7.8 Riparian protection/streambank erosion control

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Preamble: Riparian streambank protection or 'treatment' may occur through a range of techniques including hard engineering approaches such as rip rap, groynes, dykes, gabion baskets, with soil bioengineering such as brush layering, fascines, and plantings.

State of knowledge of "Riparian protection / streambank erosion control" attribute: Good / established but incomplete

Good state of knowledge because we understand the process, there are quite a few studies and many observations of bank erosion in the field (though unlikely to be comprehensively recorded), and there is agreement on what stream bank erosion is, what riparian streambank protection is, and what the benefits are. However, there is little to no spatial coverage of either current active bank erosion or of riparian areas that have been 'protected' which currently limits this as a national attribute.

Part A—Attribute and method

A1. How does the attribute relate to ecological integrity or human health?

Established/vegetated riparian margins and stable streambanks can benefit the ecological integrity and human health of adjacent waterbodies in several ways. This attribute should be read in conjunction with Riparian margin establishment/protection attribute (Matheson 2024). The stream bank protection attribute focuses on ensuring stream bank soil is stabilised (either via hard engineered or nature-based (plant) solutions). Stable streambanks help reduce erosion and thus reduce sediment impacts in water bodies (Marden et al., 2005; Hughes 2016, 2021).

Streambank erosion is a natural geomorphic process (along with other erosion processes) which occurs in all channels as adjustments of channel size and shape are made to convey the discharge and sediment supplied from the stream or river catchment.

As a natural process, bank erosion is generally beneficial to the ecology of waterways, since erosion and deposition create a variety of habitats for flora and fauna which contributes to ecological diversity (Environment Agency 1999). Conversely, an increase in sediment supply due to accelerated stream bank erosion, which can often be linked to land-use change, is a major cause of non-point source pollution within river systems. In such cases mitigations (hard and soft engineering solutions) are required to reduce those impacts.

Stream bank erosion can be classified into two basic groups. Those dominated by gravitational or mechanical failures (mass movement) and those where hydraulic-induced failure mechanisms (fluvial erosion) dominate. Gravitational failures include both mass movement failures and individual grain failures. The two process groups are often linked (e.g., a hydraulic-induced mechanism, such as bank undercutting, can cause a gravitationally-induced collapse such as a cantilever failure). Identification of bank erosion processes, via a bank assessment survey, is important for determining suitable measurement techniques and for choosing appropriate remedial options. The conditions under which different processes occur are determined by bank material characteristics and local soil moisture conditions (O'Neill and Kuhns 1994).

Active stream bank erosion is often treated as part of river engineering and/or catchment management. Hard engineering approaches such as rip rap, groynes, dykes, gabion baskets, bank grading, crib walls, geotextiles, etc may be used singly or in combination with each other and in combination with soil bioengineering including brush layering, fascines, wattle fences, hydroseeding, planting, etc (e.g., Schiechtl & Stern 1994; Rey et al., 2018).

A2. What is the evidence of impact on (a) ecological integrity or (b) human health? What is the spatial extent and magnitude of degradation?

How well stable streambanks and riparian margins protect ecological integrity varies through space and time. Factors influencing this protection include upstream and upslope land use, rainfall, streamflow, geology, past land use and river history (legacy effects), storm frequency, protection/interventions, etc.

Often effects from unstable and eroding banks are felt locally though if bank erosion is extensive, it is a process that may contribute significantly (up to 100%) to the stream's sediment load (De Rose 1999; Hughes 2021). However, in New Zealand there is little data on the contribution of bank erosion to measured river sediment yields and it has been a relatively poorly studied process (Watson & Basher 2006; Hughes et al., 2021; De Rose & Basher 2011; Smith et al., 2019).

Since the establishment of Catchment Boards and later Regional Councils under the Soil Conservation and Rivers Control Act 1941, many rivers have been managed for flood protection. Much of this work relates to addressing issues of bank erosion. Thus, at least for the main stem of rivers on flood plains, councils will have a reasonable idea of where areas of bank erosion are, their severity, and the degree of controls in place. However, for smaller rivers and streams this information is unlikely to be known. There are no national inventories or surveys of bank erosion as catchment sources of sediment. This limits the effective implementation of nation-wide catchment prioritisation and rehabilitation measures.

Clearance of indigenous vegetation in the 19th and 20th centuries has accelerated erosion (including bank erosion) in many places in New Zealand. It is likely that many New Zealand catchments are still responding to these disturbances (Hughes 2021). Catchment-wide channel erosion in response to land disturbance is a widely reported occurrence (e.g., Wasson et al., 1998; Kondolf et al., 2002; Downs & Gregory 2004). Such disturbance-induced channel adjustment will continue until a new steady state is reached under the modified discharge and sediment supply regime (Harvey and Watson 1986).

