Te Panonitanga o te Mahere Wai Māori Hukihuki: Kōrerotia mai o whakaaro mō te aukati kararehe pāmu

The draft Freshwater Plan Change: Have your say on stock exclusion

Northland REGIONAL COUNCIL
Te Kaunihera ā rohe o Te Taitokerau

Kōrero whakataki

Introduction

The draft Freshwater Plan Change sets a direction for improving the health of freshwater in Te Taitokerau.

Once the plan change is adopted by Northland Regional Council, it will include:

- a new vision for our freshwater
- the outcomes we want for freshwater
- new limits and rules for activities that impact freshwater.

One of the most effective tools for improving freshwater is to keep stock away from waterways, wetlands, and off highly erodible land.

The further stock are kept from waterways, the greater the environmental benefits – especially where wider setbacks include riparian vegetation. We think we will need both wider setbacks for stock and enhanced riparian vegetation to achieve the improvements needed in freshwater health.

We also think there is a case for excluding stock from our most erodible land to limit erosion and sediment going into waterways.

The more we do, the greater the environmental benefits – but the higher the costs for landowners, many of whom are already facing tough times. This can be mitigated somewhat by allowing sufficient lead-in time, but even so the costs will be significant.

We need your input to make decisions that will work for our community as well as our waterways.

Now is your opportunity to share your thoughts and feedback. The more feedback we get, the better informed our decisions will be.

Glossary

“Highly erodible land” is land we have mapped which is steep and most at risk of erosion.

“Setback” is the distance stock is excluded from a waterway, measured from the edge of the bank.

“Stock” means dairy cows, dairy support cattle, beef cattle, pigs, and deer.

“Stock exclusion” includes any method for keeping stock out of waterways (e.g. fence or electric halters) or off highly erodible land.

“Waterways” means streams, rivers, and lakes.

"Ephemeral streams" have a natural bed level above the water table at all times, with water only flowing during and shortly after rain. They do not meet the definition of an intermittently flowing river or stream.

"Intermittently flowing river or stream" is a river or stream that is naturally dry at certain times of the year and has two or more of the following characteristics:

1. it has natural pools, and
2. it has a well-defined channel, such that the bed and banks can be distinguished, and
3. it contains surface water more than 48 hours after a rain event which results in river flow, and
4. rooted terrestrial vegetation is not established across the entire cross-sectional width of the channel, and
5. it appears as a blue line on topographical maps at 1:50,000 scale.

He aha ngā ture ināianei?
What are the existing rules?

There are already rules requiring stock exclusion from waterways. These include Government Stock Exclusion Regulations[1] and rules in the Regional Plan for Northland[2]. The current rules require:

- Dairy cows and pigs must be excluded from all continually flowing streams, rivers, wetlands >0.05 hectares, artificial watercourses, and the coastal marine area.
- Beef cattle and deer must be excluded from same areas as dairy and pigs, but only in lowland/low slope areas (there are some exceptions)
- Dairy support cattle must be excluded from same areas as dairy and pigs, but with some exceptions in hill country areas.
- Sheep must be excluded from Inanga spawning sites (margins of rivers and estuaries inundated by spring tides).

The setback requirement (see glossary) varies between three metres and no setback, depending on the waterway.

If the rules cannot be met, then a resource consent can be applied for.

There are currently no rules requiring stock be excluded from highly erodible land.

A more detailed summary of the current rules can be found here: https://www.nrc.govt.nz/environment/farm-management/keeping-stock-out-of-waterways/

The existing rules need to change. This is because:

- The Government's National Policy Statement for Freshwater Management directs us to significantly improve the health of freshwater in our region. Keeping the status quo would not markedly improve the quality of our freshwater – it would mean only minor improvements and no new stock exclusion requirements would apply after 2025.
- Most of our streams, rivers and lakes are in a poor state. The strong message from tāngata whenua, communities and the Government is we must improve the health of freshwater to provide habitats for our native plants and animals, safeguard the health of our communities, and enhance our resilience to climate change.

We need to look at some new rules that will work better for protecting our freshwater.

[1] https://environment.govt.nz/acts-and-regulations/regulations/stock-exclusion-regulations/
[2] https://www.nrc.govt.nz/your-council/about-us/council-projects/new-regional-plan/

Pātai 1: Me pēhea nei te tawhiti o te noho a ngā kararehe pāmu i ngā arawai?

