

RIPARIAN ACTION STRATEGY



clarence

VALLEY COUNCIL

Acknowledgments

The development of this strategy is the result of contributions from the representatives of the Riparian Action Strategy Steering Committee including:

- Clarence Valley Council
- Northern Rivers Catchment Management Authority
- Land and Property Management Authority
- Department of Environment, Climate Change and Water
- Industry and Investment NSW
- WetlandCare Australia
- Clarence Cane Growers Association
- Clarence Landcare Inc.
- Private land managers

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Cover: *Lomandra hystrix* on the banks of the Orara River

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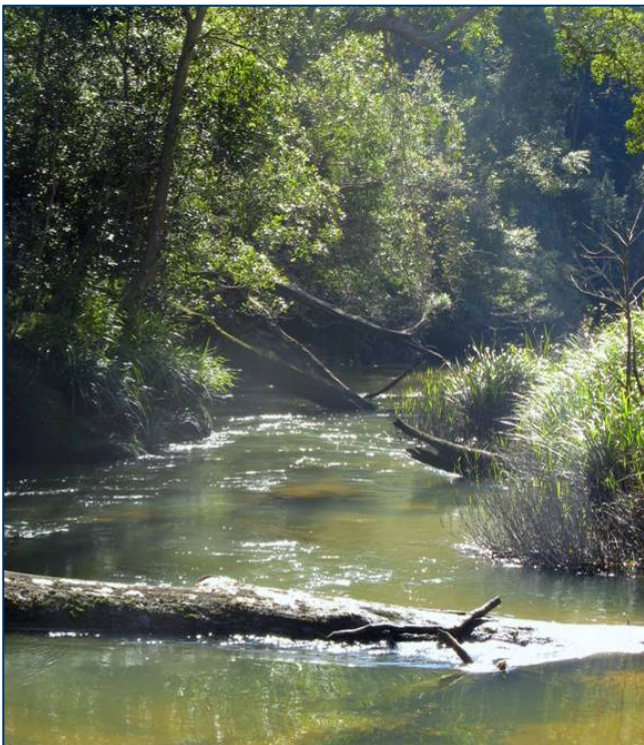
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Executive Summary

Riparian areas are widely recognised as being critically important to a range of terrestrial and aquatic ecological processes and the community's wellbeing.

Healthy riparian areas support biodiversity, provide food, habitat and shade for the waterway and stabilise river banks. These areas also filter nutrients, contaminants and sediment from rainfall runoff and reduce the impact of weeds. Riparian areas in good condition also help improve the overall quality and productivity of agricultural lands, are popular recreation places and significantly contribute to land values and tourism. Many riparian areas contain sites of cultural and spiritual significance for Aboriginal and non-Aboriginal Australians.

Throughout the world, riparian areas are increasingly under threat from human activities. The fertile, moist soils are very productive and are highly valued within the agricultural industry for stock grazing and crop production. Population growth and urban development along waterways are also contributing to the degradation of riparian areas.



Intact riparian vegetation provides numerous functions

Agricultural and urban activities have impacted on riparian areas in the Clarence Valley, causing wide spread clearing of riparian vegetation and altered flood, fire and hydrological regimes. This has resulted in numerous problems including a decline in biodiversity, increased rates of stream bank erosion, poor water quality, proliferation of terrestrial and aquatic weeds and reduced recreational and aesthetic qualities. These activities have also caused this landscape to be more vulnerable to natural

processes and events such as water flow, floods and fires.

Due to the increasing pressure on riparian areas, effective management programs and techniques need to be implemented to protect this environment. Land managers face the difficult task of balancing the needs of individuals and community with ensuring the integrity and viability of riparian areas.

This strategy aims to guide the management of riparian areas within the Clarence Valley Local Government Area (LGA). It provides a framework to guide Council in a coordinated approach to achieve effective on-ground outcomes with the limited resources available.

This strategy identifies the issues affecting riparian areas and provides a decision support tool to assist Council land managers prioritise riparian areas for protection and/or rehabilitation including:

- A desktop assessment of riparian condition based on available data
- Methodology for conducting a comprehensive assessment and prioritisation of specific riparian sites for on ground works
- Methodology for prioritising specific riparian sites for on-ground works

Strategic goals for riparian management are:

- Goal 1: Protect riparian areas in good or 'near intact' condition outside of conservation areas
- Goal 2: Implement assisted regeneration in areas in moderate condition
- Goal 3: Implement revegetation in areas in degraded condition
- Goal 4: Increase community training and engagement
- Goal 5: Improve riparian management coordination
- Goal 6: Ensure this strategy is implemented and remains a relevant working document

This strategy also outlines management principles for public riparian lands and recommendations for Council for improved riparian management.

Guidelines are included which provide an overview of the numerous issues and recommend riparian management practices. These can be used by Council and other service providers, community and landholders.

This strategy is based on current best practice and complements national, state, regional and local plans and legislative controls. It is the result of a collaborative approach by key stakeholders engaged in the management of riparian areas across the Clarence Valley.

Introduction

Area

The Clarence Valley Council (CVC) administers an area of 10,440 km² which represents an estimated 50% of the landmass of the Northern Rivers region. Approximately 6,670 km length of riparian area exists within the Local Government Area.

Clarence Valley Council was created in February 2004 with the amalgamation of the Copmanhurst, Grafton, Maclean and Pristine Waters LGAs. It is bounded by the Kyogle and Richmond Valley Council areas to the north, the Coral Sea to the east, Coffs Harbour City and Bellingen Shire to the south and Glen Innes Severn Council area, Guyra Shire and Tenterfield Shire to the west.

The Clarence Valley LGA is located on traditional country of the Bundjalung, Gumbayngirr and Yaegl Aboriginal people.

The Clarence Valley LGA extends from the New England Plateau, Gibraltar Ranges, river plains and coast line. Significant areas of the LGA are National Park, State Forest and Nature Reserves. The climate is largely warm ranging from subtropical on the coast to temperate on the tablelands, with an annual rainfall of up to 1,500 mm.

Landuse is predominantly rural, with expanding residential areas and some industrial and commercial districts. Much of the rural area is used for forestry, agriculture and grazing, including beef cattle and sugarcane. Fishing is also an important industry. In more recent years tourism has become a major industry, especially along the coast. Settlement is based around the main city of Grafton and the townships of Maclean, Yamba and Iluka, with many small villages and localities along the coast and inland.

The LGA's most significant natural feature is the Clarence River. The river system extends approximately 380 km from Yamba to the Queensland border districts. Approximately 75 islands form part of the Clarence River system. It is the largest coastal river catchment in NSW at 22,700 km² and its large alluvial floodplain supports the majority of the population, agriculture and industry. The river supports a range of recreational and commercial uses including festivals and events, fishing, prawn trawling, water skiing, cruising, rowing and more. The river is also an important cultural symbol for the Aboriginal and non- Aboriginal community.

The *Clarence River Estuary Management Plan* (Umwelt 2003) and *Independent Inquiry into the Clarence River System* (Healthy Rivers Commission 1999) identified riparian management as being one of the major impacts on the health of the Clarence Estuary and water quality. It has been estimated that the majority of the Clarence catchment has 20-50%

of the stream length cleared of native riparian vegetation (Clarence Valley Council 2009b).



Clarence Valley Council boundaries

Strategy purpose

Clarence Valley Council, natural resource management partners and private landholders recognise the importance of effective riparian management. The Riparian Action Strategy has been initiated by the Clarence Floodplain and Estuary Partnership to ensure that riparian areas within the LGA are managed, utilised, protected and rehabilitated in a coordinated approach that provides the most beneficial and sustainable outcomes.

The purpose of the strategy is to align the actions and resource allocation of all organisations concerned with riparian management in the LGA, toward a common direction. This strategy can be used to identify issues affecting riparian areas, to assess riparian condition and determine priority areas for the allocation of resources and funds to implement on-ground works. It also sets out Council's objectives and actions for future riparian management.

The strategy endeavours to increase landholders and community capacity to deliver on-ground riparian protection and rehabilitation outcomes by providing an overview of the numerous issues and approaches to riparian management.

This strategy is based on current best practice and complements national, state, regional and local initiatives, plans and legislative controls.

Strategy aim

The overall aim of the Riparian Action Strategy is to provide a framework for the LGA to strategically improve the management of riparian areas. Consequently, this strategy aims to:

- provide direction to public and private land managers
- improve the communication and coordination across the LGA
- maximise the benefit of resources allocated for riparian management
- address catchment-wide riparian issues in a logical, integrated and sustainable way
- assist management agencies in budgeting and planning resources
- assist proponents of projects in the Clarence Valley area to see how their projects contribute to overall objectives
- identify issues affecting riparian areas
- provide a methodology to assess riparian condition
- provide a methodology to determine priority areas for protection and rehabilitation
- increase landholder and community capacity to deliver on-ground riparian protection and rehabilitation outcomes

Key stakeholders

Stakeholders involved in implementing this strategy include:

- Clarence Valley Council
- Northern River Catchment Management Authority
- Land and Property Management Authority
- Department of Environment, Climate Change and Water
- Industry and Investment NSW
- WetlandCare Australia
- Clarence Valley Community
- Cultivators
- Commercial Fishing Industry
- Recreational Fishing Industry
- Clarence Landcare Inc.
- Bush Regenerators
- Private Land Managers

Limitations of this strategy

This strategy does not include a comprehensive riparian condition assessment due to the large amount of time, funds and resources that are required to conduct an accurate riparian condition assessment throughout the LGA. Instead, this strategy utilises all data available at the time and provides guidelines for the use of additional data as it becomes available in the future, and a methodology for conducting further assessments. It is envisaged that as information becomes available it will be collated into a GIS database that allows practitioners to easily access all the available spatial information.

It is important to acknowledge that the implementation of the strategic goals set out in this

strategy is based on the availability of resources. Council and its partner's ability to allocate the necessary resources is determined by budget restraints and the availability of funding sources.

Implementation of protection and/or rehabilitation works in all areas that are determined as high priority may also be limited due to the current landuse, management practices and/or landholder support. The acceptance of riparian restoration works in the community may be restricted to perceived or actual factors such as the loss of land and its production value, loss of stock access, lack of available finances, time commitment, flood damage to fences, ongoing weed control, and an increase in fire risk associated with revegetated sites. Climatic extremes such as droughts and floods, and economic slumps, will further limit the availability of resources.

Some landholders may also have a conservative approach to adopting different land management practices that have unknown risk. There is a shift occurring from primary production to lifestyle use and subdivisions in riparian areas for waterfront residences, where more emphasis is being placed on aesthetic, recreational and real estate values. This could be positive in terms of riparian rehabilitation; however, the shift presents some challenges including a loss of knowledge, skills and equipment for pest plant and animal control and fencing.

The strategic goals may be implemented progressively over time and may require an opportunistic approach that can take advantage of available funds, resources and landholders that are ready and willing to undertake works.

Legislation and management framework

Various legislation applies to riparian areas in the Clarence Valley LGA. In Appendix 3 these acts and policies are listed and common activities conducted in riparian areas affected by legislation are examined.

This strategy contributes to National, State and Regional plans and targets including:

- Australian Government – Caring for Our Country
- State – NSW State Plan, Priority environmental solutions priority areas E4 and E8
- State – Natural Resources Commission State-wide Targets for Natural Resource Management (NRM)
- Regional – Northern Rivers Catchment Action Plan
- Regional – Northern Rivers Invasive Plants Action Strategy
- Council – Clarence Estuary Management Plan: Actions E2, W22 and E1
- Council – Clarence Valley Sustainability Initiative
- Council – Clarence River Way Master Plan
- Council – Clarence Valley Council Biodiversity Management Strategy (in prep.)

Understanding Riparian Areas

Definition of a riparian area

Defining the width of riparian land can be complex due to the diverse and transitional nature of the boundary between riparian and non-riparian environments. For the purpose of this strategy the riparian area is defined as the land alongside creeks and rivers, including the riverbank itself. Riparian areas are also defined within state legislation and local by-laws and regulations.

Riparian functions and values

Riparian areas are particularly important because they are where land and water meet in the landscape and, as a result, support a diversity of terrestrial and in-stream ecological processes (Lovett and Price 2007).

Stream bank stability can be maintained by the root systems of trees, shrubs and grasses which bind and hold the soil together. Decreased stream bank erosion in times of strong flow reduces the loss of valuable land, maintains river courses and prevents turbid water conditions and the sedimentation of waterways.

A highly diverse range of organisms are supported by the fertile and moist soils of riparian areas. Habitat, food, water and shelter from predators and harsh physical conditions are provided. These areas are also safe sites for resting and roosting and play a crucial role as a corridor for the movement of plants and animals.

Habitat for native aquatic organisms is provided by riparian trees and woody debris, which under natural conditions occasionally fall into the water.

Food for fish and other native aquatic fauna is provided by native riparian vegetation in the form of leaf litter, plant debris, fruit, flowers, seeds and insects. This forms the basis of nutrient input into the aquatic environment, and hence is the first and most vital link in the food chain.

The amount of sediment, nutrients and contaminants from adjacent land which reach the waterway can be reduced by healthy riparian vegetation. Vegetation slows the overland movement of water, and causes the particles to be deposited on the land before they reach the creek. The roots of riparian plants can take up and remove some of the nutrients and contaminants moving towards the waterway in underground flows.

Shade and shelter provided by riparian vegetation can regulate stream temperature. Moderate in-stream temperatures are required by native fish and aquatic organisms to live and breed successfully. Algal blooms and aquatic weed infestations can also be reduced by the effect of shade, cooler water temperatures and low nutrient levels.

Terrestrial weed invasion and establishment can be prevented or inhibited by native groundcovers, a dense canopy, undisturbed soil and low nutrient levels.

Increased agricultural productivity can result from healthy riparian areas. Shelter from climatic extremes and improved water quality can benefit stock health. Improved pasture can result from nutrients, top soil and rainfall being more effectively retained and erosion and loss of land reduced.

People depend on riparian areas to gain access to waterways for recreation, enjoyment and to maintain good health and wellbeing. Common recreational activities include canoeing, kayaking, walking, fitness training, sailing, swimming, boating and picnicking.



Many culturally significant sites are located in riparian areas. Riparian areas and waterways are prominent in Aboriginal traditional culture as they provide water, food and shelter and are of significant spiritual value. The location of some Aboriginal sites, such as places used for burials, camp sites and food gathering and preparation, are also located in riparian areas. In the early European settlement of Australia most towns were established on rivers or estuaries for their ports, transport, water supply and highly productive land. These riparian areas play a major role in culturally significant activities, provide reminders of the past and educate future generations about our shared culture and relationship to our rivers.

Land market values and tourism are also influenced by the condition of riparian areas. Anecdotal evidence from real estate agents suggests that well managed riparian frontage can add up to 10% to the market value of a rural property (Price and Lovett 2002).

Degradation of riparian areas

The human impact since European settlement of Australia is very noticeable on riparian land, with large-scale changes in condition and health throughout much of southern and eastern Australia.

Riparian areas of the Clarence Valley floodplain were once 100-400 m wide covered in Riverine rainforest and cleared within 10 years during the late 1800's.

The lack of intact riparian vegetation on the banks of the upper and lower estuary was highlighted in the *Clarence River Estuary Management Plan* (Umwelt 2003). The degradation of native riparian vegetation is also listed as a key threatening process under the *Fisheries Management Act 1994*.

Human activities are increasingly placing riparian areas under threat. The clearing and modification of native vegetation for agricultural and urban based activities are a major threat to riparian areas in the Clarence Valley LGA. The agricultural sector values riparian areas for the highly productive fertile and moist soil. Waterfront locations are also in high demand for urban residences and recreational activities. These pressures leave riparian areas highly vulnerable to overuse and practises such as:

- uncontrolled stock access
- cultivation
- clearing to enhance river views
- slashing
- mowing
- fire
- poisoning
- flood mitigation and drainage systems
- any development or construction such as roads, buildings and rock revetments
- recreational activities such as off-road vehicle use, boating and camping

Impacts

Inappropriate activities can have a detrimental impact on the riparian area itself and on the numerous vital functions that these areas provide.

Stream bank erosion is a natural and dynamic process that has intensified due to human activities. Erosion is increased by clearing of native riparian vegetation, uncontrolled stock access in riparian areas and increased flow. Bank erosion can cause the loss of highly productive and valuable land, increased sediment transported downstream, damage to assets and infrastructure such as roads, bridges and levee banks, and invasion by noxious weeds.

Excessive amounts of nutrients can enter waterways if there is a lack of healthy riparian vegetation to take-up and trap these contaminants. Sources of nitrates and phosphates include fertilisers, fire ash, stormwater runoff, sewage, septic and stock effluent. Large amounts of nitrogen and phosphorus can lead to eutrophication, making the water unsuitable for stock, native aquatic life and humans.

Biodiversity is reduced in degraded riparian areas due to the lack of habitat, food, shelter and movement corridors.