A3. What has been the pace and trajectory of change in this attribute, and what do we expect in the future 10 - 30 years under the status quo? Are impacts reversible or irreversible (within a generation)?

As land use has changed, the associated hydrological regime in rivers changes. Hence regions that have experienced significant changes in land use or land use practices (vegetation removal, increased soil compaction, land drainage, etc) bank erosion is likely to have increased, e.g., Southland (Ellis et al., 2018; Poole 1990). In other areas where bank erosion has been identified and mitigation measures implemented, e.g., in many main stem rivers, bank erosion is likely to have declined. Many lowland rivers now have fully armoured channels and associated stop banks, mostly to reduce flooding risk, but also to reduce and loss of land by bank erosion (Brierley et al., 2023).

Climate change projections suggest increasing storminess in many regions indicating a concomitant increase in erosion is likely. How this will preference bank erosion over other erosion processes is unknown. Bank erosion has not generally been included in modelling exercises aimed at understanding climate change impacts, (e.g., Basher et al., 2020; Neverman et al., 2023) though it is represented in some sediment yield models such as SedNetNZ (Dymond et al., 2016).

Impacts are only partially or temporarily reversible. In short timescales (years to decades), hard engineering and soil bio-engineering (vegetation +/- hard engineering) will reduce and "treat" localities where bank erosion is prevalent, i.e., river engineering. At decadal to century timescales and in the most severe rain events, geomorphic thresholds are crossed and bank erosion may appear in places where it previously didn't exist and/or treated areas may be re-activated.

A4-(i) What monitoring is currently done and how is it reported? (e.g., is there a standard, and how consistently is it used, who is monitoring for what purpose)? Is there a consensus on the most appropriate measurement method?

This attribute is not routinely monitored either nationally or regionally.

Some councils may carry out periodic surveys and bank erosion assessments (e.g., as part of monitoring stream bank vegetation), e.g., Norris et al., (2020). Similarly, at much finer scales, many communities, catchment groups, and iwi undertake periodic stream and bank assessment surveys as part of catchment 'health' and cultural assessments.

There is no consistent methodology in use nor nationally agreed monitoring methodology for assessing bank erosion. Many approaches are qualitative or at best semi-quantitative. Similarly, there is unlikely to be any standard methodology to determine treatment monitoring.

A possible metric might be the length (or %) of a stream or river that has active bank erosion (often assessed as bank retreat) and the proportion of that active bank has been treated. Measures of bank erosion may also be incorporated into more general erosion and river bank vegetation surveys.

A4-(ii) Are there any implementation issues such as accessing privately owned land to collect repeat samples for regulatory informing purposes?

If this attribute were to be monitored it would require access to private land to firstly undertake a stream/bank assessment and secondly, determine what treatment has been carried out and if it was successful.

Unlike other erosion processes, remote sensing may not be as effective in monitoring stream bank erosion and its treatment largely because of spatial resolution, i.e., rivers and streams are linear features and eroding stream banks (and treated stream banks) may not be visible on typical aerial photographs or via other remote sensing methods, possibly with the exception of repeat LiDAR. Private land would also have to be accessed in order to validate any remote sensed mapping.

A4-(iii) What are the costs associated with monitoring the attribute? This includes up-front costs to set up for monitoring (e.g., purchase of equipment) and on-going operational costs (e.g., analysis of samples).

This attribute is not being routinely monitored and, therefore, costs are hard to assess.

Repeat or differential LiDAR might be a useful future methodology but currently this is very expensive relative to potential benefits.

A5. Are there examples of this being monitored by Iwi/Māori? If so, by who and how?

I am not aware of any monitoring being carried out by representatives of iwi/hapū/rūnanga. However, erosion is of very high interest to Māori and various hapū/iwi are focused on monitoring erosion and mitigating risk. Successful erosion control within the catchment is required to achieve the cultural aspirations of Ngāti Porou. See, for example, the Waiapu River Restoration project (Led by Te Rūnanganui o Ngāti Porou) that focuses on erosion in the Waiapu catchment https://www.ngatiporou.com/nati-news/the-waiapu-river-restoration. See also the Waiapu Koka Huhua initiative https://ourlandandwater.nz/wp-content/uploads/2022/02/TMOTW-Case-Study-Waiapu-Kokahuhua.pdf, where restoration ofriparian plantings is a key mitigation.

Bank erosion assessment may be included in iwi 'cultural health' monitoring of local streams.

Our Land & Water National Science Challenge has developed a "Register of Land Management Actions" (https://ourlandandwater.nz/project/register-of-land-management-actions/) which may include aspects of bank erosion treatment.

A6. Are there known correlations or relationships between this attribute and other attribute(s), and what are the nature of these relationships?

