‘Riparian – it’s just a vibe’: Developing definitions for management and mapping

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Key points

- Clear workable definitions for riparian zones are needed for effective management.
- The influence of riparian vegetation on controlling riverbank erosion varies and a fixed buffer width does not encapsulate this.
- Riparian zones should be divided into proximal and distal management areas, with proximal being on or near the bank where there is greatest interaction between terrestrial and aquatic zones.
- Processes of riverbank erosion can be used to guide areas where and how riparian vegetation has the greatest influence.

Abstract

Standardised condition assessment and rehabilitation monitoring methods are currently being developed for rivers across Queensland. These techniques, as well as things like carbon and biodiversity markets, often refer to riparian areas. The term riparian has a range of definitions and riparian zones are rarely mapped based on components and processes so that they can be quantified. Instead, standard buffer widths are typically applied. This has resulted in confusion about what exactly is being managed and why. As part of our current work, we have collated the uses of the word riparian in Queensland and Commonwealth Legislation to see how it is applied. A review was also made of different definitions used in peer reviewed and grey literature. Based on the review an interim definition of riparian was developed to support the needs in Queensland for riparian condition assessment and rehabilitation. A method also is outlined for delineating the proximal riparian zone, which has the greatest influence on the ecosystem service of regulation of bank erosion by vegetation. The delineation of a proximal zone has been considered both spatially and temporally to help managers understand variability in the effects that riparian vegetation may have on influencing riverbank erosion processes. This can then better inform riparian zone delineation and more effectively enact existing legislation.

Keywords

Riparian definition, Riverbank erosion, Riparian mapping, Ecotone, Aquatic transition zone

Introduction

A new Queensland Condition Assessment Tool (CAT) for Natural Resource Managers was initially intended to be a Riparian CAT. This was in response to river management actions often occurring in the riparian zone. However, the ambiguity in the definition of riparian (Dodds et al., 2025) led to confusion about the spatial extent and features that were to be included in the CAT. Were just the riverbanks being included, or was the whole floodplain being assessed?

To address the confusion associated with the term ‘riparian’, which is so widely used in river management, the DETSI Queensland River Management Program (QRMP) sought to clarify its meaning to allow consistency in communication with respect to the Queensland context. This work briefly reviews different definitions of riparian. It also outlines how the term is used in legislation and policy.

Currently for management in Queensland 'the riparian area as any area within 50 metres of a (mapped) stream, or riverine/lacustrine wetland' (Healy & Tindall, 2019), a definition which is strongly influenced by the QLD Vegetation Management Act 1999 that seeks to protect regulated vegetation within a buffer distance from the 'defining banks' (DESI, 2024). However, there is no consistent spatial dataset of the defining bank, or definition to support its delineation based on form and/or processes.

River management actions occurring in the riparian zone often involve re-establishing native vegetation to mitigate erosion processes. Some guidance on riparian vegetation widths was provided by Abernethy & Rutherfurd (1999) which included how to determine widths for stabilising banks when the bed was stable based on bank height. This work will outline a process-based approach to defining riparian zones relevant to management actions by understanding the different roles that vegetation may play with respect to riverbank erosion. These different roles are then used to describe how relevant riparian buffers may change spatially and temporally in and on the bank, landward and downstream.

Variability in existing definitions of riparian

Thirty different definitions from dictionaries, academic literature and grey literature were identified; a similar review has also recently been undertaken by Dodds et al. (2025). While riparian can refer to many different waterbodies the scope of this review was for rivers. The review identified that it is the interface between land and river, that is a riverbank or relates to the riverbank (Australian Water Information Dictionary, Merriam-Webster online dictionary). It has been defined as including the riverbed (DETSI, 2026), riverbank (Naiman & Decamps, 1997), and floodplain (Verry et al., 2004). They can also be variable both spatially and temporally (Capon & Dowe, 2007). However, Lovett & Price (1999) suggest that there is reciprocity between watercourses and land, with the riparian zone influencing and being influenced by the channel. However, they also point out that there is no rule of nature that defines riparian widths, and they are; therefore, often determined by management objectives.

