Nil	$0
Bellingen	Nil	$0
Byron	Maintenance of traps, drains, kerbs, gutters, pipes, pits and culverts	$459,500
Clarence Valley	Improvement works near estuaries and wetlands	$100,000
Coffs Harbour	Gross pollutant trap maintenance	$12,000
Kempsey	Gross pollutant trap maintenance	$118,414
	Drain repairs and cleaning	$135,769
Kyogle	Improvement works	$116,000
Lismore	New drainage works	$60,000
	Maintenance of existing structures	$110,000
Nambucca	Nil	$0
Port Macquarie-Hastings	Drainage remediation and upgrades	$180,000
	Gross pollutant trap maintenance	$12,000
Richmond Valley	Gross pollutant trap maintenance	$16,000
	Evans Head wetlands works	$17,000
Tweed	Urban system upgrade	$406,648
	New drainage works	$853,000
	Maintenance of existing drainage	$405,568
	Gross pollutant trap maintenance	$47,000
Reporting region total		$3,048,899

4.2 Wetlands

INDICATORS: Wetland condition (CONDITION)
Wetland pressure (PRESSURE)
Data source: OEH Data quality: Low
INDICATOR: Wetland remediation (RESPONSE)
Data source: Councils Data quality: Medium

Wetlands are biologically important. They support a range of ecosystem functions including providing habitats, breeding grounds and nurseries for waterbirds, frogs, fish, invertebrates and plants; and supporting threatened species and endangered ecological communities. Many migratory birds travel vast distances to visit our wetlands (DECCW 2010b). Despite these important ecosystem services, there is very little information on the location, type or condition of wetlands in the CMA Region.

At a state level, only 14 wetlands were assessed as part of State of the Catchments 2010, and most of those had little supporting data (see Table 35). Various studies have been conducted to accurately map the wetlands of the CMA Region, but all have significant inaccuracies and do not describe wetland condition. To rectify this, some councils have conducted their own mapping of wetlands, however, no condition information is available. This indicates a severe gap in data for wetlands across the CMA Region.

Photo: Little Llangothlin Nature Reserve
Photo by: Shane Ruming

Table 35: Condition of 14 key wetlands in Northern Rivers CMA Region (Source: OEH)

Wetland	Type	Overall Pressure	Overall Condition	Pressure			Condition			
				Catchment	Hydrological	Habitat	Biota	Biota - Pests	Water Quality	Soil Quality
Barley Fields Lagoon	Upland freshwater lake	4	2	4	1	4	nd	nd	nd	nd
Belmore Swamp/ Swan Pool	Coastal floodplain swamp	4	5	3	4	4	nd	5	nd	nd
Bundjalung National Park Swamps	Coastal dune swamp	4	5	2	1	4	nd	5	nd	nd
Bunyip Swamp	Coastal floodplain swamp	4	2	4	1	4	nd	nd	nd	nd
Cowans Pond	Coastal freshwater lake	4	5	4	1	4	nd	5	nd	nd
Dangars Lagoon	Upland freshwater lake	4	2	4	1	4	nd	nd	nd	nd
Dumaresq Dam	Upland freshwater lake	4	2	4	3	4	nd	nd	nd	nd
Everlasting Swamp	Coastal floodplain swamp	4	5	4	3	4	nd	5	nd	nd
Lake Hiawatha and Minnie Waters	Coastal dune lake & lagoon	3	5	1	1	4	nd	5	nd	nd
Little Llangothlin Lagoon	Upland freshwater lake	4	5	4	1	4	nd	5	nd	nd
Lower Bungawalbin Wetland	Coastal floodplain swamp	4	2	4	3	4	nd	nd	nd	nd
Round Mountain Swamps	Upland swamp	4	5	3	1	4	nd	5	nd	nd
Tuckean Swamp	Coastal floodplain swamp	4	5	4	4	4	nd	5	nd	nd
Upper Coldstream	Coastal floodplain swamp	4	5	4	3	4	nd	5	nd	nd

Rating	Pressure
1	very low
2	low
3	moderate
4	high
5	very high
nd	no data

The condition of and pressures on the 14 assessed wetlands are summarised in Table 36. Catchment disturbance includes urbanisation, agriculture, vegetation removal, infrastructure and fire. Hydrological disturbance involves nutrients entering the wetland, water and soils quality, vegetation patterns, the biota (flora and fauna) present, alteration of the wetland's structure and the wetland's productivity. Habitat disturbance includes any activity that modifies or removes a wetland such as agriculture, urbanisation etc.