Question 1: How far away from waterways should stock be kept?

We have looked at three setback distances for keeping stock away from all permanent and intermittently flowing rivers and streams. We do not think rules should apply to ephemeral streams (see glossary).

These distances are:

- A three-metre setback.
- A five-metre setback.
- A ten-metre setback.

The setback distance would likely also apply to lakes. There are also waterbodies with high ecological values where larger setbacks are likely to be needed because they are very sensitive to the impacts of stock (such as outstanding waterbodies and high-value dune lakes). However, we have focussed on options for rivers and streams, as this is likely to affect landowners most.

To gain the most benefit, the stock exclusion areas around waterways would need to be planted with native riparian vegetation.

The benefits and costs of these setback distances are shown in the table below. We have also included the status quo and a 30-metre stock exclusion area for comparison.

The costs are presented as an average per farm per year. They include fencing, water reticulation, and lost operating profit. The riparian planting cost estimates include planting and ongoing maintenance.

Stock exclusion distance from waterway	Water quality improvements				Co -benefits		Financial costs (per farm per year)
	Sediment reduction	E. coli reduction	Freshwater habitat and ecology improvement	Mauri*	Mitigating climate change	Terrestrial biodiversity improvements	
Comparator: Status quo**	0	0	0	0	0	0	The costs associated with existing regional and national regulations will not change with the options being considered.
Three-metre setback	3	4	1	1	1	1	Stock exclusion: $5,500 – $8,200 (non-dairy farm) Riparian planting: $1,400 – $2,100
Five-metre setback	4	6	2	2	2	2	Stock exclusion: $10,200 – $16,500 Riparian planting: $4,600 – $9,300
Ten-metre setback	6	7	5	5	3	4	Stock exclusion: $12,600 – $24,500 Riparian planting: $9,200 – $18,500
Comparator: Thirty metres	7	7	8	8	5	8	Stock exclusion: $19,700 – $65,300 Riparian planting: $27,300 – $55,600

*Mauri is the life force given to all things through a Māori perspective. The numerical values attained and compared to the effects of stock exclusion and riparian planting have been compared against the attributes in the TWWAG Stage 2 report: *Ngā Roimata o ngā Atua*. Further work is being done to assess different methodologies and confirm these values.

** 'Status quo' refers to the current state as of October 2023. It does not take into account national and regional rules to apply from 2025.

Scoring: 0 = no improvement (from status quo), 5 = moderate improvement, 10 = major improvement. Scoring is indicative only and is intended to show the relative difference based on the available evidence.

Assumptions:

- All stock are excluded from all waterways, including intermittently flowing rivers and streams.
- There is established riparian planting in the stock exclusion areas (this will likely take many years after stock is excluded).

Should an averaging approach be used?

An averaging approach could be used for stock exclusion for distances of five metres and greater to recognise the practicalities of fencing off waterways to exclude stock.

For example, under a 10-metre average exclusion rule, a landowner might choose to put the fence three metres away from the waterway in some places and 15 metres away in other places to maintain an average distance of 10 metres across the length of the waterway on the property.

Even using an averaging approach, stock exclusion would need to be a minimum of three metres away from waterways, as three metres is the standard applied in Government regulations.

What does the science say?

Excluding stock reduces sediment in our waterways. Stock erode the banks and disturb the beds of waterways, which increases sediment. Keeping stock off stream banks is more effective in smaller, narrower streams with low banks than in larger, wider rivers with high banks[3].

Research shows that to reduce contaminants (nitrogen, phosphorus, sediment, *E. coli*) in our streams and rivers, we need to target smaller streams in headwaters as well as lowland streams and rivers. A large proportion of contaminants come from smaller streams on higher slopes. About 85% of *E. coli* come from these small streams[4].

Native freshwater species live in smaller streams in the upper parts of catchments, and the quality of their habitat is compromised by a lack of riparian vegetation. Riparian vegetation provides shade, reduces water temperature, filters contaminants, stabilises banks, and improves freshwater habitats and biodiversity. At least 10 metres of riparian vegetation is needed to noticeably improve the ecological health of freshwater[5]. In addition, the more riparian vegetation we have, the more effective it is at reducing the impacts of climate change, such as droughts and floods. A wider setback – for example, 30 metres – would deliver greater benefits.