Decreased agricultural productivity can result from top soil stripping and bank erosion of valuable land. Uncontrolled stock access in riparian areas can lead to reduced stock health, growth and productivity from poor quality drinking water and heat or cold stress from lack of shelter.

Excess sediment from adjacent land can reach the waterway in degraded riparian areas, causing highly turbid conditions and numerous problems such as:

- Reduced light in the water column restricts photosynthesis in water plants, creating less food and oxygen for aquatic animals.
- Water temperatures increase and dissolved oxygen levels decrease as the suspended particles absorb heat.
- Native fish can suffer from disease, slow growth or death as particles obstruct their gills.
- Native aquatic plants and fauna habitat can be smothered by sediment as it settles out of the water column.
- Native fauna can be outcompeted by introduced species as they have adapted to the low loads of sediment and nutrient which naturally occur in Australia.
- Damage to pasture, crops and infrastructure can occur as suspended sediment is transported downstream where it settles on the floodplain and estuary.



Cultivation in riparian areas

Aquatic weeds and algae grow prolifically in waterways surrounded by degraded riparian areas due to the extra nutrients, light and higher water temperatures from the lack of shade. Aquatic weeds and algae out-compete native species, reduce light and oxygen levels, cause fish kills, reduce water movement, obstruct irrigation and drainage infrastructure, spoil the community's enjoyment of the waterway and can be very costly to manage.

Blue-green algae blooms can also pose a risk to human health. The toxins they produce can affect humans and animals and cause gastro-intestinal, skin, eye and respiratory irritations, and in severe cases damage the liver and neurological system and cause death.



Prolific aquatic weed growth can occur where riparian vegetation is limited

Chemicals such as hydrocarbons, trace metals, pesticides, fungicides and herbicides can find their way into river systems from agricultural, urban or industrial areas through spray-drift, surface runoff, stormwater and sub-surface water movement. Many of these products are highly toxic to aquatic animals and plants and have serious health consequences for humans, wildlife and stock if ingested.

Pathogens such as *Cryptosporidium* spp. can enter the waterway from a number of sources including septic tank leakage and grazing livestock. Human pathogens can cause gastro-intestinal illness, which may be fatal to some people if ingested from untreated water.

Contaminants derived from recreational activities in riparian areas include human waste, rubbish, detergents, and soaps and ash from campfires.

Terrestrial weeds can establish and proliferate more readily in areas with damaged vegetation, disturbed soil and increased nutrient levels. Weed seeds can invade from upstream or adjacent areas or germinate and proliferate from existing seed bank. Weeds grow quickly and can out-compete native plants. Weeds can decrease riparian biodiversity, reduce native habitat and food supply, reduce public access and recreational opportunities, threaten agricultural production and can be difficult and expensive to manage.

Property values can depreciate due to bank erosion, poor water quality, weed infestations, and poor aesthetic values.

Assets can be lost as a result of bank erosion in degraded riparian areas. The loss of major public assets such as roads, bridges and levees can be devastating to the community.

Cultural and heritage sites can be impacted by degraded riparian condition and threaten the cultural links people have to these significant parts of the landscape.

The community and tourist's enjoyment of riparian areas and waterways is greatly reduced in degraded areas. People are not attracted to degraded riparian areas which would be otherwise used for relaxation, nature appreciation or recreational activities which are important for the community's fitness, social interaction, mental health and wellbeing.



Loss of land through erosion

Climate change

Climate change may exacerbate the pressures already occurring in riparian areas and complicate restoration efforts. The predicted reduced mean flow and high temperatures will lead to elevated nutrient levels, poor water quality and the prolific growth of algal blooms and aquatic weeds. An increase in severe weather events such as drought, bushfires, intense storms and flood events may produce significant disturbance to native riparian vegetation and soil, increasing bank erosion and terrestrial weed establishment.

Rising sea level may increase the erosion of coastal riparian areas and impact on drainage and groundwater in low-lying coastal floodplains, leading to potential increases in the duration of floods, water logging of soils, salt inundation and more extreme storm surges.

Assessment and Prioritisation of Riparian Areas for Management

The condition of riparian areas in the Clarence Valley LGA can range from near-intact to those which are heavily degraded with many threats and little chance of returning to original condition. It would be ideal to protect and/or rehabilitate all of these riparian areas, however, this is not possible as there are not enough resources to do so.

Priority riparian areas for on-ground improvements are determined by conducting a detailed assessment of the riparian areas current condition, its ability to recover and the potential benefits of improvement works. However, it would be unrealistic to develop a detailed assessment given the vast length of riparian land in the Clarence Valley LGA (over 6,670 km), the remoteness, time, cost and resources required to monitor and assess these areas. However, the following methodology allows for riparian issues throughout the LGA to be addressed in a logical, integrated and sustainable way.

Riparian areas can be assessed using one or more of the following three methods. The amount of resources available will determine which method is used.

1. Desktop assessment
2. Site assessment
3. Prioritisation of riparian areas for management

Desktop assessment of riparian condition

The desktop assessment categorises riparian areas throughout the LGA based on condition using the limited data that is currently available. Canopy density and erosion indicators have been used to categorise riparian areas as good, moderate or degraded condition, as shown in Table 1 (see Appendix 1 for detailed methodology).

The recovery potential of riparian areas has been determined using regrowth and understory indicators (see Appendix 1 for detailed methodology). The condition and recovery potential of riparian areas have been combined together to determine the six desktop assessment categories shown in Table 2.

Table 1. Riparian condition categories utilising erosion and canopy density data.

		Erosion		
Canopy density		Nil/Minor	Moderate	Severe/Extreme
	> 50%	Good	Good	Moderate
	20-50%	Good	Moderate	Degraded
	< 20%	Moderate	Degraded	Degraded

Table 2. Desktop assessment priority categories based on riparian condition and recovery potential data.

Category	Condition	Recovery Potential
1	Good	Good
2	Good	Moderate to low
3	Moderate	Moderate to good
4	Degraded	Moderate to good
5	Moderate	Low
6	Degraded	Low

The condition and recovery potential of riparian areas within the Clarence Valley LGA are depicted in Map 1 and Map 2 and as a GIS layer in MapInfo, using the desktop assessment methodology. The maps are divided into the three systems based on the geomorphic type:

1. Upper system
2. Mid system
3. Floodplain

Limitations

Numerous indicators could be used to determine riparian condition and recovery potential; however, this desktop assessment has been limited by the data available at the time. This information has been provided by Council and the Department of Environment, Climate Change and Water's (DECCW's) Multiple Attribute Data which was collected between 1995 and 2007.

The desktop assessment is to be used as a preliminary assessment tool only and a further detailed assessment is recommended. If additional data or resources for a more detailed LGA-wide riparian assessment become available, the following indicators could be added:

- weeds species present and density
- key fish habitat
- water quality results

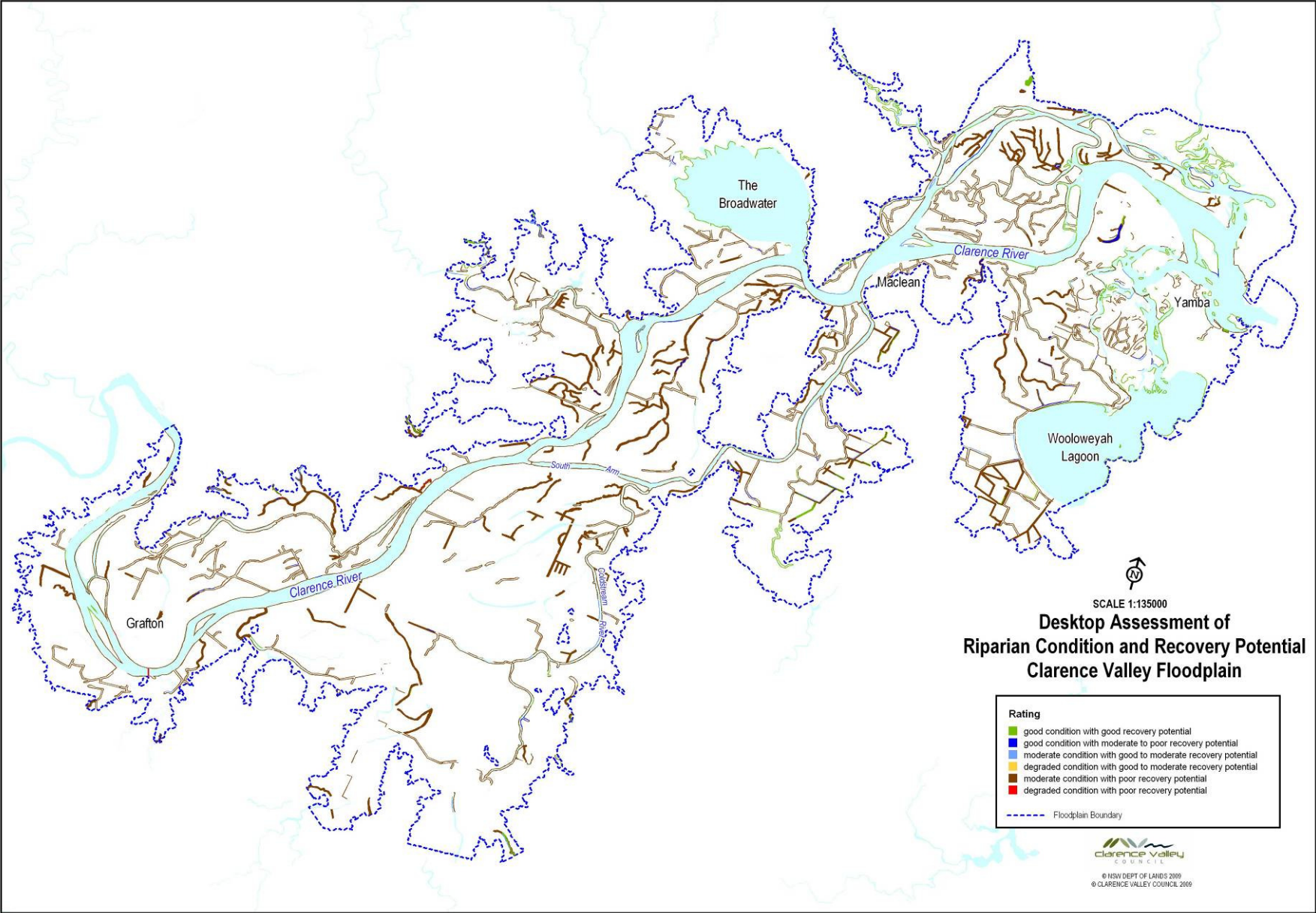
Site assessment of riparian condition

Two methods for assessing specific riparian areas are provided.

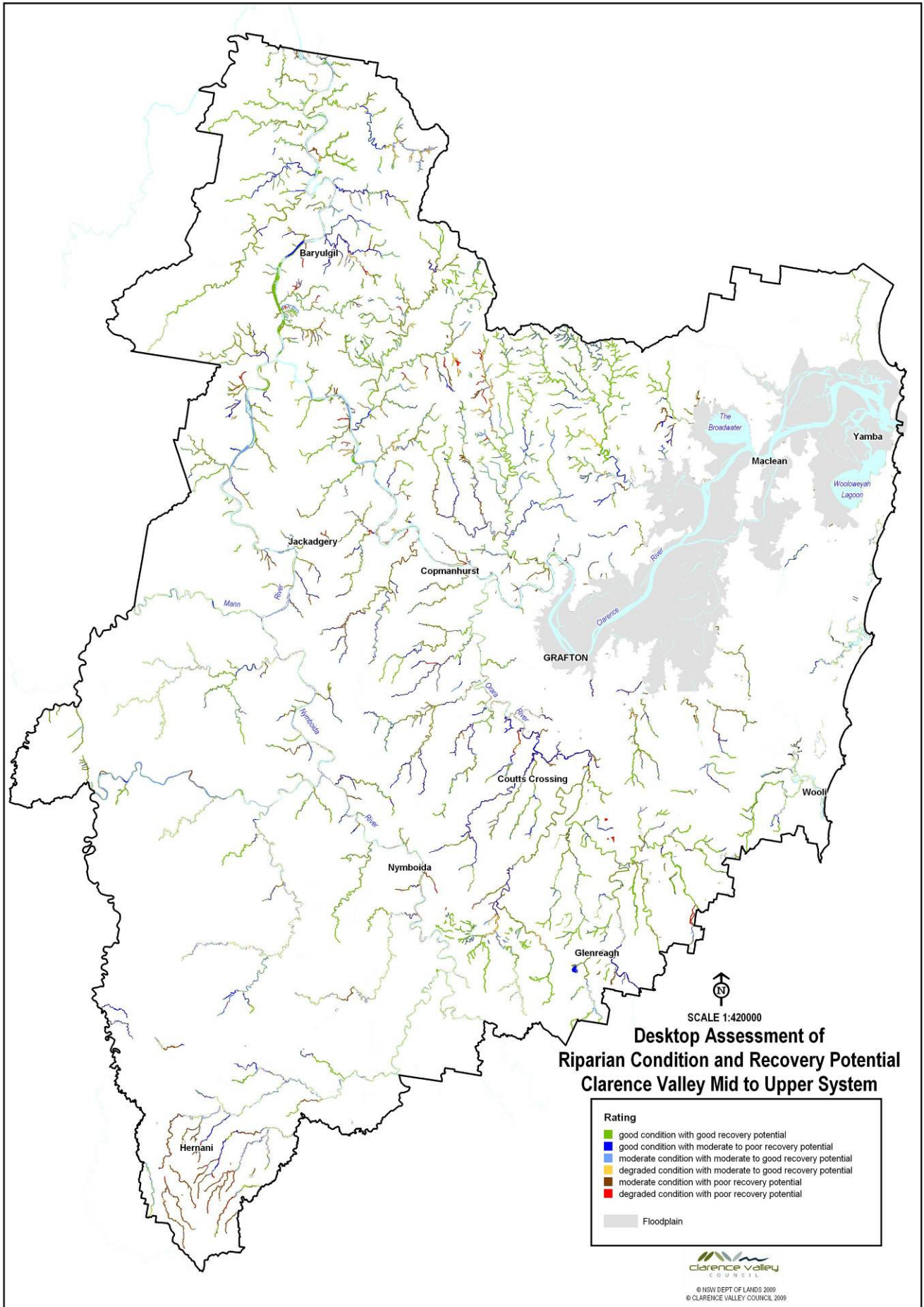
Descriptive site assessment

This method is used to provide a rapid and general site assessment of a riparian area. A riparian area can be placed into one of six categories based on its condition and recovery potential as outlined in the preliminary desktop assessment (Table 2). The *Descriptive site assessment* sheet begins on page 16 and can be printed and used by assessors in the field.

Map 1. Desktop assessment of riparian condition and recovery potential – Floodplain



Map 2. Desktop assessment of riparian condition and recovery potential – Mid to Upper System



Comprehensive site assessment and condition index

This method is to be used to obtain a detailed assessment of a riparian area. It can also be used to determine a condition index which is useful for comparing and prioritising numerous similar sites. The condition index is determined by summing all indicator scores.

The *Comprehensive site assessment and condition index* sheet begins on page 18 and can be printed and used by assessors in the field. The assessment and index is based on riparian condition, recovery potential and financial and social indicators such as:

- vegetation cover and density
- evidence of native regeneration
- landuse
- vegetation formation
- width of vegetation
- opportunity to expand or connect fragmented areas of native vegetation
- native regeneration
- weed species, density and severity
- habitat features
- bank stability/erosion
- site significance
- potential to contribute to community engagement and awareness of riparian issues
- threat identification and rehabilitation requirements
- area available for riparian management
- estimate of rehabilitation works
- landholder support

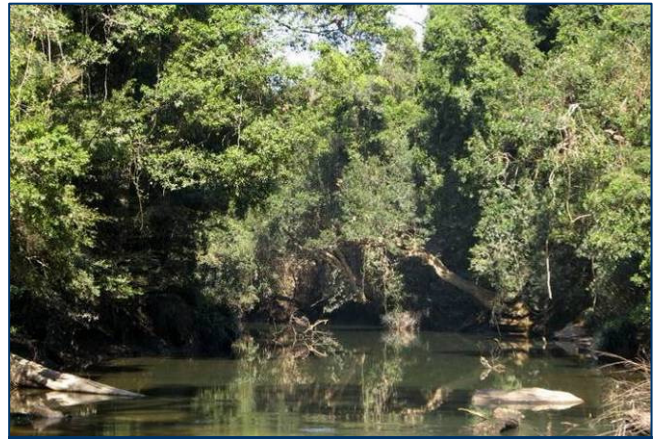
Prioritisation of riparian areas for management

Priority areas for riparian management can be based on the results of the desktop assessment or site assessments outlined previously. The condition of the riparian area determines the priority for management and the management focus as depicted in Table 3.