For condition, biological indicators are presence, abundance and health of wetland flora and fauna. Pest species measures the ratio of native to introduced species. Water quality measures pH, salinity and turbidity. Soil quality measures soil pH, salinity, moisture, erosion and modifications.

The summary in Table 36 indicates overall poor condition with high pressure. In relation to pressures on wetlands, the positive is that most have not had their hydrological structure altered, however, habitat and catchment impacts are high. There is little condition information available other than for pest species.

Table 36: Wetlands condition summary

Pressure			Condition		
Catchment	4	high	Biota	no data	
Hydrological	2	low	Biota - Pests	5	very poor
Habitat	4	high	Water Quality	no data	
			Soil Quality	no data	
Overall Pressure	4	high	Overall Condition	4	poor

There has been some degree of wetland remediation in most LGAs in the reporting region in 2011–12. Table 37 shows the area remediated in each LGA. The primary activity was weed removal.

Photo: Crescent wetland Photo by: Nigel Blake

Table 37: Wetland remediation in the reporting region

LGA	Area (ha)	Trees	Land type	Activity	Funding	Volunteer hours*
Ballina	21		Public land	Weed removal, planting, mangrove management	Council, Landcare	
Byron	28	150	Public land	Primarily weed removal, some planting	Council, Environmental Trust	
Clarence Valley	8	250	Private and public land	Weed removal	NRCMA	468
Coffs Harbour	128	6,784	Public land	Weed removal and planting	Council, NRCMA	-
Lismore				Wetland restoration conducted by Richmond River County Council		
Port Macquarie-Hastings		400	Public land	Primarily regeneration, some weeding and planting at one site	Council grants and private donations	9,167
Richmond Valley	1	598	Public land	Weed removal and planting	Council	
Tweed	347	500	Public land	Weed removal and planting	Council, Environmental Trust, developer contribution, residents	180
Richmond River County Council#	31		Private and public land	Aquatic weed removal	Council, Landholder, Environmental Trust and OEH	
NRCMA-funded projects^	5,236			Weed removal and planting	Northern Rivers CMA	

Richmond River County Council restored wetlands in Ballina, Lismore, and Richmond Valley Council
* Volunteer numbers are substantially underestimated as not all volunteer groups report hours
^ Total not given as the Northern Rivers CMA figures include the work reported by councils funded by Northern Rivers CMA

4.3 Groundwater

INDICATOR: Groundwater quality (CONDITION)
Groundwater extraction (PRESSURE)
Number of groundwater dependent ecosystems under water sharing plans (RESPONSE)
Data source: NSW Office of Water Data quality: Medium

Groundwater is an important contributor to ecosystem functioning because in some locations it may be the only water supply for wetlands, streams and surrounding habitats. It is also an important source of water for rural areas, and for some towns in the CMA Region. For example, Kempsey supplied nearly 40% of its water from groundwater sources in 2011–12. Rous Water also has bores for groundwater supply, but these have not been used in the past few years. Groundwater in NSW is managed under groundwater water sharing plans, which specify the sharing of the water resource between users and the environment (NOW 2011). The Northern Rivers CMA Region is covered by 25 groundwater water sharing plan regions.

In terms of monitoring, at this point there is little groundwater quality data available, and metering of groundwater extraction has not yet been introduced (it is to be phased in). However, this report includes information on the current long-term annual groundwater extraction limits by water source, number of active groundwater water sharing plans, and number of groundwater dependent ecosystems under water sharing plans.

4.3.1 Groundwater extraction and status of groundwater water sharing plans

As groundwater extraction is not yet metered (except in large urban areas) it is difficult to accurately quantify groundwater usage. Metering is currently being introduced, but at this stage pressure reporting is based on the allocation of groundwater compared to the long-term annual extraction limit. Table 38 shows allocation by water source and water sharing plan status as of 2012. It indicates that currently the Alstonville Basalt groundwater source is over allocated, and the Stuarts Point source is at 92%. This has placed the Alstonville Basalt groundwater source in the highest risk category, with Stuarts Point at moderate risk.