The use of the term riparian in legislation and policy that influences Queensland river management

The Federal Register of Legislation was searched for text containing the phrase 'riparian'. There were 46 results that were mainly focused on law relevant to environmental protection or water entitlements. For example, the Murray-Darling Basin Amendment Act 2003 includes 'Natural diversity of habitats and biota within the river channel, riparian zone and the floodplain should be maintained or enhanced.'

Queensland legislation (https://www.legislation.qld.gov.au/search/) was also searched for the word 'riparian', producing 26 results. Most of these results (16 of 26) were part of Water Plans for various river basins. These Plans seek to maintain and support the functions that riparian systems perform, they also consider the impact on riparian vegetation of proposed changes to water use, alongside other values that may be influenced.

In both these searches of legislation although 'riparian' is mentioned it is not defined. This is an effective way to write legislation as it can leverage the best or most recent knowledge to support the law. However, this again highlights that there need to be logical and effective definitions that sit alongside the legislation.

An interim working definition of riparian zones for managers

The wealth of different interpretations to what is considered riparian alongside the use, but limited definition, of the term in legislation resulted in the QRMP creating a standardised definition that could be used by QLD natural resource managers.

> *Riparian zones represent the interface between terrestrial and freshwater aquatic ecosystems, and influence or are influenced by water from the channel, floodplain or groundwater. These areas are often, but not always, distinguished by landforms, hydrology, vegetation, and soils.*

While this is a deliberately general definition it is intended to suggest that the riparian areas are not only identified by vegetation, and that they are not solely riverbanks in the highly diverse types of rivers across Queensland. The definition allows for the floodplain to be included; however, this is often too extensive to be the focus of river management works. To allow for this disparity it is suggested that a proximal (near to the river) and distal (far from the river) zone be considered as separate management entities. The proximal area is often what is being considered when the riparian zone is discussed with respect to its influence on bank erosion. The proximal zone should be mapped based on the processes and outcomes that management works are set out to achieve. The attributes that influence and can delineate riparian areas have been outlined by Dodds et al. (2025). The strength of influence of the attributes on the riparian zone, or how the river influences the variable, often drop off sharply with distance landward from the river. However, the ability to include a distal riparian zone means that the functions that it performs are not excluded even though they may not be priorities for investment by catchment managers.

Defining the proximal riparian zone based on the ecosystem service of regulation of bank erosion by vegetation

In this work we have considered the ecosystem services provided by vegetation in riparian zones as related to the use of revegetation to control riverbank erosion rates. The components and processes related to this ecosystem service, and how they operate spatially with different landforms, can define a proximal riparian zone for vegetation management. The riparian proximal zone can provide numerous ecosystem services, such as habitat, water quality regulation, microclimate regulation (shading), and food subsidies among many others (Capon & Petit, 2018). Although these are not part of this work, they may be considered separately to define relevant riparian zones for these services.

Taking the simple case of a single channel, laterally migrating stream, it would be expected that on the outside of a meander bend there would be a steep eroding bank. The proximal riparian zone in this case would play a role in the physical processes of the stream. There are three main cases of riverbank heights with vertical bank faces (Table 1) that could be considered in terms of the relationship between the river processes and vegetation:

1. The bank is less than 2 m, is dominated by sub-aerial preparation and fluvial entrainment (Lawler et al., 1999)
2. The bank between 2m and 10 m, mass failure can occur as well as sub-aerial preparation and fluvial entrainment
3. The bank is > 10 m and very low densities of tree roots are likely to extend to the toe of the bank (Docker and Hubble, 2008; Dodds et al., 2025)

Table 1 Different riverbank erosion processes on a vertical bank influenced by riparian vegetation

Vertical bank height (m)	Root depth	Location of proximal zone	Indicative proximal zone widths	Dominant riverbank erosion processes	Riparian vegetation geomorphic influence
<= 2	Floodplain surface to baseflow	Bank face and proximal floodplain surface (radius of dominant root ball width)	10 m	Fluvial entrainment, sub-aerial preparation and erosion	Root hydraulic resistance on bank surface, including abutments (Rutherfurd & Grove, 2004)
2-10	Floodplain surface to baseflow	Bank face, proximal floodplain surface and subsurface to baseflow	30 m Maximum landward extent of mass failures	Mass failure and fluid entrainment	Soil buttressing; bank drainage modification; surcharge; and root reinforcement (Abernethy & Rutherfurd, 1998)

