Landcare Research
Manaaki Whenua
POLICY BRIEF

A National Riparian Restoration Infrastructural Network – is it value for money?

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KEY FINDINGS

Riparian management is considered by central government, local authorities, and industry to be a crucial element in efforts to implement the National Policy Statement for Freshwater Management (NPS-FM). Should a national-level policy be rolled out to exclude and restore the riparian margins on all primary production lands, then understanding the costs and benefits of this policy is important.

Using a model-based, spatially explicit analysis we investigated the potential environmental benefits and economic costs of such a national initiative.

We found that:

- A national-level planting initiative could yield net benefits of $1.7 billion to $5.2 billion per year
- Positive net benefits from retiring and restoring riparian margins on primary sector land arise under most cost/benefit, riparian width, and riparian effectiveness scenarios.
- The benefits typically outweigh costs by between 2:1 and 20:1
- When the costs of restoring the riparian margin are low (fencing and natural revegetation), the optimal width of the buffer is estimated at 30 m. At medium and high costs (fencing with mānuka/kānuka planting) the optimal riparian width was 27 and 17 m, respectively.

BACKGROUND

The National Policy Statement for Freshwater Management (NPS-FM)[1] sets the direction for how local authorities, such as regional councils, are to manage freshwater in their jurisdictions. To do this, councils are setting objectives, policies, and rules for freshwater quality and quantity in their regional plans to safeguard the water-related services (benefits) that communities enjoy, such as irrigation, mahinga kai, and swimming.

Maintaining or improving water quality requires setting limits on nutrient, sedimentation, and pathogen loads. In many catchments, improved agricultural management practices and riparian management can help reduce these loads. The restoration and revegetation of riparian margins can filter sediment from overland flow, unused nutrients, and toxins. Restoring riparian margins also provide co-benefits that are unrelated to freshwater quality such as sequestering carbon (climate benefit), providing habitat and shading for aquatic organisms, as well as other biodiversity gains. Riparian restoration could also help recreate the unique and culturally familiar landscapes of New Zealand.[2]

While riparian margins play an important environmental role, they also reduce the productive area on a farm and exclude livestock from streams, meaning farms will need to invest in alternative water supplies. To assess the full implications of restoring New Zealand's riparian margins requires an understanding of both the benefits and the costs of any such initiative.

The Land and Water Forum[3] and DairyNZ[4] emphasise the complexity of the interactions between agriculture and freshwater quality, and recommend or require excluding stock from waterways.[5] Stock exclusion is also part of the latest set of proposed national freshwater reforms.[6] Further riparian management is noted as being important in many instances for water quality benefits and for managing other potentially negative impacts such as weed invasion. While acknowledging the co-benefits of riparian restoration, the need for more detailed research is emphasised to identify locations where these co-benefits are likely to be achieved while keeping the cost to farmers reasonable.

Along with improving the management of the nation's freshwater resources, the central government has an objective to double the value of agricultural exports.[7] As New Zealand's export branding is based on a 'clean, green' image, there is domestic and international pressure to maintain that image. The Parliamentary Commissioner for the Environment[8,9] concludes that this will be difficult, and therefore costly, to achieve at higher production levels.

In addition to improved farm management and infrastructure, restoring riparian margins may help maintain environmental quality. In New Zealand, programmes for riparian restoration have been driven by industry or community initiatives. The adoption of riparian restoration in national policy requires an understanding of the environmental co-benefits that can be expected, and of the regional and industrial distribution of the costs.

This policy brief starts to explore this question of the costs and benefits of riparian management by assessing the net benefits of riparian restoration across the productive landscape of New Zealand. The brief presents the results of a model-based, spatially explicit analysis of riparian margin restoration that suggests the restoration of riparian margins is likely to produce welfare improvements for New Zealand.

APPROACH

We first estimated baseline numbers for annual net revenue (profit) and environmental impacts (nitrogen (N) leaching, phosphorus (P) loss, soil loss, and greenhouse gas (GHG) emissions) from different land-use types using the comparative-static agri-environmental model, NZFARM.[10] This takes into account regional differences in soils, macro-topography, climate, and farm input costs.