Table 38: Groundwater allocations and risk category for the Northern Rivers CMA Region
(Source: NOW)

Water source	Rainfall recharge (ML)	Annual extraction limit (ML/yr)	Total requirements ML/yr	Risk Category^	% allocated	Groundwater sharing plan status
Alstonville Basalt — Bangalow, Zone 3	11,667	2,333	1,268	2	54.3	Commenced
Alstonville Basalt — Coopers, Zone 4	3,533	707	0	1	0	Commenced
Alstonville Basalt — Alstonville, Zone1	11,575	2,315	2,791	3	120.5	Commenced
Alstonville Basalt — Lennox, Zone 6	1,720	344	25	1	7.3	Commenced
Alstonville Basalt — Tuckean, Zone 2	12,404	2,481	3,003	3	121	Commenced
Alstonville Basalt — Wyrallah, Zone 5	3,573	715	38	1	5.3	Commenced
Bellinger Alluvium			1,300	1		Commenced
Bellinger Coastal Sands	10,358	5,180	10	1	0.2	Proposed
Brunswick Coastal Sands	45,847	12,014	352	1	2.9	Proposed
Brunswick River Alluvium	9,656	4,828	270	1	5.6	Proposed
Brunswick River Fractured Rock	11,944	7,204	457	1	6.3	Proposed
Clarence and Coffs Harbour Alluvium	149,459	0	4,695	1	no limit set	Proposed
Clarence Coastal Sands	77,042	24,317	45	1	0.2	Proposed
Clarence Moreton Basin — Bellinger River	4,704	3,537	0	1	0	Proposed
Clarence Moreton Basin — Brunswick River	649	488	4	1	0.8	Proposed
Clarence Moreton Basin — Clarence River	357,065	270,496	,517	1	0.6	Proposed
Clarence Moreton Basin — Richmond River	147,418	111,486	1,743	1	1.6	Proposed
Clarence Moreton Basin — Tweed River	31,187	23,800	70	1	0.3	Proposed
Clarence River Fractured Rock	20,456	13,060	320	1	2.5	Proposed
Coffs Harbour Coastal Sands	20,294	5,825	123	1	2.1	Proposed
Coffs Harbour Metasediments	400,660	206,731	1,433	1	0.7	Proposed
Dorrigo Basalt		5,000	131	1	2.6	Commenced
Hastings Coastal Sands	77,192	48,731	1,333	1	2.7	Proposed
Hastings River Alluvium	37,955	capped	1,757	1	capped	Proposed
Lorne Basin Groundwater Source	40,215	28,151	48	1	0.2	Proposed
Macleay Coastal Sands	37,535	24,277	3,488	1	14.4	Proposed
Macleay River Alluvium	52,391	capped	10,702	1	capped	Proposed
Nambucca Alluvium	21,091	capped	3,437	1	capped	Proposed
Nambucca Coastal Sands	9,987	5,112	61	1	1.2	Proposed
New England Fold Belt Coast — Bellinger River	37,115	20,084	1,606	1	8	Proposed
New England Fold Belt Coast — Brunswick River	16,492	8,246	224	1	2.7	Proposed

Table 38: Continued

Water source	Rainfall recharge (ML)	Annual extraction limit (ML/yr)	Total requirements ML/yr	Risk Category^	% allocated	Groundwater sharing plan status
New England Fold Belt Coast — Clarence River	427,987	221,552	364	1	0.2	Proposed
New England Fold Belt Coast — Hastings River	148,239	74,119	1,922	1	2.6	Proposed
New England Fold Belt Coast — Macleay River	310,153	155,076	10,795	1	7	Proposed
New England Fold Belt Coast — Nambucca River	59,535	29,768	3,549	1	11.9	Proposed
New England Fold Belt Coast — Richmond River	2,477	1,241	30	1	2.4	Proposed
New England Fold Belt Coast — Tweed River	69	34	0	1	0	Proposed
North Coast Fractured Rock	72,922	43,753	533	1	1.2	Proposed
Richmond Coastal Sands	191,770	116,625	1,254	1	1.1	Proposed
Richmond River Alluvium	182,414	109,448	4,530	1	4.1	Proposed
Richmond River Fractured Rock	2,007,254	1,233,859	2,310	1	0.2	Proposed
Stuarts Point	7,032	3,868	3,564	2	92.1	Commenced
Tweed Coastal Sands	47,988	24,169	755	1	3.1	Proposed
Tweed River Alluvium	27,520	capped	60	1	capped	Proposed