Management strategies should aim to protect intact riparian vegetation and in situations where degradation has occurred, seek to rehabilitate and restore (LWRRDC 1999).

The highest priority reaches are those in good condition, which only require maintaining or a minor level of intervention and funding to achieve original condition. The lowest priority reaches are those in degraded condition with a low recovery potential, which require a high level of intervention and funding to return some of the elements of original condition.

The priority of a riparian area can also be affected by other issues such as geomorphic type, natural processes, access, rehabilitation costs and the opportunity to build community capacity. The following describes the three major river systems within the LGA and the management issues within each system that may affect a site's priority.



Example of a riparian area in good condition with good recovery potential



Example of a riparian area in moderate condition with moderate recovery potential



Example of a riparian area in degraded condition with low recovery potential

Upper system

The upper system is characterised by waterways with rocky river beds, bounded by steep sloped valleys. The riparian areas are predominantly in good condition with the main threats being weeds and the removal of riparian vegetation for agriculture.

Management of riparian areas in the upper system should focus on conservation with some assisted regeneration. Implementation of best management practice is necessary for weed control, recreation,

sustainable timber harvesting, potato farming and water harvesting.

Specific plans of management may have been adopted, such as the *Boyd River Recovery Project 2007- 2010* and the *Nymboida River Project Management Plan* (Clarence Landcare Inc. 2005). In such cases where detailed assessment and actions for a specific area have been adopted, then that plan is applicable with this strategy and used to deal with those issues not covered by this strategy.

Riverside parks and reserves in the upper LGA are included in the *Caring for Our Riverside Parks and Reserves: A Strategy for Managing Riverside Recreation and Riparian Vegetation. Riverside Recreation and Camping Strategy* (Clarence Valley Council 2009a).

Table 3. Riparian priority categories and management focus.

Priority	Category	Management focus
1	Good condition with good recovery potential	Focus on conservation
2	Good condition with moderate to low recovery potential	Focus on assisted regeneration
3	Moderate condition with moderate to good recovery potential	
4	Degraded condition with moderate to good recovery potential	
5	Moderate condition with low recovery potential	Focus on revegetation
6	Degraded condition with low recovery potential	

Mid system

The mid system is characterised by flatter, wider river beds surrounded by steep sloped valleys. Riparian areas are a mixture of good, moderate and degraded condition, with the main threats being weeds and the clearing of vegetation for agriculture.

Management of riparian areas in the mid system should focus on conservation, assisted regeneration and some revegetation. Implementation of best management practice is necessary for stock grazing, weed control, fire use, recreation and water harvesting.

Floodplain

Riparian areas in the lower system are characterised by wide river beds surrounded by flat floodplain area with highly productive and fertile soils. The condition of riparian areas on the floodplain is predominantly moderate.

There are many threats to riparian condition on the floodplain due to the increase in population including clearing of vegetation for agriculture, weed infestations, urban development and infrastructure. The following issues are commonly occurring in floodplain riparian areas:

- increased stream bank erosion
- loss of land and assets
- Increased nutrient, sediment and contaminant levels in waterways
- decreased terrestrial and in-stream biodiversity
- degraded water quality
- prolific terrestrial and aquatic weed growth
- algae blooms
- poor aesthetics
- decreased property values
- decreased recreational opportunities and enjoyment

Priority should be given to sites where the expansion of riparian areas in good or moderate condition can maximise landscape connectivity.

The priority of floodplain riparian areas should also be increased when compared to similar areas in the mid and upper systems. The most beneficial and sustainable outcomes can be provided by conducting on grounds works close to the major population centres (Grafton, Maclean and Yamba). This will greatly reduce transport and labour costs during initial works and maintenance, and to engage with the broader community and encourage improved riparian management.

Management of riparian areas in the floodplain should mainly focus on revegetation and assisted regeneration, with the few good condition areas conserved.

Implementation of best management practice is necessary for stock grazing, cane farming, weed control, fire use, urban planning and maintenance, flood mitigation and drainage systems, recreation, water harvesting and for climate change and sea level rise.

Limitations

It is acknowledged that prioritisation is a difficult process, and this approach may not be suitable in all situations and that other factors, not identified here, may need to be taken into consideration. For instance, a specific funding stream may become available to address a particular impact. Therefore, this prioritisation process will work best when comparing similar riparian areas.

While it is possible to undertake the prioritisation process without the support of landholders, their support is necessary if any on ground works are undertaken.

Descriptive site assessment

Riparian condition

Condition	Condition characteristics	Agree	Disagree
<p>Good condition</p> <p>Examples of these are intact reaches and are generally found in the uncleared upper parts of the catchment or within national parks, state forest reserves or similar.</p> <p>An area in good condition must have all of the following characteristics (but none from the condition categories below).</p>	The riparian land – including wetlands, the channel and floodplain – undergoes natural flooding and sediment movement.		
	The area naturally self-adjusts and quickly recovers from natural disturbances such as floods.		
	Riparian vegetation is intact (continuous and undisturbed), aboriginal, at most has only small amounts of weeds, and exists as a diverse vegetation community with a range of age and structural levels (i.e. groundcovers, shrubs and trees of all ages which reflect an ecologically diverse, pre-development, uncleared catchment).		
	The riparian vegetation offers effective resistance to natural disturbance and accelerated erosion.		
<p>Moderate condition</p> <p>Examples of these commonly occur throughout the catchment. These are areas where degradation is recoverable with little input (revegetation or small-scale erosion-control works). In these areas weed species could be acting to prevent erosion and therefore must be considered as effective riparian vegetation cover.</p> <p>An area in 'moderate' condition has one or more of the following characteristics (but none from the condition category below).</p>	Localised degradation of the riparian area, typically indicated by unnatural or accelerated rates of erosion in isolated areas, or flooding modified by human intervention.		
	Features such as pools, riffles, wetlands and islands may be degraded by isolated accelerated erosion, sedimentation, or grazing impacts from livestock.		
	Vegetation is patchy and/or weed infested but is generally still effective at controlling all but some localised accelerated erosion.		
	Flooding cycles have been modified by human intervention.		
<p>Poor condition</p> <p>Examples of these areas are over widened degraded reaches where sediment regimes have been dramatically altered. There is usually significant evidence of erosion, very little riparian vegetation (generally only one-tree wide or less) and the site requires in-stream erosion-control structures to assist in rehabilitation and stabilisation. Some reaches may have significant sediment slugs moving through them.</p> <p>An area in 'poor' condition has one or more of the following characteristics.</p>	The area is undergoing unnatural or accelerated rates of erosion over extended areas (e.g. hundreds of metres to kilometres).		
	Excessively high volumes of mobile sediment blanket the bed and/or fill the channel over many kilometres so that the streambed is generally uniform.		
	Indigenous riparian vegetation is generally absent or ineffective against controlling accelerated rates of erosion.		

Adapted from Schneider G. (2007) *Where land meets water - Resource kit: A guide to riparian management in the Hunter Valley*. Hunter-Central Rivers Catchment Management Authority, Tocal, NSW.

Using the table above the condition of the riparian land assessed is: _____

Descriptive site assessment

Riparian recovery potential

Recovery potential	Recovery Potential characteristics	Agree	Disagree
Good	No recovery of the riparian area is occurring or is required as all adjacent riparian land is stable within natural limits of erosion and sedimentation.		
	The riparian area and its vegetation has not been recently disturbed by human activity or has fully recovered from past disturbances.		
	There is no excessive sediment supply (slugs).		
	Degradation has stopped (e.g. existing pressures from livestock access or major weed infestations have been removed) or has been reduced so that natural recovery is occurring (e.g. erosion has stabilised and vegetation is regenerating) at a relatively quick pace.		
	If existing pressures (e.g. livestock access, major weed infestations) are removed it is likely that indigenous vegetation regeneration and stabilisation of erosion sites will occur quickly.		
Moderate	Recovery through erosion stabilisation and/or vegetation growth is not occurring (or is occurring slowly) due to existing pressures (such as livestock access or major weed infestations). If these pressures are removed, it is likely that indigenous vegetation regeneration and/or stabilisation of erosion sites will only occur slightly faster.		
	Only minor sediment, indigenous riparian vegetation seed or snags are being deposited in the riparian area, or an excess sediment supply is occurring in moderate discontinuous slugs (i.e. the sediment slugs are not continuous over many kilometres).		
Low	Upstream reaches are poorly vegetated with appropriate indigenous plants, or are heavily weed infested.		
	Recovery through erosion stabilisation and/or vegetation growth is not occurring (or is minimal). Degradation through erosion, sedimentation or vegetation removal is still occurring.		
	No (or very little) sediment, riparian vegetation seed, or snags are being deposited in the riparian area, or there is an excessive, large and continuous sediment supply (a slug) extending over many kilometres.		

Adapted from Schneider G. (2007) *Where land meets water - Resource kit: A guide to riparian management in the Hunter Valley*. Hunter-Central Rivers Catchment Management Authority, Tocal, NSW.

Using the table above the recovery potential of the riparian land assessed is: _____

Site details

Site location:

Property Address:

Lot(s):

DP(s):

Registered owner of land:

Site contact:

Ph:

Assessed by:

Date of assessment:

Site description

Description:

Landuse e.g. recreation, stock grazing, cane, dairy:

Site sketch (Photos attached?):

Native vegetation

Tick relevant boxes for vegetation formation and vegetation strata:

Rainforest
Wet Sclerophyll
Dry Sclerophyll

Grassy Woodland
Forested Wetland
Saline Wetlands

Freshwater Wetlands
Grassland
Heathlands

Ground cover:

Absent
Grasses
Ferns
Other:

Shrub layer:

Absent
Scattered
Common

Mid storey:

Absent
Trees/ shrubs
Palms/ Tree Ferns
Rainforest spp.
Vines

List dominant canopy species:

Current width of vegetation:

Wide > 20 m

Moderate 5-20 m

Narrow < 5 m

Is the site in a position to expand or connect fragment areas of native vegetation?

Yes
No

Native regeneration

Enter score (1-5) in appropriate box:

- 5 Native regeneration common throughout
- 4 Native regeneration common but a bit patchy
- 3 Native regeneration commonly observed, but tending to be very patchy or scattered
- 2 Native regeneration observed, but minimal
- 1 No native regeneration observed

Score:

Weeds

List the weed species present:	Canopy	Mid-storey	Ground/shrub	Weed Category
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Enter score (1-5) in appropriate box for both Weed Density and Weed Severity:

Weed Density/Infestation:

- 5 Few or no weeds observed (No or Light Infestation).
- 4 Weeds mainly around edges or very scattered (Light to Mod)
- 3 Weeds common, but patchy or scattered (including canopy)
- 2 Weeds throughout excluding canopy (Heavy infestation)
- 1 Weeds throughout including the canopy (Heavy infestation)

Weed Severity:

- 5 No problem weeds
- 4 Mostly Priority E weeds
- 3 Mostly Priority D weeds
- 2 Mostly Priority C weeds
- 1 Mostly Priority B weeds

Habitat features

Enter rating in boxes. Ratings are 0 = Absent, 1 = Few observed, 2 = Common, 3 = Abundant

<input type="checkbox"/> Tree Hollows > 5 cm (inc dead trees)	<input type="checkbox"/> Rocks/ Boulders	Score: <input style="width: 100px;" type="text"/>
<input type="checkbox"/> Fallen Logs > 30 cm or with obvious habitat features	<input type="checkbox"/> Caves/ Overhangs	
<input type="checkbox"/> Native Grasses/ Rushes/ Sedges		

Bank erosion

- 3 Relatively stable, no visible signs of erosion
- 2 Erosion occurring in some areas
- 1 Severe active bank erosion/slumping

Score:

Significant areas

- Is the site within or immediately adjacent to:
- Vegetation of high conservation significance
 - Endangered ecological community
 - Presence of threatened species
 - Key fish habitat
 - Significant assets
 - Indigenous or non indigenous cultural sites

Community

Is there an opportunity to contribute to community engagement and awareness of riparian issues?

Yes
 No

Is there an opportunity to positively impact on community recreational use and amenity? e.g. improving access to a river in a public recreation area etc.

Yes
 No

Priority

TOTAL SCORE:

Threats

What are the current or potential threats to this riparian area?

- | | | | | | |
|--------------------------|-----------------------|--------------------------|---------------|--------------------------|-----------------------|
| <input type="checkbox"/> | Uncontrolled Stock | <input type="checkbox"/> | Fire | <input type="checkbox"/> | Urban development |
| <input type="checkbox"/> | Weeds | <input type="checkbox"/> | Feral animals | <input type="checkbox"/> | Altered drainage |
| <input type="checkbox"/> | Erosion/sedimentation | <input type="checkbox"/> | Clearing | <input type="checkbox"/> | Recreation activities |

Details:

Stock management

Objective:

- | | |
|--------------------------|---|
| <input type="checkbox"/> | To exclude grazing by all domestic stock in riparian area |
| <input type="checkbox"/> | To control graze the riparian area |

Actions:

- | | | | |
|--------------------------|-------------------|--------------------------|------------------------------------|
| <input type="checkbox"/> | Construct fencing | <input type="checkbox"/> | Install an off-stream water source |
|--------------------------|-------------------|--------------------------|------------------------------------|

Requirements:

- | | | | |
|--------------------------|----------------------------|--------------------------|----------------------|
| <input type="checkbox"/> | Metres of fencing required | <input type="checkbox"/> | Water supply |
| <input type="checkbox"/> | Traditional fence | <input type="checkbox"/> | Electricity supply |
| <input type="checkbox"/> | Electric fence | <input type="checkbox"/> | Trough |
| <input type="checkbox"/> | Electricity supply | <input type="checkbox"/> | Maintenance |
| <input type="checkbox"/> | Solar power supply | <input type="checkbox"/> | Other infrastructure |
| <input type="checkbox"/> | Gates | | |
| <input type="checkbox"/> | Maintenance | | |

Details:

Cost Estimate: \$

Weed management

Objective:

To reduce the current extent/area of weeds infestation

Actions:

Control target weed species:	Current extent/ areas:	Proposed control methods:
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Cost Estimate: \$

Other

Will management of this site compliment previous restoration works?

Yes:

No:

Is this site easy and safe to access and carry out improvement work?

Yes

No:

Recreation management

What recreational activities take place in and around this riparian area?

- Camping (reside > 24 hrs) (caravans and tents)
- Overnight stays (reside < 24 hrs)
- Canoeing/kayaking/rafting
- Picnic/BBQ/play
- Bushwalking
- Recreational fishing
- Recreational motor boating / waterskiing
- Heritage site viewing – European
- Heritage site viewing – Aboriginal
- Short walks
- Lookout – scenery/vista viewing
- Sight seeing/scenic drive stop
- Mountain biking (cross country)
- Swimming
- Nature study
- Vehicle (car, 4WD, motorbike, etc)
- Other

What damage is visible at this site?

- Clearing of vegetation and timber for campsite furniture and fires or river access
- Ground cover damage and soil exposed/ compacted due to trampling, informal trails, vehicle access etc
- Litter present
- Fire scars present
- Human waste present
- Animal faeces present

Actions:

- Remove litter/rubbish and/or faeces from site
- Remove informal trails/structures
- Tidy-up around site (mow grass, trim vegetation)
- Provide infrastructure such as regulatory or interpretation signage, viewing platforms, car park areas, safety fence etc

Summary

1. Desktop assessment category:
2. Descriptive site assessment :
3. Condition index:

Strategic Goals

This strategy encompasses six goals for riparian management in the Clarence Valley LGA. The goals have a number of actions and/or referrals to relevant guidelines that can be used to protect, maintain and rehabilitate riparian land.

Goal 1: Protect riparian areas in good or 'near intact' condition outside of conservation areas

The main focus for this goal will be on protection through conservation agreements. A low level of intervention, funding and resources may be required for threat abatement and to return sites to near original condition. Protection of these areas can be achieved by the following actions:

- Negotiate and implement conservation agreements (e.g. Property Vegetation Plan, State Conservation Area).
- Mitigate or remove any threats to these riparian areas (see Guidelines 2, 3, 4 and 5).
- Monitor and maintain these areas

Goal 2: Implement assisted regeneration in areas in moderate condition

The main focus for this goal will be on rehabilitation to return some elements of original condition. A medium level of intervention, funding and resources will be required to remove or mitigate threats to assist in the natural regeneration of native vegetation. Rehabilitation of these areas can be achieved by the following actions:

- Develop a site management plan for the highest priority sites in this category.
- Mitigate or remove any threats (see Guidelines 2, 3, 4 and 5).
- Monitor and maintain these areas.

Goal 3: Implement revegetation in areas in degraded condition

The main focus for this goal will be on rehabilitation to return some elements of original condition. A high level of intervention, funding and resources will be required to remove or mitigate threats and to revegetate areas. Rehabilitation of these areas can be achieved by the following actions:

- Develop a site management plan for the highest priority sites in this category.
- Mitigate or remove any threats (see Guidelines 2, 3, 4 and 5).
- Revegetate areas that show little or no evidence of natural revegetation.
- Monitor and maintain these areas.