Stream bank erosion is correlated and can likely be grouped with other erosion processes, e.g., shallow landslide erosion, surface erosion, and gully erosion in assessments or models of erosion (e.g., NZEEM, HEL). It may or may not be directly correlated with the other listed land/soil attributes.

In the LUC/Land Resource Inventory the key/dominant erosion process for that polygon is described along with its severity, e.g., in LUC as Sb stream bank erosion (Lynn et al., 2021), along with secondary erosion processes. Severity is rated in 6 classes based on % of a reach in which stream bank erosion occurs along both banks and the lateral erosion or stream bank retreat (Lynn et al., 2021).

Part B—Current state and allocation options

B1. What is the current state of the attribute?

Current state of stream bank erosion is not well understood at the national scale (the process is well understood and locally/regionally its general distribution (or prominence as an erosion process) might be, at least for the main stem lowland rivers). Understanding in my opinion, is not advanced enough for this to be used as a national indicator across all streams and rivers.

To be used as an indicator would require significant investment and assessment to establish a baseline state for each region of active stream bank erosion, and its treatment. Once a national layer was available, it could then be monitored (5-yearly) relative to the starting baseline.

B2. Are there known natural reference states described for New Zealand that could inform management or allocation options?

I do not know of any natural reference states for this attribute. As bank erosion is a natural geomorphic process understanding what the situation was like pre-European is impossible.

A pre-European reference state, while potentially attractive, would be impossible to quantify and would not be attainable in contemporary New Zealand. Stream bank erosion would have existed in New Zealand pre-Europeans (and pre-humans), but it was the clearance of indigenous forest in both islands for farming in the 19th and 20th centuries that exacerbated erosion of all types, including stream bank erosion. Land use and land use practices on erosion-prone land are still contributing to further erosion of all types. Vegetation clearance altered the hydrologic response of catchments and would have contributed to an increase in bank erosion.

B3. Are there any existing numeric or narrative bands described for this attribute? Are there any levels used in other jurisdictions that could inform bands? (e.g., US EPA, Biodiversity Convention, ANZECC, Regional Council set limit)

I am unaware of any existing numeric or narrative bands for this attribute.

B4. Are there any known thresholds or tipping points that relate to specific effects on ecological integrity or human health?

Thresholds or tipping points for this attribute have not yet been defined.

Severe bank erosion is likely to have significant local effects on ecological integrity, i.e., within metres but effects would dissipate rapidly from the active source. Cumulatively, if a large proportion of both stream banks were active, and not treated, then sediment loads would increase and impacts to downstream receiving bodies such as lakes and estuaries would be elevated, and locally stream beds would be inundated with sediment. Differentiating sediment sources by erosion process at the catchment scale is only possible using sediment fingerprinting techniques (Vale et al 2022).

B5. Are there lag times and legacy effects? What are the nature of these and how do they impact state and trend assessment? Furthermore, are there any naturally occurring processes, including long-term cycles, that may influence the state and trend assessments?

Lags and legacy effects for this attribute are likely. Depending on the treatment method, it may take some years for bioengineering methods to become effective. Hard engineering such as rip rap are effective immediately they are implemented.

B6. What tikanga Māori and mātauranga Māori could inform bands or allocation options? How? For example, by contributing to defining minimally disturbed conditions, or unacceptable degradation.

In addition to discussing this attribute directly with iwi/hapū/rūnanga, there is likely to be tikanga and mātauranga Māori relevant to informing bands, allocation options, minimally disturbed conditions and/or unacceptable degradation in treaty settlements, cultural impact assessments, environment court submissions, iwi environmental management and climate change plans, etc.

River/streambank condition is one of several metrics in cultural health assessments (Tipa & Tierney 2003).

Part C—Management levers and context

C1. What is the relationship between the state of the environment and stresses on that state? Can this relationship be quantified?

The state of streambank and riparian protection is driven by the need for land to continue to be used for agriculture and urban purposes. This includes vegetation removal from banks which has a direct effect and vegetation removal/change within the contributing catchment which changes the hydrological regime (indirect effect). Where bank erosion is severe, productive land is lost during high river flows, requiring landowners to move fences and often requiring regional councils to invest in river engineering approaches such as rip rap, bank grading, planting etc. Where land has protective measures in place and eroding stream banks have been stabilised, such measures are expected to benefit the ecological health of adjacent waterbodies in ways described in A1. At a general level the relationships between the activities that result in bank erosion and how it is treated are understood, but at the local level they are often not, i.e., we are often treating the symptom rather than the cause (Ellis et al., 2018). For example, bank erosion is recognised locally, and interventions are made to treat it locally, but it may be occurring in response to changes in the catchment that alter the hydrological regime far removed from where the bank erosion is manifested (Hughes et al., 2016).