Vertical bank height (m)	Root depth	Location of proximal zone	Indicative proximal zone widths	Dominant riverbank erosion processes	Riparian vegetation geomorphic influence
>10 m	Floodplain surface to 10 m	Subsurface to baseflow extent that can have moisture conditions reduced by vegetation.	>30 m – extent of distal zone or floodplain width	Fluid entrainment, and mass failure	Bank drainage modification and root reinforcement

Vertical bank heights change as the sediment becomes more cohesive, and so the dominant erosion processes alter alongside the role that vegetation plays. In low vertical/steep eroding banks, the effects of exposed roots may be the main influence of vegetation, reducing the shear stress on the bank surface (Rutherfurd & Grove, 2004), and so the width of the proximal riparian zone would depend on the extent of the roots provided by vegetation growing on the floodplain surface. As the vegetation could be destabilised and collapsed into the river once a significant proportion of the root ball is exposed, it is assumed that the zone from the bank face would only be the radius of the root ball (or the canopy of the associated tree if broader). This distance would also represent the influence of the tree on subaerial erosion and preparation processes, reducing desiccation for example (Couper, 2003). Considering the River Red Gum (*Eucalyptus camaldulensis*), a common riparian tree species, Ellis et al. (2018) found for the Bogan and Macquarie Rivers in the Murray-Darling Basin that canopy widths of 529 lives trees ranged from 3-25 m, or radii of 1.5-12.5.

As the bank height increases, mass failures will become an influential process, but the cohesion of the bank material may limit the density and extents of vegetation roots. However, the cohesion and buttressing effects of roots would still influence the development of failure planes and tension cracking (Darby & Thorne, 1994), slowing or halting some mass failures. The evapotranspiration, and alteration of interception and flow paths via stems and roots would alter the riverbank drainage (Simon & Collison, 2002) and can increase the factor of safety for the riverbank.

The proximal buffer zone that would have a strong influence on the process of mass failure would depend on the type and size of the failures. Changes in soil moisture conditions would be both at the individual tree scale and cumulative over the floodplain. Failures that do not extend far landward, such as slab failures (Simon, 1989), could be influenced by the dimensions of a single tree root ball. Larger rotational failures may be large enough to include trees on the failure surface and would therefore require multiple root balls to effectively interact with the failure, or else risk surcharging the failure (Zu & Hubble, 2026). Hubble et al. (2010) suggested that for the Nepean River critical failure surfaces could extend around 30 m landward from the bank toe on a 10 m high bank if they were vegetated with trees, and 12 m landward on a vegetated 5 m high bank.

Less coherent failures, such wet flows (Grove et al., 2013), appear to have a lower root cohesion influence as they occur during periods when the soil is saturated. These periods of saturation would also overwhelm any influence vegetation may have reducing soil moisture through interception and evapotranspiration. The main influence of vegetation in these cases may be basal endpoint control (Thorne & Tovey, 1981), reducing the rate of undercutting of the bank toe.

In very high vertical banks, such as those found in macrochannels (Croke et al., 2014), the effect of tree root balls is decreased. Basal protection on the bank toe is minimal, and failures planes can reach under the root zone. The main influence of vegetation in these situations would be to manage the moisture conditions within the bank and reduce tension cracking on the floodplain surface. It may be that understorey vegetation can play a role in reducing tension cracking if there is sufficient ground coverage.

These hypothetical situations help understand the variability in interactions with bank height and erosion processes. Switching vegetation effectiveness, to floodplain sub-surface and surface processes as bank height increases. In cases where the riverbank has a slope that can support vegetation, the riparian zone processes change and resistance to erosion is also provided by the above ground vegetation. For example, flexible vegetation with a high volume of foliage, such as shrubs, with sufficient root strength to resist the surface drag without being dislodged, can play an important role in erosion control through reducing fluvial entrainment. Management actions to mitigate erosion processes can involve reshaping banks to install a slope suitable for vegetation establishment, enhancing the role of above ground vegetation in erosion management. This vegetation can also influence the moisture content in the sediment and so reduces the influence of vegetation on the floodplain surface. The extent of the proximal riparian zone in these situations would likely to be the extent of the riverbank.