^ Risk categories: 1= low, 2= moderate, 3= high

As of February 2012, only 4 of the 25 groundwater water sharing plans, covering approximately 92,000 hectares (less than 2% of the CMA Region), had commenced. The remaining 21, which cover 98% of the CMA Region, were still in draft form (see Table 38). Fortunately, the two plans that have commenced cover nearly 90% of the groundwater dependent ecosystems (GDEs) in the CMA Region. Of the 23 identified high priority GDEs, only one is covered by a water sharing plan, but an additional 11 are within the national park estate, offering some form of protection (see Table 39).

Table 39: Groundwater dependent ecosystems under water sharing plans (Source: NOW)

Groundwater dependent ecosystems (GDEs) under water sharing plans (WSPs)	Total GDEs in CMA Region	% GDEs under WSPs	Comment
1,169	1,302	89.8	additional 12 in national parks or nature reserves
High priority GDEs under WSPs	**Total high priority GDEs in CMA Region**	**% high priority GDEs under WSPs**	**Comment**
1	23	4.3	additional 11 in national parks or nature reserves

4.4 Near-shore marine

INDICATOR: Marine water quality (CONDITION)
Data source: OEH, councils Data quality: Medium
INDICATOR: Rocky reef biota (CONDITION)
Data source: OEH, Southern Cross University
Data quality: High, Medium
INDICATOR: Area of marine protected areas (RESPONSE)
Data source: DPI Data quality: High
INDICATOR: Coastline management (RESPONSE)
Data source: Councils, county councils Data quality: High

The near-shore marine environment includes beaches, rock platforms, and shallow reefs along the coast, and is one of the most utilised of all environments. It is subject to urban development on foreshores (which results in habitat loss and disturbance), it is a primary area for recreation (such as walking, beach going, swimming, surfing, fishing and boating), and it also receives discharges from stormwater, waste water treatment plants and rivers. It is a dynamic environment, with storms and ocean swell altering the shape of the beaches and river mouths changing shape as flows rise and fall.

The near-shore marine environment in the Northern Rivers CMA Region is valued for its high biodiversity, with two marine parks and an aquatic reserve adjacent to the mainland, and a third marine park in the waters off Lord Howe Island. To maintain this high level of biodiversity, and to ensure coastal waters and beaches are clean for our use, monitoring of condition and impacts is required. As there is little information on the near-shore environment itself, this section includes summaries of a number of programs investigating the marine waters of the Northern Rivers CMA Region.

Photo: Red Anemonefish
Photo by: David Harasti

4.4.1 Marine water quality

Marine water quality is monitored at a state level under the NSW MER Strategy, measuring chlorophyll-a levels to determine the presence of algal blooms, and locally through council Beachwatch programs supported by OEH, which monitor levels of bacterial contamination in beach waters. State monitoring of marine water quality uses satellite imagery to determine chlorophyll-a levels, which are an indicator of algal blooms. Algal blooms are a build-up of phytoplankton (microscopic, one-celled plants) and can occur naturally from nutrient-rich upwellings of cold water on the continental shelf. However, algal blooms also occur after the discharge of treated waste water and pollutants from land and rivers. Most algal blooms occur in spring and summer, and are generally harmless. Only occasionally do blooms contain potentially harmful species (Creese et al. 2011). Figure 26 shows the percentage of days where chlorophyll-a concentrations were above the water quality guideline of 1 microgram per litre (SEAWiFS and MODIS are the satellites that collect the imagery used for analysis.) In the Northern Rivers CMA Region, data is analysed from five locations: Cape Byron, Yamba, Solitary Islands (Coffs Harbour), Crescent Head and Laurieton. Results indicate that the CMA Region has a higher number of days exceeding the guideline than the rest of NSW. Yamba and Laurieton consistently have the highest number of exceedences, with these peaking in 2009. Yamba would be influenced by discharge from the Clarence River and upwelling water at Evans Head, and peaks in 2009 would reflect the severe flooding that occurred that year. Laurieton is well known for natural upwellings and resulting algal blooms (Creese et al. 2011).