In the next step, we simulated a national policy of restoring the riparian margin on all land parcels used for primary production. The riparian areas to restore (or riparian buffers) were identified by overlaying a baseline land use map with New Zealand's permanent waterways.

This allowed us to estimate the costs (lost revenue from productive land that forms part of the riparian margin and the costs associated with planting, fencing and alternative water supplies for pastoral activities) and benefits (reductions in N-leaching, P and soil loss, GHG emission, and restored biodiversity gains) of riparian restoration. The environmental benefits arise from a reduction in land used for production, lower intensity of environmental impacts caused by riparian filtering, and further contributions (if any) from the riparian margins.

With the exception of biodiversity, we estimate the benefits in physical and monetary units. We conduct sensitivity analysis of cost levels and benefit valuation (high-medium-low), margin width (5, 10, 20, 50 metre) and margin effectiveness to assess the robustness of our conclusions. A more detailed description of the study is provided in Daigneault et al.[11] and the caveats about the assessment are outlined in Box 1.

BENEFITS AND COSTS OF RIPARIAN MARGINS

The baseline (see Table 1) reflects current land use and provides the reference point for comparing policy scenarios. Approximately 16.6 million hectares (Mha) of land is being used for primary production with a further 8.7 Mha in native vegetation. The total length of permanent waterways is just over 508,000 kilometres (km), and around 348,000 km are located on land in agricultural and forestry uses.

Figures 1 and 2 show the national cost of restoring riparian margins of varying widths, split out by industry and cost type respectively. Figure 1 shows that, at 5-m-wide margins, sheep and beef production carries the largest share of costs. Sheep and beef farms, which constitute the largest land area in New Zealand, carry most of the burden of constructing fences, alternative water supplies, and planting. However, as the riparian buffer width increases, the opportunity cost of reduced production areas increases more strongly for more profitable primary sectors, such as dairy.

Figure 2 illustrates this argument by showing the decomposition of total costs by cost type for each of the riparian buffer widths. The costs of fencing and constructing alternative water supplies vary with stream length but not with margin width. As the width of riparian margins increases, the opportunity costs associated with lost profits take up a growing share in the total cost of a national riparian restoration initiative. This shifts the cost burden from sheep and beef production which, by its extent, has a greater stream length, to more profitable industries that would lose more when more high-value land is retired.

Table 1. Baseline statistics for each land use

Land Use	Area (Kha)	Net Farm Revenue (mil NZ$)	Net GHG (MtCO2e)	N Leach (Kt)	P Loss (Kt)	Sediment (Mt)	Stream Length (km)
Dairy	2,085	7,128	13.3	79.2	1.8	8.8	31,802
Sheep & beef	11,025	1,403	21.9	112.6	5.7	137.0	226,909
Other Pasture	1,263	417	1.6	7.7	0.5	10.4	22,027
Arable & horticulture	341	1,057	0.4	5.9	0.1	0.5	2,709
Forestry	1,926	991	-21.7	3.9	0.4	6.2	36,486
Native	8,698	0	-5.2	10.4	0.9	23.0	160,233
Other Land	2,028	22	0.4	2.0	0.1	27.7	28,505
NZ Total	**27,367**	**11,018**	**10.7**	**221.7**	**9.5**	**213.6**	**508,672**

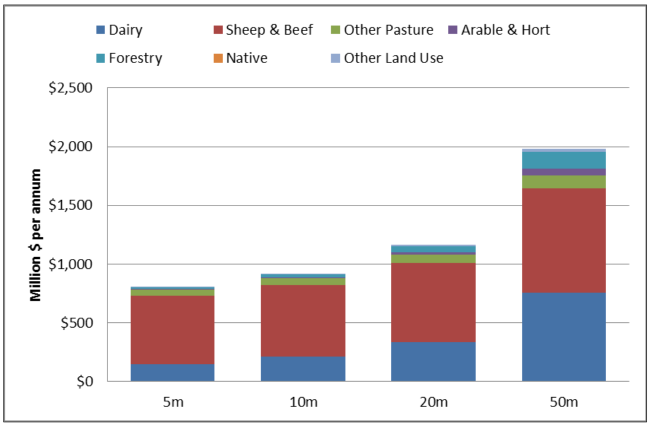

Figure 1. Sectoral cost of restoring riparian buffers nationally.