Goal 4: Increase community training and engagement

Community engagement and training has improved the implementation of riparian management within the Clarence Valley. The importance of managing riparian areas and the need to rehabilitate or protect these areas can be achieved by increasing opportunities to engage land managers via the following actions:

- Develop and implement a communications strategy.
- Integrate riparian management into other relevant NRM training projects.
- Promote best riparian management practices.
- Ensure that the community are provided with regular updates on the implementation of this strategy.
- Support national initiatives that raise the profile of riparian management (e.g. National Water Week).
- Facilitate resources and personnel to run programs.
- Ensure staff are trained in identification and management of riparian issues.
- Recognise and reward individual and community achievements in riparian management.
- Provide access to funding opportunities to implement on-ground actions and training.

Goal 5: Improve riparian management coordination

It is important that all stakeholders involved with riparian management in the Clarence Valley and adjoining catchments work together to strategically manage riparian areas, and to maximise the benefit of allocated grant funds and resources. This can be achieved by implementing the following actions:

- Identify all stakeholders and appropriate contacts and representatives.
- Develop joint funding submissions for priority riparian areas within Clarence Valley Council, and across the Northern Rivers Catchment Management Authority (NRCMA) and neighbouring CMA regions, where possible.
- Consult with regional, state and national organisations regarding objectives and investment strategies.

Goal 6: Ensure this strategy is implemented and remains a relevant working document

The implementation of the following actions will help achieve this goal:

- Seek funding to implement the various components of the strategy.
- Form a review panel to meet annually to monitor the progress of the strategy.
- Ensure stakeholders are committed to implementing and monitoring the strategy.

Management Principles for Public Riparian Lands

The following principles are designed to guide the management of lands that adjoin waterways and are owned or controlled by Council or other public authorities or service providers. Many of these riparian areas, in particular their natural assets, have not always been managed in accordance with best practice management methods due to insufficient funding or NRM expertise, leasing conditions or inspection regimes. Clarence Valley Council should manage these lands consistent with the *Riparian Action Strategy Guidelines* and the specific principles here under. Implementation of these management principles will demonstrate Council's commitment to improved riparian management, and ensures expectations placed on private land managers are equivalent to those directing public land managers.

Planning

- Adequate setbacks between riparian land and new development are to be provided as in Guideline 1.
- Subdivisions (via perimeter roads and public open space) and new developments should front onto riparian land and not back onto it.
- New subdivision or urban development fronting waterways, especially the Clarence River or major tributaries, should provide for suitable public access and rehabilitation of vegetation along the riparian area. It is preferred that land is dedicated to Council as public land. Where dedication is not practical or desirable to Council then public access can be provided using other mechanisms, (e.g. Section 88B of the *Conveyancing Act 1919* or easement en gross under the *Crown Lands Act 1989* (or similar)).
- Services and roads should not be located in riparian areas. Where essential, locate as far landward as possible.
- Limit crossings of the riparian corridor to maximise connectivity and where necessary use non-destructive techniques such as direct drilling for pipes and piered crossing for roadways.
- Avoid piping, straightening or channelising open stream channels. Alternatives to rock armouring should be properly considered in all circumstances.
- Treat stormwater before discharge as per adopted stormwater management plans and 'sustainable water' provisions in Council Development Control Plans (DCPs).
- Asset Protection Zones for bush fire management associated with development are to be located outside the riparian area.
- Plan revegetation works to be compatible with flood mitigation, public use and adopted plan of management/management plan requirements.
- The sale of land should include covenants for riparian vegetation, consistent with this strategy.

- Road reserves located in riparian areas should not be sold. These reserves should be retained for riparian rehabilitation and to provide access to these areas.
- Any new structures within the riparian area should be compatible with the *Clarence River Waterfront Facility Strategy* (LPMA in prep.).

Access

- Access to the watercourse should be minimised and be located at strategic locations as appropriate (i.e. consistent with other principles herein and adopted management plans, reserve plans of management or operational plans).
- Walking tracks, bike tracks and other recreational opportunities should not compromise the integrity of the riparian corridor.

Protection of assets through restoration and rehabilitation

Streambank erosion and riparian degradation can threaten assets such as levee banks, roads and other service mains or infrastructure with varying degrees of consequences. Each site requires an assessment to be conducted based on the following factors to ensure that a suitable plan of management is implemented:

- Factors which affect erosion such as the soil type, bank height, flow pattern and wind, wave and tidal action.
- An asset evaluation which includes a valuation of the asset, the value to Council and the community and the consequences of further riparian degradation (e.g. cost of relocation versus repair and maintenance).
- Protection of the asset can be by soft, intermediate or hard treatments (as in Guideline 4) or relocation or abandonment of the asset.



Severe erosion and road collapse in a riparian area

- Where possible stream bank stabilisation should be by soft treatment requiring the removal of stock and weeds, and encourage regeneration of local native vegetation that is capable of reinforcing the bank structure and long-term ecological function of the site.
- The plan of action should be determined in a timely manner to avoid costly and difficult works to repair damage to the asset and/or catastrophic consequences. Where possible, options to relocate assets at threat (short- to long-term) should be thoroughly investigated to ensure minimal impact on riparian land and reduce longer term costs to Council and the public.
- In most instances a Review of Environmental Factors (REF) and necessary permits will be required (Guideline 4).
- Prioritise riparian protection and rehabilitation works using the assessment and prioritisation of riparian areas for management provided in this strategy.
- All streambank restoration works should include a riparian vegetation rehabilitation plan.

Maintenance

- Most riparian areas and foreshore community open space should not be mowed to allow for the natural regeneration of local native vegetation. Grass mowing should be limited to intensive recreation areas, sporting fields and areas necessary for direct access to waterways or assets such as boat ramps. Mowing in these areas should be at a higher height to provide for improved filtering capacity, whilst encouraging better root development and healthy vegetation cover. In-stream or intertidal aquatic vegetation, such as native reeds, should not be 'mowed' unless essential for access.
- If applicable, an agreement between an adjoining or nearby landholder and the public land manager could be entered into to allow the periodic grazing of the public land to reduce the need for mowing and/or weed control. Pulse grazing of riparian areas for weed control could also be agreed to if the grazier agrees to observe riparian management plans and use low impact grazing practices described in Guideline 2.



A mowed riparian area – an example of poor riparian management

Agreements for occupation of land for grazing and other uses

The following special conditions are to be added to leasing/licensing agreements where the leased/licensed area adjoins a waterway. Some of these properties are leased/licensed with additional requirement for the management of riparian areas.

- The Lessee/Licensee undertakes to erect a fence at least 10 m (subject to site assessment and the individual circumstances of the case) from the top of the river bank to protect the riparian area in accordance with the *Riparian Action Strategy Guidelines*.
- Watering points may be provided by the lessee/licensee subject to Council approval. Off-stream watering points are preferred to avoid stock access and degradation to riverbanks.
- Pulse grazing of the riparian area is permitted intermittently throughout the term of the lease/licence agreement to control weed growth. The licensee undertakes to observe riparian management plans and pulse graze the riparian section of land in accordance with the lease/licence conditions and Guideline 2.
- The Licensee shall undertake to abide by the recommended carrying capacity for the licensed area as advised by the Livestock Health and Pest Authority. The Licensee shall not overgraze or place more livestock on the licensed area than it is reasonably capable of carrying so as to cause degradation of the licensed area.
- Inspections are to be conducted once every 12 months as per current clause. However, an inspection every 3 to 6 months is recommended after the special conditions for riparian management are agreed to, before gradually moving to 12 month inspections. A separate agreement or covering letter may be required.

Reserves

All Council managed parks and reserves (whether classified as Crown, community lands or operational) shall be managed as per the Council's *Riparian Action Strategy Guidelines*, except in the following circumstances:

- Reserves subject to the Council adopted *Caring for our riverside parks and reserves: A strategy for managing riverside recreation and riparian vegetation* (Clarence Valley Council 2009a) where that Strategy contains specific management actions regarding riparian land. Where that Strategy is silent then the *Riparian Action Strategy* will apply.
- Reserves subject to specific or generic plans of management (as applicable) under the *Local Government Act 1993*, *Crown Lands Act 1989* or other relevant legislation, which contain specific management actions regarding riparian land.
- Reserves subject to other management plans accepted by Council (e.g. a roadside

management plan utilised by the Roads and Traffic Authority for the Pacific Highway corridor).

Aboriginal and non-Aboriginal culture and heritage preservation

Many riparian areas contain sites of cultural and spiritual significance for Aboriginal and non-Aboriginal Australians. Riparian land and waterways are prominent in Aboriginal culture as they provide access to water, food and shelter and have been locations used for burials, rituals and ceremonies. These areas may contain cultural objects or sites such as middens, camp sites and scar/canoe trees.

Many riparian areas also contain evidence of their historically important role in the early European settlement of the Clarence Valley. Most towns on the Clarence were established along the River. These areas can contain wharfs, bridges, buildings and historic monuments or relics. It is important to protect and maintain these riparian heritage sites to provide a cultural link to the landscape, an area for culturally significant activities or to provide reminders of them. These areas play an important role in the education of future generations about our shared culture and cultural connection to our rivers.



Reedy Creek Aboriginal Camp Site is significant Aboriginal cultural heritage area

Management of riparian areas needs to be considerate of both known and potential cultural heritage values (Aboriginal and non-Aboriginal). Activities on riparian land associated with heritage values would generally be consistent with the *Australia ICOMOS Burra Charter, 1999* (Australian ICOMOS Inc. 2000), which advocates the principle to 'Do as much as necessary and as little as possible'. Where Aboriginal objects or sites may be harmed or non-Aboriginal heritage items may be impacted, consultation and any necessary permits shall be obtained prior to work proceeding.

Recommendations for Council for improved riparian management

1. Undertake an assessment of assets in riparian areas and develop a management strategy as part of a lease review.
2. Council is to assess and prioritise Council-managed land for riparian protection or rehabilitation work.
3. Council is to review the method for agreeing to lease properties containing riparian areas. A Sustainability Assessment (using Councils Sustainability Reporting Framework) is to consider the size of the property, the appropriate width of riparian area, if the management complies with the *Riparian Action Strategy* guidelines, and if leasing this land is financially viable.
4. Council is to liaise with other government agencies responsible for managing public riparian lands to advise of the adopted *Riparian Action Strategy* and guidelines.
5. A detailed desktop assessment of riparian areas is required throughout the Clarence Valley LGA to include the data collated in the *Clarence Valley Council Biodiversity Management Strategy* (in prep.).

Riparian Management Information

Table 4 gives a summary of the main threats that are likely to affect riparian areas in the Clarence Valley LGA and information regarding their management.

If a particular issue is not identified here, there are a number of key contacts, publications and web sites given in Appendix 2 that could assist.

Table 4. Summary of threats to riparian areas and management information

Threats	Management information
Clearing of vegetation	Guideline 1: Riparian vegetation management
Stock	Guideline 2: Stock management in riparian areas
Weeds	Guideline 3: Riparian weed management
Erosion	Guideline 4: Bank erosion management
Fire	Guideline 5: Riparian fire management
Climate change and sea level rise	Guideline 6: Managing riparian areas for climate change and sea level rise
Recreational activities	Clarence Valley Council (2009a) <i>Caring for our riverside parks and reserves: A strategy for managing riverside recreation and riparian vegetation. Riverside Recreation and Camping Strategy.</i> Clarence Valley Council, Grafton, NSW.

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- Umwelt Environmental Consultants (2003) *Pathways To A Living Estuary – Clarence Estuary Management Plan*, Report prepared for Clarence River County Council. Report No. 1485/R04/V3, Umwelt Environmental Consultants, Toronto, NSW.

Guideline 1: Riparian Vegetation Management

Function of riparian vegetation

Riparian vegetation provides many functions such as:

- wildlife habitat, shelter, food and movement corridor
- improved aesthetic values
- nutrient, sediment and top soil retainment
- shade over waterways to regulate water temperature
- improved property market values
- community enjoyment
- reduced erosion and loss of land and assets
- reduced algae and aquatic weed growth
- support a diverse range of native flora and fauna
- inhibit terrestrial weed growth
- improve water quality
- stock shelter from climatic extremes
- provide habitat for birds and insects species which help protect pastures and crops from damage by pests
- stream geomorphology
- a source of large woody debris

Avoid damage to riparian vegetation

Any impact on native vegetation should be avoided. The following activities degrade riparian vegetation. *Those marked with an asterisk (*) may require permits or result in penalties.*

- Uncontrolled stock access to riparian areas.
- Cultivation in riparian areas.
- Inappropriate recreational activities.
- Removal of dead wood from riparian areas.*
- Removal of snags.
- Vegetation clearing to enhance river views.*
- Slashing, mowing and burning of riparian vegetation.*
- Removal or destruction of riparian vegetation by activities such as poisoning, clearing, mowing, slashing and fire.*
- Removal or damage to aboriginal cultural sites, hollow trees and fig trees.*
- Construction of flood mitigation and drainage systems, roads, buildings, rock revetments and jetties.*

In circumstances where removal of trees or native vegetation is essential and unavoidable, then plant replacement will need to be offset by rehabilitation in accordance with this Guideline and *Clarence Valley Council Biodiversity Management Strategy* (in prep.).

Impacts of degraded riparian vegetation

Damage to riparian vegetation can have a detrimental impact on the riparian area itself and on the numerous vital functions that these areas provide such as:

- increased stream bank erosion
- decreased habitat and food for native species

- poor water quality from excess sediment and nutrients
- increased light in the water column, higher water temperatures and low dissolved oxygen levels
- prolific growth of aquatic weeds and algae
- invasion and growth of terrestrial weeds
- increased water flows
- inhibited native vegetation regeneration
- decreased agricultural productivity and stock health
- reduced aesthetic qualities and community enjoyment
- depreciated capital land value
- loss of assets and areas of cultural significance
- reduced resilience against extreme events (e.g. floods, drought, climate change sea level rise)

Rehabilitation

Where degraded riparian vegetation exists then rehabilitation is to be conducted in accordance with this Guideline. Landholders interested in rehabilitating riparian areas are encouraged to contact the organisations listed in Appendix 2 for assistance and funding opportunities. Some funding bodies have specific requirements such as minimum widths for riparian areas or complete stock exclusion, before they approve funding for fencing, plants and other riparian works.



Clarence Valley Landcare Inc. providing training in riparian vegetation rehabilitation

Buffer width

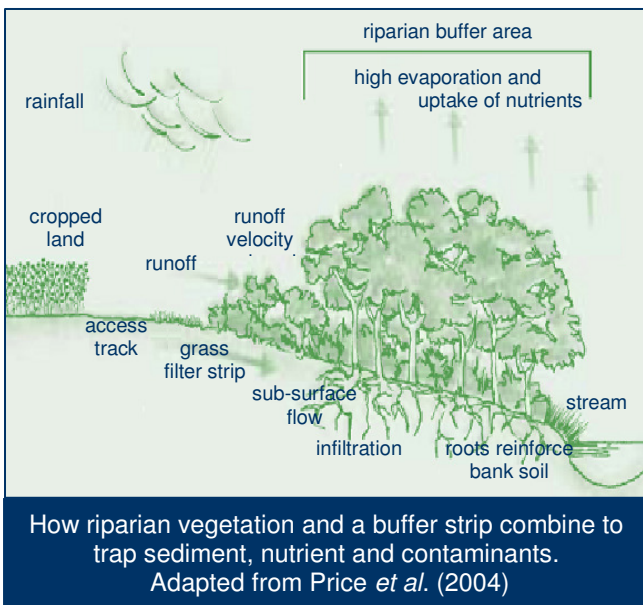
The appropriate amount of area to be dedicated to riparian rehabilitation and/or improved riparian management can be determined by factors such as the location (e.g. outside or inside bend), erosion potential, bank slope, length and gradient, relevant legislation and the land manager's objectives. The actual width required should be determined for each situation and through seeking technical advice (Appendix 2). However, as a general rule, wider is better and will last longer (Price *et al.* 2004).

Existing working properties

Council recommends a minimum riparian buffer width of 10 m from Mean High Water Mark (MHWM) (or 'normal' water level for non-tidal waterways) or from 'top of bank' for steeply sloping banks, for the purpose of improving disturbed riparian areas on existing working properties. This buffer should not be slashed, accessed by stock grazing or otherwise cleared or degraded. Where this buffer is degraded then rehabilitation is recommended. Council considers this width as necessary to provide *basic* riparian functions, while allowing for continuing production on working properties. In situations where the buffer is vegetated with local endemic species and greater than 10 m wide, Council would not support clearing of the established endemic vegetation.