C2. Are there interventions/mechanisms being used to affect this attribute? What evidence is there to show that they are/are not being implemented and being effective?

C2-(i). Local government driven

There are several mechanisms employed to affect riparian protection-streambank control in New Zealand. Principally these are delivered to landowners through regional and district councils via incentives, voluntary actions or in some cases via regulatory processes. Council staff usually provide advice to landowners via farm planning or catchment planning processes. Financial support for fencing and planting on a cost-share basis is the primary mechanism for action on the ground. Often, central government through large funding programmes (see C2) complement local rates investment. Where bank erosion is severe and critical infrastructure is threatened, councils usually fund hard engineering directly with or without landowner contributions.

C2-(ii). Central government driven

Examples of current and past funds that have supported riparian and streambank protection include One Billion Trees Fund, the Provincial Growth Fund, Hill Country Erosion Fund, Jobs for Nature, etc. Such funds are usually implemented via MPI or MfE. Most of these programmes report metrics on funding inputs rather than on what has been achieved. Some information may be available through https://ourlandandwater.nz/project/register-of-land-management-actions/. Further, few if ever, evaluate if the desired outcome is delivered, in part because there is a delay or lag of years to decades between when the intervention is implemented and when a potential outcome might be reached. Where data are recorded, they tend to be simple metrics such as length of stream retired from grazing, number of plants planted, etc.

C2-(iii). Iwi/hapū driven

Erosion risk and mitigations to prevent these occurring is of high interest to hapū/iwi, especially in the areas severely impacted by Cyclone Gabrielle (for example). Iwi planning documents such as Environmental Management Plans and Climate Change Strategies/Plans may contain policies/objectives/methods seeking to influence erosion outcomes for the benefit of current and future generations.

C2-(iv). NGO, community driven

Increasingly, community catchment groups undertake planting and action on the ground, either in partnership with councils and landowners or increasingly directly with collectives of landowners within catchments. Some of these initiatives fall under the umbrella of organisation such as the NZ Landcare Trust, Tane's Tree Trust, NZ Farm Forestry Association, Forest & Bird, The Nature Conservancy of Aotearoa New Zealand, Pure Advantage (O Tatou Ngahere), etc., while others are developed independently.

Some primary sector bodies via industry levies (e.g., Dairy NZ, Beef & Lamb NZ, Fonterra, etc.) provide advice to landowners on what and how to do riparian protection and may also require landowners to keep records of metrics such as length of streams fenced, numbers of plants planted in riparian margins etc.

C2-(v). Internationally driven

As discussed above, there are many pathways for landowners to get advice and to implement action on the ground to protect land, water, habitats, and biodiversity. While there are many initiatives occurring across the country, coordination is often lacking and recording of what is being done where is less than optimal.

Several international agencies also contribute advice and/or funding to projects in this space including WWF, The Nature Conservancy, IUCN, etc.

Part D—Impact analysis

D1. What would be the environmental/human health impacts of not managing this attribute?

If this attribute (or erosion in general) was not managed, further losses to ecological integrity (sedimentation in rivers, wetlands, hydro dams, estuaries and oceans), reduced clarity in freshwaters, etc., particularly in the areas where streambank erosion is active would likely result. Continuing degradation of both hill country and lowland soils would lead to reduced productivity, and in some cases loss of high value land on flood plains (Heaphy et al., 2014; Soliman & Walsh 2020; Walsh et al., 2021).

Not managing this attribute and erosion in general may lead to further cultural impacts for Māori particularly in some sensitive locations. It may also impact the mental wellbeing of some landowners who successively lose their land due to stream and river bank erosion if there is no support from councils to mitigate such occurrences, especially after small to medium floods.

D2. Where and on who would the economic impacts likely be felt? (e.g., Horticulture in Hawke's Bay, Electricity generation, Housing availability and supply in Auckland)

Economic impacts from not managing this attribute (and erosion in general) will affect both urban and rural sectors in New Zealand. Ultimately it affects all New Zealanders as taxes and rates are the major sources of funding for managing erosion and its impacts.

Farmers and landowners, iwi and urban dwellers are all affected. Impacts are likely to include further decline in freshwater health, increased costs of managing sediment in water bodies, drinking water etc, and increased costs associated with repairing flood damage resulting from large storm events.

D3. How will this attribute be affected by climate change? What will that require in terms of management response to mitigate this?

Climate change is projected to result in more storminess, but some regions may experience either a decline in total rainfall or an increase. As rainfall is a key driver of most erosion, climate change impacts are likely to be variable, though erosion overall is expected to be greater.

Managing this attribute will increase overall resilience to future climate changes. However, the pace of implementation of measures to manage erosion (in general) is unlikely to keep up with the perceived, modelled, or real changes arising from climate change (e.g., Vale et al., 2022; Vale & Smith 2023).

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