Temporal changes in the role of the proximal riparian zone

The proximal riparian width can be mapped based on the processes and form (components) at a point in time. However, the forms and processes may significantly change temporally, both because of natural and anthropogenic disturbance. Catchment Evolution Models (CEMs) can aid in understanding how the channel may change over time and how this will influence the proximal riparian width and functions. For example, in an anabranching river system the process of avulsion creates a new channel on the floodplain (Schumm et al., 1996). This process will be used to exemplify the change in the role of vegetation from the initial state of a distal riparian zone (vegetated floodplain) to the development of a proximal one (channel banks of daughter channel). Understanding these changes can aid managers in considering not only the current conditions of the river system but also the expectation of how it will change over time.

In an avulsion the daughter channel incises into the floodplain, overcoming the surface resistance provided by vegetation and the substrate. This may occur as the result of a headcut undermining existing vegetation cover. As the channel deepens and widens it may progress through the following stages:

1. Initial incision: erosion of the bed and banks through fluvial entrainment. The proximal zone would initially develop by providing initial flow resistance on the surface. Then as the incision develops the exposure of roots would slow the rate of both incision and widening.
    a. Proximal Riparian Zone: surface - bankface root zone
2. Continued incision: reaches a critical height, then mass failure may increase the rate of widening. Assuming steep to vertical banks, the cohesion of the soil provided by roots, and the regulating effect of evapotranspiration on soil moisture become influential.
    a. Proximal Riparian Zone: subsurface - floodplain subsurface tree root zone
3. Lateral erosion: the process of lateral erosion becomes the dominant process. As this occurs the channel develops steep eroding banks and more gently sloping or complex slope banks. This would mean that on steep banks that are dominated by floodplain vegetation providing bank surface root flow resistance. The shallower banks are dominated by surface vegetation resistance (drag) and the bank toe.
    a. Proximal Riparian Zone: above ground – foliage hydraulic resistance or surface and bank face root zone

Understanding these changes that may occur in an undisturbed system, can aid the understanding of what may occur if the potential for a vegetated proximal riparian zone is removed by vegetation clearance in an area prone to avulsion. In this case it would be likely be faster development of the avulsion with flow events delivering higher amounts of sediment than in a vegetated state.

Conclusions

The development of many different meanings of the term riparian, and the fact that the term is embedded into law and policy, means where possible standard definitions should be used for management. The ‘riparian zone’ or ‘buffer width’ are commonly used terms in river management and are often determined by fixed widths from the river centreline, bank toe, or bank top. It is recommended that when managing the riparian areas that a clear delineation is made between the total riparian extent (distal riparian zone) that may be defined by the hydrology, vegetation, and soils that indicate the interaction of aquatic and terrestrial systems and the proximal zone which has the greatest influence on the channel.

Rather than using a fixed width to delineate the proximal zone, the approach suggested here is that a more process-based approach could be taken. The ecosystem service focused on was the regulation of bank erosion by vegetation. This may not always require the delineation of the bank top, rather the relative elevation of the floodplain surface to the channel baseflow. Where possible the type and landward extent of mass failures should be identified, and some rule sets are needed to determine the optimal vegetation buffer extents that influence these failures.

Missing from this work is the inclusion of the rate of migration of river systems, which need to be better evaluated across Queensland. A proximal riparian zone that is based on a static river system is unlikely to achieve management goals, hence Abernethy and Rutherfurd (1999) included a distance estimated by the rate of migration multiplied by the time to vegetation establishment. Other effects of vegetation such as in controlling runoff and hydraulics at varying scales have also been excluded for simplicity.

It is hoped that better clarity in the definition and mapping of riparian zones will lead to more effective management outcomes and application of legislation.

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