Where practical, a riparian buffer width of minimum 50 m (and up to 100 m) is desirable to provide improved ecological, habitat and fisheries value (refer to 'New developments' below). Riparian areas which are narrower than 10 m commonly suffer from edge effects (e.g. weeds, erosion, runoff and poor water quality) and require a greater effort to maintain in a healthy and sustainable condition.

Where a minimum width of 10 m cannot be achieved due to a road running along the riverbank, it is recommended that the other side of the road be revegetated to create shelter and reduce the edge effect on exposed riparian vegetation.



New developments

Council recommends a minimum riparian buffer width of 50 m from MHWM (or 'normal' water level for non-tidal waterways) on each side of a watercourse of 3rd order or higher to be retained. This 50 m riparian buffer area is to be zoned for Environmental Management (or equivalent). If existing riparian vegetation is in a degraded condition then rehabilitation will be required to improve riparian function, such as implementation of the 'Sustainable Water' requirements in Councils development control

plans. A minimum riparian buffer width of 100 m is recommended for properties with high conservation value or where threatened species occur on the property or adjacent watercourse.

Filter strips

For maximum trapping of sediment, nutrients and other contaminants, combine the 10 m riparian vegetation buffer with a grass filter strip (Price *et al.* 2004). A minimum width of 5 m is recommended for a grass filter strip to be effective over more than one rainfall runoff event.

Drains and non-permanent stream management

Most drains and non-permanent streams in the Clarence Valley LGA lack riparian vegetation. Many have problems such as bank erosion or slumping, aquatic weeds, high water temperatures, low dissolved oxygen and high nutrient levels. A variety of native vegetation species should be established to shade the waterway and provide habitat value where space and maintenance needs allow. By planting native grasses such as *Lomandra* on banks, multiple benefits can be achieved without impacting on productive land or access to the drain for maintenance. See Heesom and Kimber (2003) for further information.



Assisted regeneration

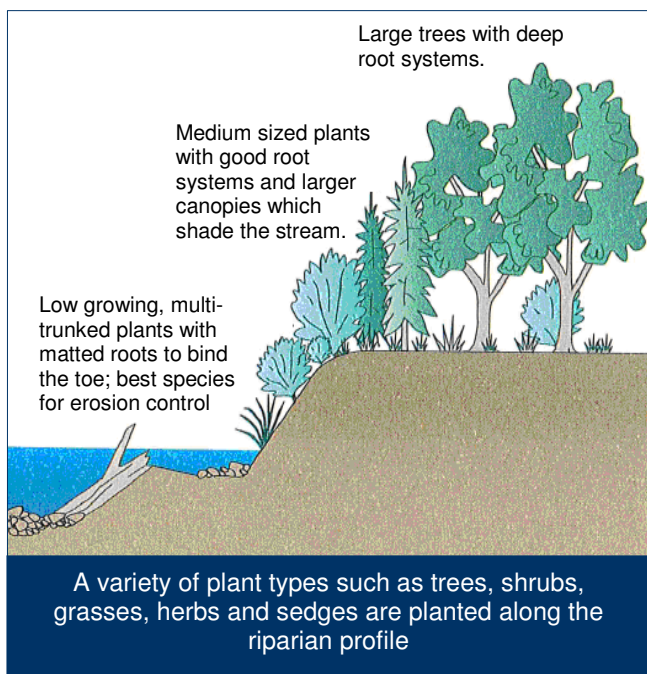
Assisted regeneration of riparian vegetation involves encouraging juvenile plant growth from the existing native vegetation and seed stores. Firstly, determine if an adequate seed bank or regeneration exists. Then identify and remove any threats such as grazing animals or weeds. This usually involves fencing the area to remove stock and undertaking regular weed control (see Guidelines 2 and 3). Assisted regeneration is relatively cheap and less labour intensive than revegetation and ensures that the plants are adapted to the local conditions. One disadvantage of this method is that sometimes there is a low establishment rate of seedlings.

Revegetation

Revegetation will be required where the riparian land is degraded, highly modified, or has inadequate seed bank. This requires more preparation and is more expensive than assisted regeneration but can lead to greater initial success. Threats such as grazing animals or weeds also need to be identified and removed as detailed in Guidelines 2 and 3. Revegetation activities need to be timed according to season and growth periods (autumn or spring), as well as to avoid floods and other disturbances.

Plant selection

Select a variety of local (indigenous) plants species and types such as trees, shrubs, grasses, herbs and sedges to plant along the bank profile as listed in Raine and Gardiner (1997) and the figure below. This ensures that vital functions such as the provision of shade, bank stabilisation, runoff reduction, habitat and weed suppression can occur.



Planting arrangement

Plants can be positioned in lines, randomly or in clumping patterns. This will depend on factors such as future access for maintenance and weed control, if the soil is compacted and requires ripping, planting to provide shelter, or if a more natural look is required. The planting density will vary depending on the species being used.

Direct seeding

Direct seeding involves sowing seed directly into the prepared soil at the final selected location and is an inexpensive and efficient way of revegetating large areas. Indigenous seed should be used, however a permit from DECCW is required to collect seed from land other than your own. Seed conditioning or trimming can improve germination rates and watering is required immediately after planting, with follow up weed removal.

Tubestock

Tubestock should be planted after rain when the soil is moist and easy to dig. A hole about twice as wide and deep as the size of the tube is required, with suitable fertiliser and water added before planting the seedling in the middle of the hole. The soil filled in around the plant should be lightly pushed down. The plant should then be watered and mulch or a weed matt added to control weeds, reduce the effects of frost and retain soil moisture.

Longstems

Longstems are tubestock that have thick woody elongated root stems up to 2 m long that are to be buried 1-2 m to better withstand floods, dry periods, frosts, and effectively stabilise stream banks. Longstems can take up to 18 months to produce and will need to be ordered in advance and require daily watering until planted. These plants are usually planted using a mechanical auger or jetting lance, then watered, with mulch or a weed matt added to control weeds, reduce the effects of frost and retain soil moisture.

Maintenance

Guards can be used on young plants to protect them from harsh conditions. However, plastic guards are not to be used in a flood area as even biodegradable guards take a very long time to break down. Cardboard milk cartons are a good alternative.

It is very important that plans are made for follow-up work for watering, fertilizer application (if required), fence maintenance and weed control until the plants are fully established.

Further information

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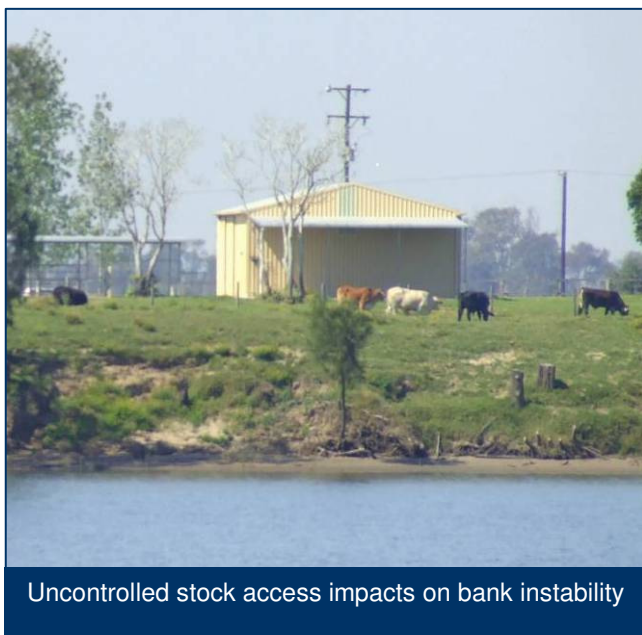
Intact riparian vegetation

Guideline 2: Stock Management in Riparian Areas

Impact of stock grazing and movement

Stock grazing in riparian areas has often been practised because of the quality pasture, shelter and water the area provides, and to control weeds. However, continuous stock access causes detrimental impacts such as:

- native plant damage and inhibited regeneration
- reduced biodiversity and wildlife habitat
- decreased stock growth and production rates caused by drinking water contaminated with viruses and bacteria from livestock waste
- increased nutrients in waterways from stock waste which promotes excessive aquatic weed and algae growth
- decreased stock shelter from extreme temperatures and winds, reducing stock performance
- stock injury and drowning
- decaying carcasses in the water which pollute waters and are a source of dangerous bacteria
- soil disturbance and compaction, causing increased erosion, the loss of land and promotion of weed growth
- increased sediment entering the water, causing turbid conditions which reduce habitat and water quality



Benefits of stock management

Controlling stock access to riparian areas can significantly lessen the impacts mentioned above and can improve economic outcomes for farmers by improving land value, and increasing productivity and reducing operating costs through:

- improving stock health by providing shelter from climatic extremes, improved drinking water and preventing injuries and drowning incidents
- improving pasture through retention of rainfall, nutrients and soil

- reducing streambank erosion and loss of land
- providing habitat for insect-eating birds and insect parasites that help protect pastures and crops from damage by insect pests

Stock management methods

Landholders interested in managing stock in riparian areas are advised to first check with the organisation listed in Appendix 2 for assistance and funding. Please note that some funding bodies have specific requirements such as minimum widths for riparian areas or complete stock exclusion, before they approve of funding for fencing, revegetation and other riparian works

To determine the most suitable way of managing stock on a property and the position of fences, gates and access ways, consider features such as waterways, bank slope, hills and gullies, pastures, native vegetation, eroding land, noxious weeds and areas subject to flooding. Also consider the man-made features like fences, buildings, stock watering points and crossings.

Ideally, fences, gates and stock access should be positioned as far from the waterway as possible. The recommended minimum and preferred widths of riparian buffer areas are given in Guideline 1. The fence can be positioned straighter when set back away from the waterway, which is cheaper and simpler to erect than one which follows the curves of the waterway.

Fencing types

There is a range of fencing options and the type used will depend on the purpose, topography, size of the area, flood regime, budget and stock type. These include:

- drop and lay down fences
- electric fences
- suspended fences and flood gates
- non-electric suspended fences
- electrified flood gates
- permanent and semi-permanent electrified stream crossing fences
- semi-permanent fences with disposable sections
- mesh flood gates
- electronic fences

Alternative stock watering

Alternative watering systems may need to be installed if riparian land is fenced. The two main options are off-stream water source and water access points.

Off-stream watering systems provide many environmental and agricultural benefits, however, it can be expensive to install initially and will require some ongoing maintenance. There are a range of water systems available and the suitability of each

will depend on the water source, the paddock layout, the distance between the water supply and water points, and the height difference between the water supply and watering points. Water can be fed to troughs by gravity or pumping. There are a range of pumps available which include solar powered, electric, diesel, petrol, wind and stock operated. Off-stream watering points should be located as far away from waterbodies with a recommended minimum spacing of 50 m between watering points and waterbodies.

- when no plants are in flower or setting seed
- when no floods, heavy rains or fires have recently occurred
- conservative stock rates or young lighter weight stock are used to reduce grazing intensity and trampling impacts
- stock are to be removed from the riparian area if there is low vegetation cover, heavily grazed trees and shrubs, poor water quality or soil pugging

Maintenance

Weeds and fire are common problems encountered by farmers when they exclude stock from their riparian areas. Information on planning for and dealing with these issues can be found in Guidelines 2 and 5.

Further information

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Price P. and Lovett S. (2002) *Managing stock, Fact Sheet 6.* Land and Water Australia, Canberra. <http://www.amlnrm.sa.gov.au/Portals/1/Caring/WMA/P/Docs/facts06.pdf>

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A stock fence inappropriately constructed within 2 m of Mean High Water Mark (MHWM)

Water access points can be constructed on the inside bend of waterways, with a gentle slope and rocks and other materials to reduce erosion. Water access points need to be fenced to prevent stock from entering the surrounding riparian land and via the waterway. Poor water quality may still be a problem because much of the stock waste will continue to enter the waterway.

Pulse grazing

The complete exclusion of stock is the best course of action, however, pulse grazing can form part of a sustainable riparian management plan. Pulse grazing, sometimes known as 'crash grazing', treats the riparian area as a separate paddock where very short-term grazing followed by long intervals of rest take place to assist in weed control and to maximise the recovery of indigenous vegetation under the following conditions:

- when native plants are dormant (mainly winter)

Guideline 3: Riparian Weed Management

The impact of weeds in riparian areas

A weed is a plant that requires some form of action to reduce its effects on the economy, the environment, human health or amenity (Natural Resource Management Ministerial Council 2007). Riparian areas are particularly susceptible to weed invasion by multiple weed species due to natural disturbance, processes associated with human activities, flooding, stock movements, grazing, favourable environmental conditions and the continued input of weed propagules from upstream and adjacent areas. Different weed species have different impacts. In general, weeds in riparian areas may:

- change vegetation community composition
- inhibit recruitment and growth of native plant species
- decrease food and habitat for native fauna, both terrestrial and aquatic
- provide food and habitat for exotic animals such as foxes and blackbirds
- change soil nutrient processes
- decrease water quality
- decrease water quantity (e.g. willows)
- reduce access and recreational opportunities (Ede and Hunt 2008)

Management of weeds in riparian areas will reduce the above impacts and result in improved ecosystem functioning such as water quality, native vegetation condition, regeneration capacity and habitat value.

Identification of weeds

It is important that the suspected weed be positively identified before deciding on a relevant management option. Landholders should contact their local council weeds officer in the first instance. An Industry and Investment NSW District Agronomist, the Australian Weeds Committee Weed Identification Tool (www.weeds.org.au), or the Australian Governments Weed Identification Tool (www.weeds.gov.au) may also be helpful.

Priority weeds in the Clarence Valley

As riparian areas often contain many weed species it is important to determine whether all species should be controlled, or whether management actions should focus on key weed species. The priority riparian weeds for management and resource allocation in the Clarence Valley LGA have been determined in *The Northern Rivers Invasive Plants Action Strategy 2009-2013* (Oakwood 2009; see Table 5). Each weed species has been categorised to reflect its impact, invasiveness, distribution and rate of spread, and also whether the species could, within 5 years, feasibly be eradicated, contained or prevented from spreading (Oakwood 2009).

In the Clarence Valley LGA resources should target Priority B weed species, with the aim of containing, decreasing and where possible, eradicating infestations of newly arrived or small infestations and then channel to larger infestations. If sufficient funding is available, control work should then be carried out on Priority C, Priority D and Priority E weeds.

Table 5. Priority weeds in riparian areas in the Clarence Valley LGA. Adapted from Oakwood (2009, Table 4e).

Common name	Scientific name	Priority
Kudzu	<i>Pueraria lobata</i>	B**
Broad Leaf Pepper Tree	<i>Schinus terebinthifolius</i>	B**
Mysore Thorn	<i>Caesalpinia decapetala</i>	B*
Honey Locust	<i>Gleditsia triacanthos</i>	B*
Chinese Celtis	<i>Celtis sinensis</i>	B*
Cockscomb Coral	<i>Erythrina crista-galli</i>	B
Willows	<i>Salix spp.</i>	B
Leucaena	<i>Leucaena leucocephala</i>	C*
Moonflower	<i>Ipomoea alba</i>	C*
Madeira Vine	<i>Anredera cordifolia</i>	C
Lantana	<i>Lantana camara</i>	C
Taro	<i>Colocasia esculenta</i>	D*
Devils Trumpet	<i>Brugmansia x candida</i>	D*
Dutchmans Pipe	<i>Aristolochia elegans</i>	D*
Broad Leaf Privet	<i>Ligustrum lucidum</i>	D
Moth Vine	<i>Araujia sericifera</i>	D
Balloon Vine	<i>Cardiospermum grandiflorum</i>	D
Cats Claw Creeper	<i>Macfadyena unguis-cati</i>	D
Trad/Striped Trad	<i>Tradescantia fluminensis</i>	D
Black Locust	<i>Robinia pseudoacacia</i>	E
Narrow Leaf Privet	<i>Ligustrum sinense</i>	E
Camphor Laurel	<i>Cinnamomum camphora</i>	E
Blue Morning Glory	<i>Ipomoea indica</i>	E
Five Leaf Morning Glory	<i>Ipomoea cairica</i>	E
Castor oil	<i>Ricinis communis</i>	E
Mistflower	<i>Ageratina riparia</i>	E
Coral Berry	<i>Rivina humilis</i>	E

Key: B = Class 3 noxious weeds and/or weeds scoring 89-80; C = 79-70; D = 69-60; E = 59-40; ** = weeds with only a single infestation; * = weeds with several small infestations; No * = moderate to widespread distribution.

Control of weeds in riparian areas

Due to the vulnerability of riparian areas to weed invasion, a few days per year controlling weeds is required to effectively reduce the weed threat. As native vegetation improves the amount of time and resources required will gradually reduce.

There are a number of different control methods listed below which are most effective when used in an integrated way and not in isolation. Landholders are encouraged to contact Council or the NRCMA Community Support Officer before undertaking weed management in riparian areas for advice about possible funding and assistance, suitable control methods and the complex legal issues associated with conducting activities in riparian areas.