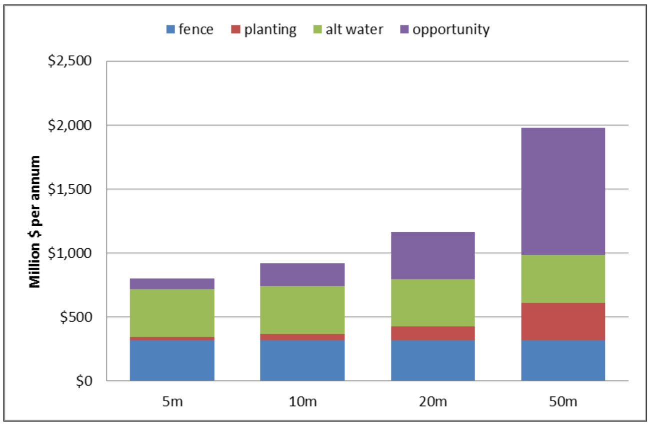

Figure 2. Cost components of restoring riparian buffers nationally.

The associated benefits of different riparian buffer widths are shown in Table 2. This illustrates that the net GHG emissions disproportionately decline as the buffer width increases. The difference between the passive (fencing with natural regeneration) and active (planting of mānuka/kānuka) restoration is caused by differences in carbon sequestration rates. Percentage changes greater than 100% in net GHG emissions indicate that the new land-use system sequesters more GHG than is emitted under the baseline: disregarding other GHG sources, New Zealand is acting as a GHG sink.

Regardless of the type of restoration, the estimated reductions in N-leaching and P-loss are of similar magnitude at each buffer width. The reductions range from 50% reduction for the 5-m buffers to ~90% reductions for the 50-m buffers. The additional benefits of increasing the riparian buffer widths beyond 20 m, however, decrease markedly. Reductions in soil loss are a slightly different story, with the additional benefits decreasing beyond the 5-m riparian buffer width.

Biodiversity gains were expressed as a percentage of the biodiversity improvement that would be expected if all of New Zealand were allowed to undergo a process of unmanaged re-afforestation.[12,13] As expected, the wider buffers provided greater biodiversity gains with natural regeneration. While we made no attempt to estimate the biodiversity gains from mānuka/kānuka planting, these would also provide habitat, stream shading, and cultural services benefits.[14]

To compare the costs and benefits of a national riparian margin restoration policy we monetise the welfare gains from reduced GHG emissions, N-leaching, P-loss and sedimentation (Table 3).

Table 2. Environmental benefits associated with different riparian buffer widths

	Buffer width (m)	Net GHG (MtCO2e)*	N Leach (Kt)	P Loss (Kt)	Sediment (Mt)	Biodiversity (% potential)
Baseline		10.7	221.7	9.5	213.6	0
		% Change from baseline				
Low cost (passive afforestation)	5	−16	−51	−50	−82	2
	10	−26	−74	−73	−90	4
	20	−54	−88	−87	−92	8
	50	−147	−90	−92	−93	23
Medium & high cost (active revegetation)	5	−26	−51	−50	−82	-
	10	−54	−74	−73	−90	-
	20	-112	−88	−87	−92	-
	50	−306	−90	−92	−93	-

Table 3. Net benefits for cost and buffer width scenarios

Cost scenario	Buffer width (m)	*Net Benefits* Net benefits ($mill)	Benefit-cost ratio
Low cost	5	3,146.1	20.6
	10	4,390.3	22.4
	20	5,127.6	18.1
	50	5,172.1	9.4
Medium cost	5	2,526.0	4.1
	10	3,735.1	5.1
	20	4,386.6	4.8
	50	4,146.6	3.1
High cost	5	2,020.2	2.5
	10	3,035.1	2.9
	20	3,277.9	2.4
	50	1,663.7	1.4

Net benefits vary between $1.7 billion and $5.2 billion annually, depending on the cost scenario. The benefit-cost ratios range from 1.4 to 22.4, which means for every dollar invested in the restoration of riparian margins creates a welfare improvement worth $1.4 and up to $22.4.