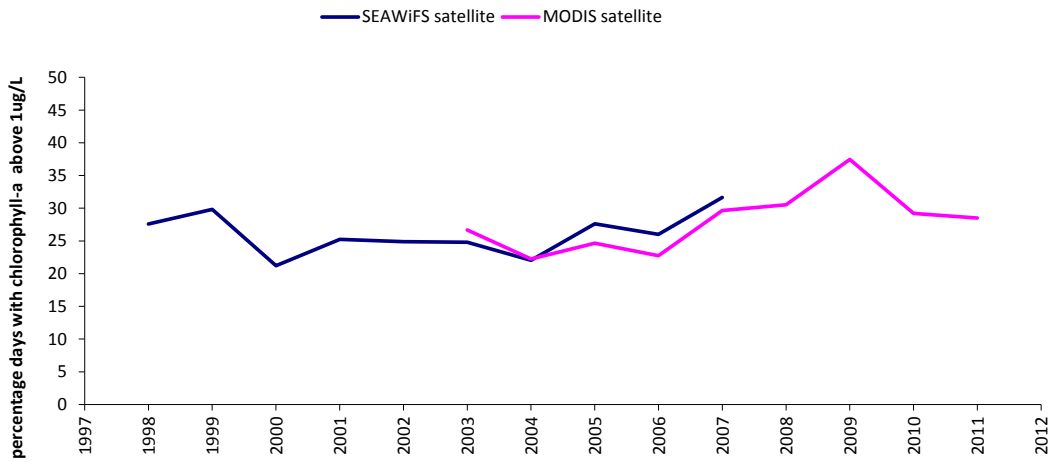


Figure 26: Percentage of days above the guideline level for chlorophyll-a in the CMA region (Source: OEH)

The Beachwatch program aims to provide information on water quality at key swimming beaches to ensure the public knows when at where it is safe to swim. The program is conducted by four councils in the reporting region: Ballina, Byron, Kempsey and Richmond Valley. Clarence Valley participated in the program until 2010, and Kempsey only joined the program in 2011. Results of the program are shown in Table 40. Generally, results indicate water quality at ocean sites is good to very good across all monitored locations, but lagoons and some estuarine locations can have a poor rating, indicating swimming is not advised as there may be high levels of bacterial contamination.

Table 40: Beachwatch water quality ratings for 2012 - 2012 (Source: OEH)

LGA	Location	Site type	2010	2011	2012
Ballina	Shaws Bay East	Estuarine	Good	Good	Poor
	Lake Ainsworth West	Lake/Lagoon	Good	Good	Good
	Shelly Beach	Ocean	Good	Very Good	Good
	Lighthouse Beach	Ocean	Very Good	Good	Good
	Seven Mile Beach	Ocean	Very Good	Very Good	Very Good
	The Serpentine	Estuarine	Fair	Good	Good
Byron	The Strand	Ocean beach	Very Good	Very Good	Very Good
	South Beach, Brunswick Heads	Ocean beach	Good	Good	Good
	Torakina Beach	Estuarine	Fair	Good	Good
	Simpsons Creek	Estuarine	Very Poor	Poor	Poor
	Belongil Beach	Ocean beach	Very Good	Very Good	Very Good
	Tallow Beach Suffolk Park	Ocean beach	Very Good	Very Good	Very Good
	Tallow Beach Byron Bay	Ocean beach	Very Good	Very Good	Very Good
	Wategos Beach	Ocean beach	Very Good	Very Good	Very Good
	Clarkes Beach	Ocean beach	Good	Very Good	Very Good
	Main Beach Byron Bay	Ocean beach	Good	Very Good	Very Good
	Broken Head	Ocean beach	-	Very Good	Very Good
Clarence Valley	Wooli estuary north (police station)	Estuarine	Good	Good	-
	Wooli estuary south (boat ramp)	Estuarine	Good	Good	-
	Iluka Bay	Estuarine	Good	Poor	-
	Kolora Lake	Lagoon/lake	Poor	Poor	-
Kempsey	Grassy Head	Ocean beach	-	-	Very Good
	Stuarts Point	Estuarine	-	-	Poor
	Back Creek	Estuarine	-	-	Poor
	Horseshoe Bay	Ocean beach	-	-	Good
	Trial Bay	Ocean beach	-	-	Good
	Saltwater Creek	Estuarine	-	-	Poor
	Hat Head Beach	Ocean beach	-	-	Good
	Korogoro Creek	Estuarine	-	-	Poor
	Killick Beach	Ocean beach	-	-	Poor
	Killick Creek	Estuarine	-	-	Poor
Port Macquarie-Hastings	Town Beach	Ocean beach	Good	-	-
	Flynns Beach	Ocean beach	Very Good	-	-
	Lake Cathie	Lagoon/lake	Poor	Poor	-
	Rainbow beach	Ocean beach	Good	-	
Richmond Valley	Airforce Beach	Ocean beach	Very Good	Very Good	Very Good
	Main Beach	Ocean beach	Very Good	Very Good	Very Good
	Shark Bay	Ocean beach	Very Good	Very Good	Very Good
	Evans River	Estuarine	Good	Very Good	Good