Herbicide use

Herbicide use is the most common and cost effective way of controlling weeds, however, it is an offence to pollute waters through the use of chemicals or herbicides. Select the herbicide type based on the weed species, location and the label directions. Herbicides must be used in accordance with the manufacturer's recommendations. For further up-to-date information please contact Council or DECCW. Legislation relating to the use of herbicide near streams is covered in Appendix 3.



Mysore thorn forms dense thickets in riparian areas

Native vegetation improvement

Weeds find it difficult to invade and become established in areas where natural vegetation is relatively intact. Assisted regeneration or revegetation will help prevent weeds from establishing (see Guideline 1).

Tree poisoning

Poisoning or ringbarking tree weed species such as willows or camphor laurel, will cause them to decline gradually while native vegetation re-establishes.

Manual removal

Hand pulling may be suitable for small weed species such as grasses and shrubs, or for infestations at an early stage of establishment. It is also appropriate for species which no herbicide is registered. Machinery could be used in areas with multiple weed species and where access is not limited. However, removal of tree weed species and their roots can leave the banks vulnerable to erosion and further weed invasion, and is not recommended in riparian areas.

Pulse grazing

Pulse grazing may be an appropriate way to control certain weeds under certain conditions. Stock will selectively graze some weeds such as ragwort and paragrass (see Guideline 2 for details).

Reduce re-invasion

Weed management in upper catchment areas may be required to provide some weed control in the downstream riparian area being managed.

Reduce excessive nutrients

By excluding stock and reducing fertiliser runoff the associated nutrient inputs will help the riparian areas become less suitable for many weeds.

Biological control

Biological control programs are effective for some weed species and may be suitable for infestations that are inaccessible. Due to the numerous weed species that often occur in riparian areas, bio-control may only form a small component of a weed management strategy.

Do not plant introduced species

Plant only native species in riparian areas. Introduced species such as willows, which have been planted in the past, have had unintentional negative impacts on riparian areas and waterways.

Further information

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Australian Government (2009) *Weeds in Australia*. www.weeds.gov.au/index.html

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Guideline 4: Bank Erosion Management

Stream bank erosion is a natural process driven by the dynamic movement of rivers and streams which are always in a constant state of change. This change frequently occurs in floodplain areas where waterways are more likely to migrate over the floodplain landform when unconstrained by steep sided river valleys.

However, the rate of bank erosion in the Clarence Valley LGA has greatly increased in many places due to the degradation of riparian areas by human activities.

Benefits of riparian vegetation

Healthy riparian areas help protect streambanks from erosion in times of strong flows in several ways. The root systems of riparian trees, shrubs and grasses bind and hold the banks together. Riparian vegetation also uses much of the water present in streambanks, improving streambank soil drainage and reduces the risk of bank collapse. Riparian vegetation can also absorb the erosive force of flows, protecting the bank. The vegetation also reduces the extremes of temperature and moisture variation that can loosen sediment from the banks through swelling and shrinking of the soil.

Causes of erosion

Bank erosion and the shape, form and location of the waterway are influenced by the amount and rate of supply of water and sediment into the system, catchment geology and the type and extent of vegetation in the catchment.

Accelerated rates of bank erosion and instability can be caused by:

- removal or disturbance of riparian vegetation through activities such as clearing, uncontrolled stock access, recreational activities, vehicle access or fire
- extreme rainfall events or increased stream flow
- excessive or inappropriate sand and gravel extraction
- stream straightening, drainage and flood mitigation works
- stream bed lowering or infill
- inundation of bank soils followed by rapid drops in flow after flooding
- redirection and acceleration of flow around infrastructure, obstructions, debris or vegetation within the stream channel
- wave action generated by wind or boat wash
- weeds such as willows can form in-stream islands and force water flow onto stream banks

Erosion can be identified by the widening and sideways migration of waterways, undercutting of the bank toe, mass bank failure, a lack of bank vegetation and large sediment deposits choking downstream reaches.

Impacts

Bank erosion can cause:

- the loss of highly productive and valuable land
- damage and loss of assets such as recreational areas, roads, bridges and levee banks which can severely impact the community
- the disturbance of riparian soils and invasion by noxious weeds
- vast quantities of sediment to be deposited downstream where it settles on the floodplain causing damage to pasture, crops and infrastructure
- turbid conditions which restricts light and photosynthesis in water plants, reducing food and oxygen availability for aquatic fauna
- excess sediment in the water column which absorbs more heat, increasing the water temperature and decreasing dissolved oxygen
- excess sediment to settle over and smother aquatic plants and aquatic fauna habitat
- excess sediment which obstructs the gills of fish, inducing disease, slower growth and, in extreme cases, death
- native species to be less able to compete with introduced species as they are adapted to Australia's naturally low sediment loads

Controlling bank erosion

Bank erosion can threaten features of the landscape, and assets in locations where the river channel wants to go to will be threatened, despite efforts to maintain the river channel in its present alignment. In general terms, it is preferred management to allow the river channel to move across the landscape in as close to a natural process as possible.



Erosion in Palmers Channel in 1946

However, from time to time, active management to slow channel movement may be appropriate. The benefit of such works needs to be assessed on a case by case basis using the criteria below. Landholders interested in undertaking erosion control

activities should contact Council for advice and further information.

- Identify the cause of erosion, the condition and recovery potential of the waterway and riparian area, soil type, bank height, flow pattern, wind, wave and tidal action, channel size and flow rate.
- Conduct an asset evaluation to assess the assets worth, value to Council and the community and the consequences of further riparian degradation, e.g. cost of relocation versus repair and maintenance.
- Consider the long-term management aim of the site, cost, design, availability of materials, maintenance, accessibility, visual impacts, environmental impacts, impact on the community, occupational health and safety considerations and landholder's needs.
- Undertake any bank stabilisation in accordance with best practice and in compliance with any requirements and permits of any relevant government agency.
- Thoroughly investigate the possible relocation of assets at threat (short- to long-term) to ensure minimal impact on riparian land and reduce longer term costs to Council and the public.
- If treatment is required, soft treatment should be used.
- The plan of action should be determined in a timely manner to avoid costly and difficult works to repair damage to the asset and/or catastrophic consequences.
- All stream bank restoration works should include a riparian vegetation rehabilitation plan.

Soft treatment

Soft treatment is a method of controlling stream bank erosion by removing or mitigating existing pressures and re-establishing local vegetation that is capable of reinforcing the bank structure and the long-term ecological function of the site. This treatment is suitable for sites that have a good potential for recovery. Methods of soft treatment include suitable riparian management practises such as assisted regeneration or revegetation (Guideline 1), removal of stock (Guideline 2) and removal of weeds (Guideline 3).

Suitable riparian management and the short-term sacrifice of valuable land will establish better long-term security of the land, infrastructure and property values. Preserving a strip of remnant riparian forest or woodland of just 10-30 m is enough to slow the erosion of river banks to a negligible, natural rate (Land and Water Australia 2006).

Intermediate and hard treatments

Intermediate and hard treatments can be used to control active, advanced or severe bank erosion or eroding vertical banks in deep water. Intermediate treatments use natural materials such as timber logs and small amounts of rock which are designed to re-establish vegetation and resemble the streams

original condition. This method is suitable for moderate condition areas with moderate recovery potential.

Hard treatments use materials such as large quantities of rock and minimal vegetation to provide long-term stability to degraded banks with little recovery potential. This method has little ecological focus and is very expensive.

Hard treatments are likely to require a permit under the *Fisheries Management Act 1994*. The use of building waste, bricks, metal, concrete rubble or material that may result in pollution should not be used for bank stabilisation or other restoration work in riparian areas.



Intermediate treatment: Rock used to provide fish habitat and bank stability in Wooloweyah Lagoon

Further information

Department of Environment and Climate Change (2009). *Environmentally Friendly Seawalls: A Guide to Improving the Environmental Value of Seawalls and Seawall-lined Foreshores in Estuaries*. DECC, Sydney, NSW.

Land and Water Australia (2006) *River Landscapes: Understanding River Landscapes. Erosion Control*. www.lwa.gov.au/apps/Understanding_River_Landscapes/erosioncontrol.htm

Price P. and Lovett S. (eds) (1999), *Riparian Land Management Technical Guidelines, Volume Two: On-ground Management Tools and Techniques*. Land and Water Resources Research and Development Corporation, Canberra.

Price P. and Lovett S. (2002) *Streambank Stability: Fact Sheet 2*. Land and Water Australia, Canberra.

Queensland Department of Environment and Resource Management (2006) *What causes bank erosion?* River Fact sheet series. www.nrw.qld.gov.au/factsheets/pdf/river/r2.pdf

Schneider G. (2007) *Where Land Meets Water Resource Kit: A Guide to Riparian Management in the Hunter Valley*. Hunter-Central Rivers Catchment Management Authority, Tocal, NSW.

Guideline 5: Riparian Fire Management

Fire can occur in riparian areas due to bushfires, cane harvesting operations, or as a tool for vegetation management such as:

- to reduce fuel loads and so protect economic and natural assets
- to control weeds
- to encourage the growth of 'green pick' for stock
- to stimulate the germination of particular species (for example, members of the Fabaceae family)
- to maintain a particular level of diversity within a vegetation community

Impact of fire

Fire is a serious threat to the integrity of most riparian vegetation. The impact of fire on riparian condition varies according to vegetation type, climate and management practices. Most riparian vegetation species are mesic – that is, they prefer moist environments and are highly susceptible to fires (Lovett and Price 2007). Generally, fire may impact on riparian areas by:

- reducing riparian vegetation diversity and density
- reducing canopy cover
- reducing shade over stream, and therefore increase temperature and sunlight
- increasing sediment and nutrient runoff into streams
- reducing vegetation vigour and flowering potential
- altering patterns of dominance within vegetation types
- promoting weeds
- destroying woody debris and leaf litter that provides shelter and foraging sites for many animals
- killing fire sensitive native species
- destruction of native seed stores and seedlings

Management of fire in riparian areas

In most instances fire exclusion, rather than use, will be the management aim. Fire exclusion generally improves riparian ecosystem functioning such as water quality, vegetation condition, regeneration capacity and habitat value.

Fire should only be used in riparian land under special circumstances. Its use should be carefully managed and its reason for use carefully considered, as there may be more appropriate options available.

If there are species identified in the riparian area that require fire to regenerate, seek advice about a suitable fire regime that considers the impacts mentioned above and other factors such as threatened species, fire history of the site, burn frequency, timing of the burn and safety.

Landholders are required to seek advice and environmental approvals from Council, NRCMA and DECCW before undertaking a burn in a riparian area as this activity is affected by legislation (see Appendix 3). A fire permit from the NSW Rural Fire Service may also be required.

Further information

Lovett S. and Price P. (eds) (2007) *Principles for Riparian Lands Management*. Land and Water Australia, Canberra.

NSW Rural Fire Service (2009) *Before You Light That Fire*. www.rfs.nsw.gov.au/file_system/attachments/State08/Attachment_20070705_94128C69.pdf

Price P. and Lovett S. (eds) (1999) *Riparian Land Management Technical Guidelines, Volume Two: On-ground Management Tools and Techniques*. Land and Water Resources Research and Development Corporation, Canberra.



Fire management has impacted on native riparian vegetation and left the area vulnerable to weed invasion and erosion

Guideline 6: Managing Riparian Areas for Climate Change

Managing riparian areas to adapt to changes in climate and sea level is not fundamentally different to current best practice. Existing pressures and threats may be exacerbated and compounded by climate change. Best practise NRM can alleviate existing and future pressures by improving land use planning and agricultural practices, restoring landscape connectivity, managing invasive species and improving water quality.

Climate change

The Earth's average surface temperature has risen 0.7 °C since 1900 (CSIRO 2007). Changes in average temperature, rainfall and evaporation are likely to lead to a possible reduction in mean flows of rivers in the Northern Rivers Catchment. These changes may also reduce water quality within the catchment as higher temperatures, low flows and elevated nutrients create more favourable conditions for potentially harmful algal blooms and aquatic weeds. In addition, decreases in runoff due to climate change may reduce the extent and function of wetlands, such as the Clarence River Estuary (CSIRO 2007).

	Present (1990) ¹	Projected Change	
		2030	2070
Temperature			
Average	Armidale: 12 – 27°C ² Coffs Harbour: 19 – 27°C ² Lismore: 20 – 30°C ² Yamba: 19 – 27°C ²	+0.2 – +1.8°C	+0.7 – +5.6°C
No. Days below 0°C	Yamba: 0	Yamba: 0	Yamba: 0
No. Days above 35°C	Yamba: 1	Yamba: 1 – 2	Yamba: 1 – 7
No. Days above 40°C	Yamba: 0	Yamba: 0	Yamba: 0
Rainfall			
Annual Average	Armidale: 790 mm Coffs Harbour: 1,647 mm Lismore: 1,343 mm Yamba: 1,457 mm	-7 – +7%	-20 – +20%
Extreme Rainfall³		-10 – +5%	+5 – +10%
Evaporation		+1 – +13%	+4 – +40%
No. Droughts per decade⁴	2	2 – 4	1 – 9
Extreme Winds		-5 – +8%	-16 – +24%
No. Fire Days⁵	Coffs Harbour: 4	Coffs Harbour: 5 – 6	Coffs Harbour: 5 – 8

¹ Present day conditions for temperature and rainfall represent long-term averages from the Bureau of Meteorology. For other variables, present day temperatures are represented as approximately 1990 conditions.
² Range represents average July and January maximum temperature.
³ Defined as 1 in 40 year 1-day rainfall event.
⁴ The values for drought represent average monthly drought frequencies, based upon the Bureau of Meteorology's criteria for serious rainfall deficiency.
⁵ Number of days annually with a "very high" or "extreme" fire danger index. Changes are for 2020 and 2050, respectively, as in Hennessy et al. (2005).

Current and projected climate change in the Northern Rivers Catchment (CSIRO 2007)

One of the most important factors affecting riparian areas relates to the expectation that climate change will result in an increase in severe weather events (Ede and Hunt 2008). Projections suggest there will be more hot days, severe bushfires, droughts and intense storms (CSIRO 2007). More frequent and extreme rainfall events and floods may cause significant disturbance in riparian areas and river bank erosion. Disturbances such as floods and fire

can also increase the likelihood of riparian weeds establishing.

Sea level rise

The NSW Government has adopted a *Sea Level Rise Policy Statement* (NSW DECCW 2009) which indicated that sea level will rise (above 1990 levels) by 40 cm to 2050, and by 90 cm to 2100. Sea level has risen 1.8 mm per year since 1950 and that rate is accelerating (CSIRO 2007). Higher sea levels may increase the erosion of coastal riparian areas. It may also impact on the drainage and groundwater in low-lying coastal floodplains leading to potential increases in the duration of floods, water logging of soils, salt inundation and more extreme storm surges (CSIRO 2007).

Benefits of management

The protection and revegetation of riparian areas is one of the biggest opportunities to improve landscape condition across a range of biodiversity, water and carbon objectives (Campbell 2008). By implementing sound management, riparian areas in the Clarence Valley LGA will be more resilient to the impacts of climate change and sea level rise, including:

- increased bank stability
- a decrease in weed infestations
- increased native vegetation, biodiversity and habitat
- improved water quality, turbidity and nutrient levels
- improved stock health
- contributions to the food web for in stream biota
- increased shading of streams, therefore keeping water temperatures within their natural range

Guidelines

These following key measures identified in Campbell (2008), will increase the resilience of riparian areas to cope with and respond to climate change impacts.

- Maximise landscape connectivity through riparian plantings, and through joining up and buffering significant remnants with revegetation.
- Make new plantings or buffers for remnants as wide as practicable.
- Use local species for habitat plantings, including understorey species, but broaden the genetic base within species as much as possible.
- Get the basics right in site preparation, establishment (especially weed control) and protection from grazing animals.
- From a water yield, water quality and in-stream habitat perspective, riparian revegetation should ideally be targeted to the northern and western sides of streams (to maximise shading benefits) and in the areas most vulnerable to erosion. It should be sufficiently wide to be ecologically

viable and to offer useful terrestrial habitat corridors.

Further information

Campbell A. (2008) *Managing Australian Landscapes in a Changing Climate: A Climate Change Primer for Regional Natural Resource Management Bodies*. Report to the Department of Climate Change, Canberra.

CSIRO (2007) *Climate Change in the Northern Rivers Catchment*. NSW Government.
www.environment.nsw.gov.au/resources/climatechange/NorthernRiversDetailedFinal.pdf

Ede F. and Hunt T. (2008) *Habitat Management Guide: Weeds. Weed Management in Riparian Areas: South-Eastern Australia*. CRC for Australian Weed Management.