The restoration of the riparian margins is cost-effective in 90% of the different cost and buffer width scenarios that were assessed.[15] Costs exceeded benefits only when the value of environmental benefits and/or riparian margin effectiveness was low.

It is worth noting that, at medium- and high-cost levels, the net benefits of riparian margins initially increase with margin width and then start to decline again.

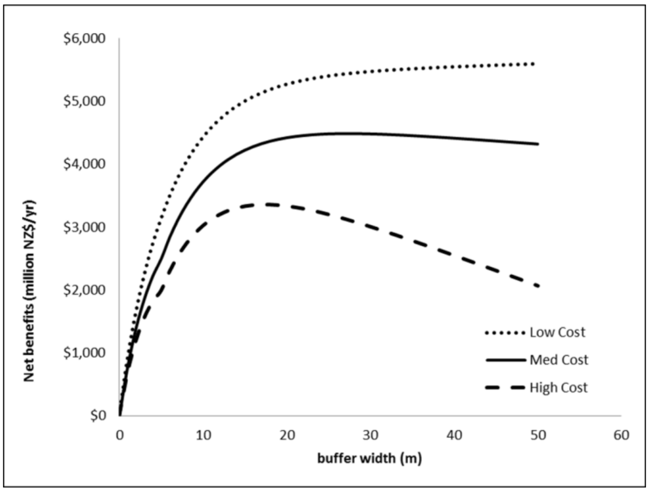

Figure 3. Optimal riparian buffer widths.

We used these relationships to estimate the optimum width of the riparian buffers. For the low cost scenario, the optimum margin width is around 30 m. For the medium-cost and high-cost scenarios, respectively, it is 27 m and 17 m (see Fig. 3).

KEY FINDINGS

From our analysis we find that:

- a national-level planting initiative could yield net benefits of $1.7 billion – $5.2 billion per year
- positive net benefits from retiring and restoring riparian margins on primary sector land arise under most cost/benefit, riparian width, and riparian effectiveness scenarios
- the benefits typically outweigh costs by between 2:1 and 20:1
- if the costs of restoring riparian margins are low (fencing and natural revegetation), the optimal width of the buffer is estimated at 30 m. At medium-high costs (fencing with mānuka/kānuka planting) the optimal riparian width was 27 m and 17 m respectively.

We acknowledge that not all the benefits and costs are included in our analysis, but our estimates of both may be conservative.

Further refinements would allow us to identify specific land parcels where costs are likely to be relatively low and/or effectiveness comparatively high. Information such as this could be used to better target policy, such as the $100 million fund that has been proposed in support of the NPS-FM.[16]

Box 1. Assessment caveats

Our assessment does not account for the considerable progress in stock exclusion that has already been achieved under the Sustainable Dairy Water Accord. To determine how this affects our estimates, we intend to include this information in a next development of the model.

We have also not fully costed all the benefits of riparian restoration. Some benefits that have not been included are contributions of healthy streams and rivers to biodiversity, freshwater biota and ecosystem health, and the terrestrial benefits and costs of an expanded network of riparian buffers across the country. These benefits are difficult to monetarise but are important to recognise in such an assessment.

ACKNOWLEDGEMENTS

We acknowledge the Ministry of Business, Innovation and Employment who funded the study through the Core allocation to Landcare Research.

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[14] Ibid 2.

[15] In total there were 72 scenarios with differing cost/benefits, buffer width and effectiveness of the riparian margin at achieving environmental gains.

[16] Ibid 6.