4.4.2 Rocky reef biota

There is little state-wide information on the status of rocky reef biota (i.e. the flora and fauna that inhabit the reefs along the coast). However, comprehensive seabed habitat mapping conducted by OEH, and local research conducted by Southern Cross University's National Marine Science Centre in Coffs Harbour and the Marine Park Authority in Solitary Islands Marine Park, provides some locally-focused research to give an indication of condition.

A comprehensive seabed habitat mapping program commenced in 2006 and is ongoing (DECCW 2010c). A total of 736 square kilometres of seabed (73,600 hectares) has been analysed in the NRCMA region, which is nearly 30% of the region's marine waters. The mapping identified and classified areas of sediments (fine sands, coarser sand, muddy sand, gravel, cobble and boulders), areas of reef and reef complexes far greater than previously identified, and benthic communities (fauna and flora of the seabed).

Photo: Mangrove Photo by: Shaun Morris

Results indicate that the Northern Rivers CMA region waters contain extensive areas of reef with varying complexity (presence of a range of reef features such as boulders, gutters, walls and pinnacles), often within the same reef system. Reef complexity is an indicator of marine biodiversity, as more complex reef structures support a greater number of different species (DECCW 2010c).

Benthic surveys conducted during the program show a mix of tropical, subtropical and temperate species, reflecting the mix of ocean currents from the north, south and east, and the change in water temperature with depth and location. Shallow inshore reefs are characterised by macroalgae (seaweed), while shallow mid-shelf reefs, just a few kilometres further offshore, were often characterised by corals. Species assemblages (the mix of different species found within a location) varied considerably even between locations of the same reef-type, indicating that individual reef locations within a small area may have unique species assemblages.

For example, Anemone Bay, at North Solitary Island (offshore from Wooli) has the highest density of host anemones recorded in the southern hemisphere, and Fish Soup, off north West Rock not far from Anemone Bay, has a unique aggregation of tropical and temperate predatory fishes not found at any of the other monitored sites.

A series of research projects on reef fish conducted within the Solitary Islands Marine Park (Malcolm et al. 2010,a and b) have shown that the warm east Australian current has a great influence on the patterns of reef fish in the CMA Region, with the inshore areas characterised by endemic (local) temperate fish species, and warmer, offshore areas influenced by the east Australia current having more tropical species and far more species overall. This results in a high regional biodiversity. The same pattern was observed for benthic (bottom dwelling) communities, with very different communities found on inshore reefs (less than 1.5 km from the coast), as compared to mid-shelf (1.5–3 km from the coast) and offshore reefs (greater than 3 km from the coast).

This has a number of management implications:

- protection of species and habitats is required at all distances from shore to ensure protection of the full range of biodiversity
- impacts on the inshore or near-shore environment may have permanent effects because communities here cannot recruit from offshore reefs as different fish and benthic communities exist there.

Long-term monitoring studies conducted at various reef sites from 2004 to 2011 measured mollusc diversity and abundance, fish species richness, and marine debris load (Smith et al. 2011). Results indicated that marine debris load has increased at locations closest to large urban areas (Cook Island at Tweed Heads and Park Beach bommie at Coffs Harbour), and is primarily fishing-related debris.