NSW Department of Environment, Climate Change and Water (2009) *NSW Sea Level Rise Policy Statement*. NSW Government, Sydney.
www.environment.nsw.gov.au

Appendix 1: Methodology for Developing Desktop Assessment Maps

- Select LGA area only (floodplain or mid-upper system)
- Select 30 m buffer around waterways only
- Create 3 *erosion* maps showing:
 1. Nil/minor erosion using Codes 11/21/41
 2. Moderate erosion using Codes 22/42
 3. Severe/Extreme using Codes 23/43/24/44
- Create 3 *vegetation* maps showing:
 1. > 50% using Attribute 6, Code f
 2. 20-50% using Attribute 6, Code e
 3. < 20% using Attribute 6, Code z, a, b, c, d
- Combine *vegetation* maps and *erosion* maps using matrix below. This should depict initial condition ratings of Good, Moderate and Degraded condition waterways in green, yellow and red

		Erosion		
		Nil/ Minor 11/21/41	Moderate 22/42	Severe/ Extreme 23/43/24/44
Vegetation	> 50% f	Good	Good	Moderate
	20-50% e	Good	Moderate	Degraded
	< 20% z, a, b, c, d	Moderate	Degraded	Degraded

- Create 3 riparian recovery potential maps showing:
 1. Good recovery potential using Attribute 7, Code 2 and Attribute 5, Code 2
 2. Moderate recovery potential using Attribute 7, Code 3
 3. Poor recovery potential using Attribute 7, Code 1 and Attribute 5, Code 1
- Combine *initial condition rating map* and *recovery potential* maps to give a *preliminary riparian condition* map using the table below. This should depict the 6 priority categories below

Desktop assessment of riparian condition and recovery potential categories

- Good condition with good recovery potential
- Good condition with moderate to low recovery potential
- Moderate condition with moderate to good recovery potential
- Degraded condition with moderate to good recovery potential
- Moderate condition with low recovery potential
- Degraded condition with low recovery potential

Appendix 2: Riparian Management Assistance

The following organisations and web sites may provide further information, assistance and funding opportunities. Please note that website addresses and links may change.

Clarence Valley Council

Chambers: 2 Prince Street, Grafton and 50 River Street, Maclean
Mail: Locked Bag 23, Grafton 2460
Ph: 02 6643 0200 (all enquiries)
Fax: 02 6642 7647
Email: council@clarence.nsw.gov.au
Web: www.clarence.nsw.gov.au

Northern Rivers Catchment Management Authority

Office: State Government Offices, Level 3, 49 Victoria St, Grafton
Mail: PO Box 618, Grafton, NSW 2460
Ph: 02 6642 0622
Fax: 02 6642 0640
Web: www.northern.cma.nsw.gov.au

Department of Environment, Climate Change and Water

Environmental Protection Authority/ National Parks and Wildlife Service
Office: NSW Government Offices, 49 Victoria Street, Grafton NSW
Mail: PO Box 498, Grafton NSW 2460
Ph: 02 6640 2500
Fax: 02 6642 7743
Email: info@environment.nsw.gov.au
Web: www.environment.nsw.gov.au

Industry and Investment NSW

Agriculture, Fisheries and Aquaculture or Forests
Office/ Mail: Wollongbar Primary Industries Institute
1243 Bruxner Highway
Wollongbar NSW 2477
Ph: 02 6626 1200
Fax: 02 6628 1744
Web: www.dpi.nsw.gov.au

Clarence Landcare Inc.

Office: Clarence Landcare Inc, Suite 2 Dougherty House 48 Prince St, Grafton
Mail: PO Box 594 Grafton 2460
Ph: 6643 5009
Fax: 6643 5006
Email: landcare@ceinternet.com.au
Web: www.clarencelandcare.com.au

Other natural resource management organisations and information

- Commonwealth Government of Australia
- Australian Government Agriculture Portal www.agriculture.gov.au
- Australian Heritage Council www.ahc.gov.au
- CSIRO Land and Water www.clw.csiro.au
- Department of the Environment and Water Resources www.environment.gov.au
- Land and Water Australia www.lwa.gov.au
- Land and Water Australia River Landscapes www.rivers.gov.au
- Rural Industries Research and Development Corporation www.rirdc.gov.au

New South Wales State Government

- NSW Aboriginal Land Council www.alc.org.au
- Rural Assistance Authority www.raa.nsw.gov.au
- Rural Fire Service www.bushfire.nsw.gov.au

Natural Resource Management organisations

- Australian Conservation Foundation www.acfonline.org.au
- Bureau of Agricultural and Resource Economics www.abare.gov.au
- Bureau of Meteorology www.bom.gov.au
- Conservation Volunteers Australia www.conservationvolunteers.com.au
- Floodplain Management Authorities of NSW www.floods.org.au
- Greening Australia www.greeningaustralia.org.au
- Meat and Livestock Australia www.mla.com.au
- Waterwatch NSW www.waterwatch.nsw.gov.au
- WWF Australia www.wwf.org.au

Cooperative Research Centres

- Beef CRC www.beef.crc.org.au
- Bushfire CRC www.bushfirecrc.com
- Bushfires and Catchments www.ewatercrc.com.au/bushfire
- Cooperative Research Centre for Forestry www.crcforestry.com.au
- CRC for Australian Weed Management www.weedscrc.org.au
- CRC for Sheep Industry Innovation www.sheep.crc.org.au
- e- water cooperative centre www.ewatercrc.com.au
- Invasive Animal Cooperative Research Centre www.invasiveanimals.com

Flora and fauna

- Australian Association of Bush Regenerators www.aabr.org.au
- Australian National Herbarium www.anbg.gov.au/cpbr/herbarium
- Birds Australia www.birdsaustralia.com.au
- CSIRO Entomology insect identification and advice www.ento.csiro.au/insect_id
- Flora for Fauna www.floraforfauna.com.au
- Florabank www.florabank.org.au
- Native Fish Australia www.nativefish.asn.au
- North Coast Weeds Advisory Committee www.northcoastweeds.org.au
- Weeds Australia www.weeds.org.au
- Weeds in Australia web site www.weeds.gov.au

Legal

- Australasian Legal Information Institute www.austlii.edu.au
- Australian Network of Environmental Defender's Offices www.edo.org.au

Appendix 3: Riparian Management Legislation

No single piece of legislation outlines landholder's legal obligations in regard to managing or undertaking works on riparian land. A range of legislation which is relevant to riparian management in the Clarence Valley is listed below.

Commonwealth legislation most applicable to riparian management

- *Environment Protection and Biodiversity Conservation Act 1999* – DEWHA

NSW legislation most applicable to riparian management

- *Environmental Planning and Assessment Act 1979* – CVC
- *Fisheries Management Act 1994* – I&I NSW and DECCW
- *Native Vegetation Act 2003* – DECCW
- *Noxious Weeds Act 1993* – CVC and I&I NSW
- *Protection of the Environment Operations Act 1997* – DECCW
- *Threatened Species Conservation Act 1995* – DECCW
- *Water Management Act 2000* – DWE

NSW legislation somewhat applicable to riparian management

- *Catchment Management Authorities Act 2003* – CMA and DECCW
- *Crown Lands Act 1989* – LPMA
- *Local Government Act 1993* – CVC
- *Soil Conservation Act 1938* – LPMA
- *Coastal Protection Act 1979 (Coastal Protection Amendment Act 1998)* – DECCW
- *Commons Management Act 1989*
- *Forestry Act 1916* – Forests NSW
- *Marine Parks Act 1997* – DECCW
- *National Parks and Wildlife Act 1974* – DECCW
- *Nature Conservation Trust Act 2001* – DECCW
- *Rural Fires Act 1997* – Rural Fire Service
- *Rural Lands Protection Act 1989*
- *Water Act 1912* – DWE
- *Wilderness Act 1987* – DECCW

Abbreviations for administrating organisations

- DEWHA – Commonwealth Department of Environment, Water Heritage and the Arts
- CVC – Clarence Valley Council
- I&I NSW – Industry and Investment NSW
- DECCW – Department of Environment, Climate Change and Water
- DWE – Department of Water and Energy
- CMA – Catchment Management Authorities
- LPMA – Land and Property Management Authority
- Forests – Industry and Investment NSW (Forestry)

Riparian activities affected by legislation

It is important that all landholders who are considering undertaking works in the riparian area consult with the relevant local authorities including:

- Clarence Valley Council
- Northern Rivers Catchment Management Authority
- Department of Environment, Climate Change and Water
- Industry and Investment NSW

This will ensure that the necessary approvals and permits are obtained before carrying out activities in or around riparian areas. Failure to do so can result in prosecution, with penalties including remedial orders and fines.

The following information describes how activities in the riparian area can be affected by legislation. Please note that this is to be used as a guide only, that legislation often changes and that the relevant local authorities should be consulted before works commence. Contacts details are listed in Guideline 2.

Clearing native vegetation in riparian areas	<p>Under the <i>Native Vegetation Act 2003</i> approval is required to clear vegetation (including burning) on land that is situated within 20 m of the bed or bank of a prescribed stream, including native vegetation, non-Aboriginal trees and dead trees, whether standing or fallen. Approval can be sought by submitting either a Development Application or by requesting a Property Vegetation Plan through the CMA. Contact CVC for further information.</p> <p>Vegetation clearance, removal of dead wood, dead trees and logs, are listed as key threatening processes for habitat under the <i>Threatened Species Conservation Act 1995</i> and the <i>NSW Fisheries Management Act 1994</i>.</p> <p>A license may also be required under the <i>Protection of Environment Operations Act 1997</i> for certain types of clearing that involve burning or if there is a risk of contamination of any waterway with sediment or herbicide during clearing.</p> <p>A permit under the <i>Rural Fires Act 1997</i> may be required for certain types of clearing that involved burning. Contact the NSW Rural Fire Service for further information.</p>
Cutting, removing, damaging or destroying mangroves, seagrasses or any other prescribed marine vegetation	Requires approval from I&I NSW (Fisheries) under the <i>Fisheries Management Act 1994</i> . Degradation of riparian vegetation and de-snagging are listed as key threatening processes for habitat under this Act.
Clearing, controlling noxious weeds in riparian areas	Weeds declared under the <i>Noxious Weeds Act 1993</i> can be removed from riparian areas as they are exempt from the <i>Native Vegetation Act 2003</i> .
Herbicide use around water ways	<p>Under the <i>Pesticides Act 1999</i>, some registered herbicides can be used in riparian areas in accordance with the conditions on the label, and if the correct guidelines for the use of herbicides near waters are used.</p> <p>A license may also be required under the <i>Protection of Environment Operations Act 1997</i> if there is a risk of contamination of any waterway with herbicide.</p>
Removing logs, rocks, rubbish and other materials from river channels and banks, dredging, construction or modification of weirs, dams, roads culverts etc on or in waterways	<p>Consent is required for almost all works within 40 m of the bed or bank under the <i>Water Management Act 2000</i>.</p> <p>Approval is required to clear native vegetation within 20 m of bank under the <i>Native Vegetation Act 2003</i>, by submitting either a Development Application or by requesting a Property Vegetation Plan through the CMA.</p> <p>Approvals are required for dredging or reclamation, impeding fish passage, damaging marine vegetation and de-snagging under the <i>Fisheries Management Act 1994</i>. Contact I&I NSW (Fisheries) for further information.</p> <p>Under the <i>National Parks and Wildlife Act 1974</i> all Aboriginal relics and places in NSW are protected. For further information contact the NRCMA.</p>
Water extraction	Water extraction for stock and domestic purposes is permitted without a license under the <i>Water Management Act 2000</i> . At the time of publication, landholders were allowed to harvest 10% of the annual runoff from the properties without a need for license under the <i>Water Management Act 2000</i> . However, a water sharing plan is currently being developed for ground water aquifers, and regulated and unregulated rivers and streams, which will determine how and in what proportions water resources will be allocated to water users and the environment. Contact DECCW for further information.
Works around flood mitigation sites	Under the <i>Water Management Act 2000</i> , DECCW is responsible for flood mitigation assets. By arrangement with DECCW, CVC is responsible for conducting works on, in and/or around flood mitigations asset sites, including levee banks and riparian plantings. This does not include privately owned structures. These assets are therefore protected and individual landholders are not permitted to carry out any activities to affect or alter these sites without approval from CVC or the Minister for Primary Industries.

Landuse and development are regulated under the *Environmental Planning and Assessment Act 1979* and the following policy framework related to riparian management:

- Former Copmanhurst Shire Council Local Environmental Plan (LEP) 1990
- Former Grafton City Council LEP 1988
- Former Maclean Shire Council LEP 2001
- Former Pristine Waters Shire - Nymboida LEP 1986
- Ulmarra LEP 1992 - Amendment No 5
- Clarence Valley Council Biodiversity Strategy (in preparation)
- Clarence Valley Council Bush Fire Risk Management Plan
- Clarence Valley Council Drain Management Plans
- Clarence Valley Council Estuary Management Plan 2003
- Clarence Valley Council Flying Fox Habitat Strategy
- Northern Rivers Regional Strategy
- Northern Rivers Catchment Action Plan
- North Coast Regional Environmental Plan 1988
- State Environmental Planning Policies (SEPP) No. 14 – Coastal Wetlands (1985)
- SEPP No. 19 – Bushland in Urban Areas (1986)

Further information

- Australasian Legal Information Institute: www.austlii.edu.au
- Department of Environment, Climate Change and Water (2009) *Native vegetation Information sheets*. www.environment.nsw.gov.au/vegetation/publications.htm
- Environmental Defender's Office Ltd NSW (2008) *Rural Landholders Guide to Environmental Law in NSW*
- Environmental Defender's Office Ltd NSW (2009) *Fact sheets*. www.edo.org.au/edonsw/site/factsheets.php

Appendix 4: Threatened Species, Populations and Communities

The following table lists the threatened species as specified in the *Threatened Species Conservation Act 1995* (TSC Act) and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The bird section also includes species listed under International Conventions (MBA), including the Japan-Australia Migratory Bird Agreement (JAMBA), China-Australia Migratory Bird Agreement (CAMBA) and the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

Common Name	Scientific Name	TSC Act	EPBC Act
Shrubs			
Acalypha	<i>Acalypha eremorum</i>	E1	E
Banyabba Grevillea	<i>Grevillea banyabba</i>	V	V
Beadle's Grevillea	<i>Grevillea beadleana</i>	E1	E
Bertya	<i>Bertya</i> spp.	E	E
Bordered Guinea Flower	<i>Hibbertia marginate</i>	V	V
Broad-leaved Pepperbush	<i>Tasmannia purpurascens</i>	V	V
Brush Sauropus	<i>Phyllanthus microcladus</i>	E1	E
Coolabah Bertya	<i>Bertya</i> spp. <i>Cobar-Coolabah</i>	V	V
Creek Triplarina	<i>Triplarina imbricate</i>	E1	E
Dorrigo Daisy Bush	<i>Olearia flocktoniae</i>	E1	E
Dwarf Heath Casuarina	<i>Allocasuarina defungens</i>	E1	E
Floyd's Ziera	<i>Zieria floydii</i>	E1	E
Fragrant Pepperbush	<i>Tasmannia glaucifolia</i>	V	V
Gibraltar Grevillea	<i>Grevillea rhizomatosa</i>	V	V
Glanugie Karaka	<i>Corynocarpus rupestris</i>	V	V
Granite Homoranthus	<i>Homoranthus prolixus</i>	V	V
Grove's Paperbark	<i>Melaleuca groveana</i>	V	V
Guthrie's Grevillea	<i>Grevillea guthrieana</i>	V	E
Gympie Stinger	<i>Dendrocnide moroides</i>	E1	E
Hairy Melichrus	<i>Melichrus hirsutus</i>	E1	E
Headland Zieria	<i>Zieria prostrata</i>	E1	E
Heart-leaved Star Hair	<i>Astrotricha cordata</i>	E1	E
Mason's Grevillea	<i>Grevillea masonii</i>	E1	E
Montane Green Five-corners	<i>Styphelia perileuca</i>	V	V
Moonee Quassia	<i>Quassia</i> spp. 'Moonee Creek'	E1	E
Nabiac Casuarina	<i>Allocasuarina simulans</i>	V	V
Narrow-leaf Melichrus	<i>Melichrus</i> spp. 'Gibberagee'	E1	E
Nettled Bottle Brush	<i>Callistemon linearifolius</i>	V	V
Nightcap Plectranthus	<i>Plectranthus nitidus</i>	E1	E
Nymboida Babingtonia	<i>Babingtonia prominens</i>	E1	E
Orara Boronia	<i>Boronia umbellate</i>	V	V
Pygmy Cypress Pine	<i>Callitris oblonga</i>	V	V
Rainforest Cassia	<i>Senna acclinis</i>	E1	E
Rupp's Wattle	<i>Acacia ruppii</i>	E1	E
Scant Pomaderris	<i>Pomaderris queenslandica</i>	E1	E
Shannon Creek Boronia	<i>Boronia hapalophylla</i>	E1	E
Silver Indigo	<i>Indigofera leucotricha</i>	E1	E
Silverbush	<i>Sophora tomentose</i>	E1	E
Square-stemmed Olax	<i>Olax angulata</i>	V	V
Sweet Myrtle	<i>Gossia fragrantissima</i>	E1	E
Swamp Mint-bush	<i>Prostanthera palustris</i>	V	V
Tall Velvet Sea-berry	<i>Haloragis exalata</i> subspp. <i>Velutina</i>	V	V
Thorny Pea	<i>Desmodium acanthocladum</i>	V	V
Torrington Beard-heath	<i>Leucopogon confertus</i>	E1	E
Trees			
Banyabba Shiny-barked Gum	<i>Eucalyptus pachycalyx</i>	E1	E
Durobby	<i>Syzygium moorei</i>	V	V
Gibraltar Mallee	<i>Eucalyptus dissita</i>	V	V
Green-leaved Rose Walnut	<i>Endiandra muelleri</i> subspp. <i>Bracteata</i>	E1	E
Narrow-leaved Rose Walnut	<i>Eucalyptus nicholii</i>	V	V
Rough-shelled Bush Nut	<i>Macadamia tetraphylla</i>	V	V

Common Name	Scientific Name	TSC Act	EPBC Act
Rusty Plum	<i>Amorpha sp.</i>	V	V
Rusty Rose Walnut	<i>Endiandra hayesii</i>	V	V
Sandstone Rough-barked Apple	<i>Angophora robur</i>	V	V
Scented Acronychia	<i>Acronychia littoralis</i>	E1	E
Square-fruited Ironbark	<i>Eucalyptus tetrapleura</i>	V	V
Weeping Paperbark	<i>Melaleuca irbyana</i>	E1	E
White Laceflower	<i>Archidendron hendersonii</i>	V	V

Mallees

Border Mallee	<i>Eucalyptus microcodon</i>	E1	E
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Epiphytes and Climbers

Arrow-head Vine	<i>Tinospora tinoporoides</i>	V	V
Cryptic Forest Twiner	<i>Tylophora woollsii</i>	E1	E
Milky Silkpod	<i>Parsonia dorriigoensis</i>	V	V
Slender Marsdenia	<i>Marsdenia longiloba</i>	E1	E
Tinospora Vine	<i>Tinospora smilacina</i>	E1	E
White-flowered Wax Plant	<i>Cynanchum elegans</i>	E1	E

Ferns and Cycads

Basket Fern	<i>Drynaria rigidula</i>	E1	E
Johnson's Cycad	<i>Macrozamia johnsonii</i>	E1	E
Narrow-leaf Finger Fern	<i>Grammitis stenophylla</i>	E1	E
Slender Screw Fern	<i>Lindsaea incisa</i>	E1	E

Orchids

Brown Butterfly Orchid	<i>Sarcochilus dilatatus</i>	E1	E
Hartman's Sarcochilus	<i>Sarcochilus hartmannii</i>	V	V
Lady Tankerville's Swamp Orchid	<i>Phaius tankervilleae</i>	E1	E
Leafless Tongue Orchid	<i>Cryptostylis hunteriana</i>	V	V
Red-flowered King of the Fairies	<i>Oberonia titania</i>	V	V
Southern Swamp Orchid	<i>Phaius australis</i>	E1	E
Spider Orchid	<i>Dendrobium melaleucaphilum</i>	E1	E

Herbs and Forbs

Ancistrachne maidenii	<i>Ancistrachne maidenii</i>	V	V
Austral Toadflax	<i>Thesium australe</i>	V	V
Bluegrass	<i>Dichanthium setosum</i>	V	V
Blumea lacera	<i>Blumea lacera</i>	E4	-
Hairy Jointgrass	<i>Arthraxon hispidus</i>	V	V
Heath Wrinklewort	<i>Rutidosis heterogama</i>	V	V
Lemon-scented Grass	<i>Elyonurus citreus</i>	E1	E
Maundia triglochinos	<i>Maundia triglochinos</i>	V	V
Mountain Angelica	<i>Gingidia Montana</i>	E1	E
Native Milkwort	<i>Polygala linariifolia</i>	E1	E
Noah's False Chickweed	<i>Lindernia alsinoides</i>	E1	E
Sand Spurge	<i>Chamaesyce psammogeton</i>	E1	E
Small Pale Grass0lily	<i>Caesia parviflora var. minor</i>	E1	E
Square-stemmed Spikerush	<i>Eleocharis tetraquetra</i>	E1	E
Stinky Lily	<i>Typhonium spp. aff. brownie</i>	E1	E
Swamp Foxglove	<i>Centranthera cochinchinensis</i>	E1	E
Tall Knotweed	<i>Persicaria elatior</i>	V	V
Tenterfield Eyebright	<i>Euphrasia orthocheila</i> subspp. <i>Peraspera</i>	E1	E
Trailing Woodruff	<i>Asperula asthenes</i>	V	V
Water Nutgrass	<i>Cyperus aquatilis</i>	E1	E

Aquatic Plants

Waterwheel Plant	<i>Aldrovanda vesiculosa</i>	E1	E
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Marsupials

Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>	V	V
Brush-tailed Rock-wallaby	<i>Petrogale penicillata</i>	E1	E
Common Planigale	<i>Planigale maculate</i>	V	V

Common Name	Scientific Name	TSC Act	EPBC Act
Eastern Pygmy-possum	<i>Cercartetus nanus</i>	V	V
Koala	<i>Phascolarctos cinereus</i>	V	V
Long-nosed Potoroo	<i>Potorous tridactylus</i>	V	V
Parma Wallaby	<i>Macropus parma</i>	V	V
Red-legged Pademelon	<i>Thylogale stigmatica</i>	V	V
Rufous Bettong	<i>Aepyprymnus rufescens</i>	V	V
Spotted-tailed Quoll	<i>Dasyurus maculates</i>	V	V
Squirrel Glider	<i>Petaurus norfolcensis</i>	V	V
Yellow-bellied Glider	<i>Petaurus australis</i>	V	V

Marine Mammals

Australian Fur-seal	<i>Arctocephalus pusillus doriferus</i>	V	V
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Rodents

Eastern Chestnut Mouse	<i>Pseudomys gracilicaudatus</i>	V	V
Hastings River Mouse	<i>Pseudomys oralis</i>	E1	E
Pilliga Mouse	<i>Pseudomys pilligaensis</i>	V	V
Sandy Inland Mouse	<i>Pseudomys hermannsburgensis</i>	V	V

Bats

Beccari's Freetail-bat	<i>Mormopterus beccarii</i>	V	V
Common Blossom-bat	<i>Syconycteris australis</i>	V	V
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	V	V
Eastern Cave Bat	<i>Vespadelus troughtoni</i>	V	V
Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>	V	V
Eastern Freetail-bat	<i>Mormopterus norfolkensis</i>	V	V
Eastern Long-eared bat	<i>Nyctophilus bifax</i>	V	V
Golden-tipped Bat	<i>Kerivoula papuensis</i>	V	V
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	V	V
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	V	V
Hoary Wattled Bat	<i>Chalinolobus nigrogriseus</i>	V	V
Large-Eared Pied Bat	<i>Chalinolobus dwyeri</i>	V	V
Large-footed Myotis	<i>Myotis macropus</i>	V	V
Little Bentwing-bat	<i>Miniopterus australis</i>	V	V
Yellow-bellied Sheathtail-bat	<i>Saccolaimus flaviventris</i>	V	V

Reptiles

Fierce Snake	<i>Oxyuranus microlepidotus</i>	E4	-
Green Turtle	<i>Chelonia mydas</i>	V	V
Leathery Turtle	<i>Dermochelys coriacea</i>	V	V
Loggerhead Turtle	<i>Caretta caretta</i>	E1	E
Pale-headed Snake	<i>Hoplocephalus bitorquatus</i>	V	V
Stephens' Banded Snake	<i>Hoplocephalus stephensii</i>	V	V
Three-toed Snake-Tooth Skink	<i>Coeranoscincus reticulatus</i>	V	V
White-crowned Snake	<i>Cacophis harriettae</i>	V	V

Amphibians

Booroolong Frog	<i>Litoria booroolongensis</i>	E1	E
Giant Barred Frog	<i>Mixophyes iterates</i>	E1	E
Glandular Frog	<i>Litoria subglandulosa</i>	V	V
Green-thighed Frog	<i>Litoria brevipalmata</i>	V	V
Loveridge's Frog	<i>Phyllorhina loveridgei</i>	V	E
Mountain Frog	<i>Phyllorhina kundagungan</i>	V	E
Olongburra Frog	<i>Litoria olongburensis</i>	V	V
Peppered Frog	<i>Litoria piperata</i>	V	V
Sphagnum Frog	<i>Phyllorhina sphagnicolus</i>	V	V
Stuttering Barred Frog	<i>Mixophyes balbus</i>	E1	E
Wallum Froglet	<i>Crinia tinnula</i>	V	V

Invertebrates

Giant Dragonfly	<i>Petalura gigantean</i>	E1	E
Nurus Brevis Beetle	<i>Nurus brevis</i>	E1	-

Common Name	Scientific Name	TSC Act	EPBC Act	MBA
Birds				
Albert's Lyrebird	<i>Menura alberti</i>	V	V	
Australasian Bittern	<i>Botaurus poiciloptilus</i>	V	V	
Barking Owl	<i>Ninox connivens</i>	V	V	
Barred Cuckoo-shrike	<i>Coracina lineate</i>	V	V	
Bar-tailed Godwit	<i>Limosa lapponica</i>	-	-	✓
Beach Stone-curlew	<i>Esacus neglectus</i>	E1	E	
Black Bittern	<i>Ixobrychus flavicollis</i>	V	V	
Black-breasted Buzzard	<i>Hamirostra melanosternon</i>	V	V	
Black-browed Albatross	<i>Thalassarche melanophris</i>	V	V	
Black-chinned Honeyeater	<i>Melithreptus gularis gularis</i>	V	V	
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	E1	E	
Black-tailed Godwit	<i>Limosa limosa</i>	V	V	✓
Broad-billed Sandpiper	<i>Limicola falcinellus</i>	V	V	✓
Brolga	<i>Grus rubicunda</i>	V	V	
Brown Treecreeper	<i>Climacteris picumnus victoriae</i>	V	V	
Bush Stone-curlew	<i>Burhinus grallarius</i>	E1	E	
Bush-hen	<i>Amauromis olivaceus</i>	V	V	
Cattle Egret	<i>Bubulcus ibis</i>	-	-	✓
Comb-crested Jacana	<i>Irediparra gallinacean</i>	V	V	
Common Greenshank	<i>Tringa nebularia</i>	-	-	✓
Cotton Pygmy-goose	<i>Nettapus coromandelianus</i>	E1	E	
Diamond Firetail	<i>Stagonopleura guttata</i>	V	V	
Flesh-footed Shearwater	<i>Puffinus carneipes</i>	V	V	✓
Fork-tailed Swift	<i>Apus pacificus</i>	-	-	✓
Freckled Duck	<i>Stictonetta naevosa</i>	V	V	
Glossy Black-cockatoo	<i>Calyptorhynchus lathami</i>	V	V	
Glossy Ibis	<i>Plegadis falcinallus</i>	-	-	✓
Gould's Petrel	<i>Pterodroma leucoptera leucoptera</i>	E1	E	
Grass Owl	<i>Tyto capensis</i>	V	V	
Great Egret	<i>Ardea alba</i>	-	-	✓
Great Knot	<i>Calidris tenuirostris</i>	V	V	✓
Greater Sand-plover	<i>Charadrius leschenaultii</i>	V	V	✓
Ground Parrot	<i>Pezoporus wallicus wallicus</i>	V	-	✓
Grey Falcon	<i>Falco hypoleucos</i>	V	V	
Grey-crowned Babbler	<i>Pomatostomus temporalis temporalis</i>	V	V	
Hooded Plover	<i>Thinornis rubricollis</i>	E1	E	
Latham's Snipe	<i>Gallinago hardwickii</i>	-	-	✓
Lesser Sand-plover	<i>Charadrius mongolus</i>	V	V	✓
Little Shearwater	<i>Puffinus assimilis</i>	V	V	
Little Tern	<i>Sterna albifrons</i>	E1	E	✓
Magpie Goose	<i>Anseranas semipalmata</i>	V	V	
Mangrove Honeyeater	<i>Lichenostomus fasciolaris</i>	V	V	
Marbled Frogmouth	<i>Podargus ocellatus</i>	V	V	
Marsh Sandpiper	<i>Tringa stagnatilis</i>	-	-	✓
Masked Owl	<i>Tyto novaehollandiae</i>	V	V	
Olive Whistler	<i>Pachycephala olivacea</i>	V	V	
Osprey	<i>Pandion haliaetus</i>	V	V	✓
Pacific Golden Plover	<i>Pluvialis fluva</i>	-	-	✓
Painted Snipe	<i>Rostratula benghalensis</i>	E1	E	✓
Pied Oystercatcher	<i>Haematopus longirostris</i>	V	V	
Powerful Owl	<i>Ninox strenua</i>	V	V	
Rainbow Bee-eater	<i>Merops ornatus</i>	-	-	✓
Red Goshawk	<i>Erythrotriorchis radiatus</i>	E1	E	
Red-tailed Black-cockatoo	<i>Calyptorhynchus banksii</i>	V	V	✓
Red-tailed Tropicbird	<i>Phaethon rubricauda</i>	V	V	
Regent Honeyeater	<i>Xanthomyza Phrygia</i>	E1	E	✓
Rose-crowned Fruit-dove	<i>Ptilinopus regina</i>	V	V	
Rufous Scrub-bird	<i>Atrichornis rufescens</i>	V	V	
Sanderling	<i>Calidris alba</i>	V	V	✓
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>	-	-	✓
Shy Albatross	<i>Thalassarche cauta</i>	V	V	

Common Name	Scientific Name	TSC Act	EPBC Act	MBA
Sooty Owl	<i>Tyto tenebricosa</i>	V	V	
Sooty Oystercatcher	<i>Haematopus fuliginosus</i>	V	V	
Sooty Tern	<i>Sterna fuscata</i>	V	V	
Southern Giant-petrel	<i>Macronectes giganteus</i>	E1	E	✓
Speckled Warbler	<i>Pyrrholaemus saggitatus</i>	V	V	
Square-tailed Kite	<i>Lophoictinia isura</i>	V	V	
Star Finch	<i>Neochmia ruficauda ruficauda</i>	E4	-	
Superb Fruit-dove	<i>Ptilinopus superbus</i>	V	V	
Swift Parrot	<i>Lathamus discolor</i>	E1	E	
Terek Sandpiper	<i>Xenus cinereus</i>	V	V	✓
Turquoise Parrot	<i>Neophema pulchella</i>	V	V	
Whimbrel	<i>Numenius phaeopus</i>	-	-	✓
White-bellied Sea Eagle	<i>Haliaeetus leucogaster</i>	-	-	✓
White Tern	<i>Gygis alba</i>	V	V	
White-eared Monarch	<i>Monarcha leucotis</i>	V	V	
White-throated Needle-tail	<i>Hirundapus caudacutus</i>	-	-	✓
Wompoo Fruit-dove	<i>Ptilinopus magnificus</i>	V	V	

Endangered Populations

- Emu population – E2
- Tusked Frog population – E2
- Endangered Ecological Communities
- Coastal Salt Marsh
- Freshwater Wetlands on Coastal Floodplain
- Littoral Rainforest
- Lowland Rainforest on Floodplain
- New England Peppermint Woodland on Sediments
- Subtropical Coastal Floodplain Forest
- Swamp Oak Floodplain Forest
- Swamp Sclerophyll Forest on Coastal Floodplain
- White Box – Yellow Box – Blakely's Red Gum Woodland

Key Threatening Processes

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands
- Anthropogenic climate change
- Bushrock removal
- Clearing of native vegetation
- Competition and grazing by the feral European Rabbit
- Competition and habitat degradation by Feral Goats
- Competition from feral honeybees
- Death or injury to marine species following capture in shark control programs on ocean beaches
- Entanglement in or ingestion of anthropogenic debris in marine and estuarine environments
- Herbivory and environmental degradation caused by feral deer
- High frequency fire resulting in the disruption of life cycle processes in plants and animal and loss of vegetation structure and composition
- Importation of Red Imported Fire Ants
- Infection of frogs by amphibian chytrid causing the disease chytridiomycosis
- Infection of native plants by *Phytophthora cinnamomi*
- Introduction of the Large Earth Bumblebee
- Invasion of native plant communities by *Chrysanthemoides monilifera*
- Invasion of native plant communities by exotic perennial grasses
- Loss and/or degradation of sites used for hill-topping by butterflies
- Predation by *Gambusia holbrooki*, Plague Minnow or Mosquito Fish
- Predation by the European Red Fox
- Predation by the Feral Cat
- Predation, habitat degradation, competition and disease transmission by Feral Pigs
- Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species and populations
- Removal of dead wood and dead trees