Mollusc richness remained steady at those locations, but had increased at Woolgoolga Reef. There was some evidence of decreasing mollusc abundance at Cook Island. Fish richness had increased at Cook Island and Park Beach (the locations with the highest fishing debris), but had decreased at Split Solitary Island. At Cook Island, the northern-most location, two species of tropical fish were recorded well south of their known distribution, indicating a possible shift due to warming waters. This program is hoping to extend the number of monitoring sites to improve condition and trend identification.

The above series of studies provides some information on the condition of marine habitats and species, but further research over a larger area is required to get true baseline information on individual habitat types and species, and studies over longer time periods are required to examine trends in condition.

4.4.3 Marine protected areas (MPA)

There are three marine parks and one aquatic reserve in the Northern Rivers CMA Region. As it is outside of the reporting region, Lord Howe Island (LHI) Marine Park is not included in this statistics presented in this section.

MPAs aim to conserve marine biodiversity and maintain ecological processes. Marine parks are generally large areas designed to protect a sample of each type of marine habitat within protective zones, whereas aquatic reserves are smaller and protect a single significant feature (Creese et al. 2011). Activities within each MPA are regulated by a zoning scheme, which allows different activities in different areas. Some zones totally protect areas and do not permit fishing, others allow only low impact fishing methods, and others allow a wide range of fishing methods.

Table 41 shows that currently, 38% of the marine waters of the Northern Rivers CMA Region (excluding LHI waters) are contained within marine parks and reserves. Complete protection zoning is in place for 6% of the Region's waters, and 17% is zoned for low impact activities.

Table 41: Marine protected areas in Northern Rivers CMA Region (Source: DPI)

Marine protected area	Total reserve area (ha)	Area zoned for complete protection — no fishing (ha)	Area zoned for low impact fishing activities — recreational and commercial (ha)
Solitary Islands Marine Park	71,829	8,650	38,860
Cape Byron Marine Park	22,048	6,105	4,160
Cook Island Aquatic Reserve	78	35	43
TOTAL	93,955	14,790	43,063
% of CMA Region marine area under protection (excl. Lord Howe Island)	38%	6%	17%
TOTAL marine area of CMA Region (excl. Lord Howe Island waters) (ha)	247,233		

4.4.4 Coastal zone management

Coasts are under increasing pressure from urbanisation, coastal recession and sea level rise. In 2010 the NSW Government introduced a requirement for all coastal councils to prepare coastal zone management plans (CZMP) under the *Coastal Protection Act 1997.* The primary aim of these plans is to better manage coastal erosion risks and inundation by identifying the areas where these impacts are most likely to occur. Coastal erosion or recession has environmental impacts, but also affects houses and other buildings, public structures and human safety. Each council must conduct a coastal hazard mapping study to identify erosion and inundation risks that are immediate, likely in 2050 and likely in 2100. Once this study is complete, councils then prepare a coastal zone management plan which specifies how these risks will be managed and the resourcing required. Table 42 shows the current status of coastal hazard mapping and coastal zone management plan preparation in the reporting region. Once the coastal hazard mapping is complete for all LGAs, it can be used as a baseline for monitoring coastal recession and inundation.

Photo: Lake Ainsworth Photo by: Ballina Shire Council
Following page photo: Green turtle Photo by: David Harasti

Table 42: Coastal zone management plan (CZMP) status by LGA (Source: Councils)

Local Government Area	Coastal hazards mapping status	CZMP status
Ballina	See Richmond River County Council	
Bellingen	Complete	Commenced
Byron	Commenced	Commenced
Clarence	Complete	Some complete and some in progress
Coffs Harbour	Complete	Commenced
Kempsey	Commenced	Commenced
Nambucca	Complete	Draft report complete
Port Macquarie-Hastings	Complete	Commenced
Richmond River County Council	Complete	Report gazetted Feb 2012 on behalf of Ballina, Lismore and Richmond Valley councils
Richmond Valley	Commenced	Commenced
Tweed	Complete	Complete

Woolgoolga Headland, NSW
Photo by S.amantha Hessey

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