Research shows that riparian vegetation can filter out sediment. A riparian vegetation buffer of five metres removes about 34% to 40% of sediment, and a 10-metre buffer removes about 60% of sediment[6]. Its effectiveness at filtering sediment varies depending on the

[3] Hughes, A. (2016). Riparian management and stream bank erosion in New Zealand. New Zealand Journal of Marine and Freshwater Research. 50: 277-290; and Robson, B. (2022). Literature review to support development of Northland's Soil Conservation Strategy: Soil erosion treatment options, relative costs, effectiveness, impact. Report prepared for Northland Regional Council.

[4] McDowell, R. W., Cox, N., Snelder, T. H. (2017). Assessing the yield and load of contaminants with stream order: Would policy requiring livestock to be fenced out of high-order streams decrease catchment contaminant loads? Journal of Environmental Quality, 46(5), 1038-1047.

[5] Baillie, B. Murfitt, J. (2023). Riparian setbacks: Summary of the science. Northland Regional Council.

[6] Semadeni-Davies et al. 2021; and Sweeney et al. (2014) in Semadeni-Davies, A; Haddadchi, A., Booker, D. (2020). Modelling the impacts of the Draft Stock Exclusion Section 360 Regulations on river water quality E. coli

width of the waterway, scale of planting, type of plants, topography and location in the river system.

The roots of riparian vegetation help to stabilise stream banks up to depths of 0.5 to 1.5 metres, especially the banks of smaller streams up to 10 metres wide. A five-metre setback is considered a minimum for stabilising banks, but 10 metres is preferable, depending on plant species.

In smaller catchments, transitioning to riparian planting can temporarily increase sedimentation because pasture grasses capture and store sediment in streambanks. As the grass dies off under increasing shade from riparian planting, these sediment sources can be remobilised until the stream reverts to the wider, shallower shape typical of forested streams[7].

In summary, while riparian buffers of three to five metres provide effective filtering, vegetated riparian buffers of 10 metres or more are needed to achieve wider ecosystem health and climate change resilience benefits for waterbodies.

However, the wider the setbacks and stock exclusion rules, the higher the costs. We are concerned about the financial cost for landowners, many of whom are already facing tough times. This can be mitigated somewhat by allowing sufficient lead-in time, but even so the costs will be significant.

We need your input to make decisions that will work for our community as well as our waterways.

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and Sediment. Prepared for Ministry for Primary Industries and Ministry for the Environment. NIWA Client Report No: 2020052AK.

[7] Robson, B. (2022). Literature review to support development of Northland's Soil Conservation Strategy: Soil erosion treatment options, relative costs, effectiveness, impact. Report prepared for Northland Regional Council.

Pātai 2: Me whai pānga ngā ture aukati kararehe pāmu ki ngā whenua ngāhorohoro rawa?

Question 2: Should stock exclusion rules apply to highly erodible land?

Elevated levels of sediment in our streams, rivers and lakes make our estuaries muddier, our waterways less appealing to swim in, and make it harder for native plants and animals in the water to survive.

Most of the sediment in our waterways comes from two main sources – sediment coming off the land (especially the steeper highly erodible land) and stream bank erosion.

There are currently no rules in the regional plan requiring stock to be excluded from mapped areas of highly erodible land.

Highly erodible land erodes more when it is in pasture and grazed. Land erodes less if it is covered in vegetation other than pasture. It is also less vulnerable to slips.

We think changing the rules to manage stock grazing on highly erodible land would encourage permanent woody vegetation, such as regenerating bush, continuous cover forestry and/or permanent carbon forests. Over the long term, this would reduce sediment runoff into our waterways and increase our region's resilience to slips.

Before

After

Slips caused by Cyclone Gabrielle on steep farmed land in the Kaipara Harbour catchment. While vegetation on these slopes may not have stopped all the slips, it would have helped to reduce it.

What land should be defined as highly erodible?

We think our current maps of erosion-prone land can be improved. We have developed two new draft maps of highly erodible land based on slope, which is the main driver of erosion risk:

- **Highly Erodible Land 1** shows areas with **high** erosion risk
- **Highly Erodible Land 2** shows areas with **severe** erosion risk.

We already have rules that control earthworks and land preparation on highly erodible land, but there are currently no rules for vegetation clearance or stock exclusion on this land.

Status quo			
Map	**Area (ha)**	**Basis for maps**	**Summary of current rules**
Erosion Prone Land	252,409 (18.8% of land in the region)	Land defined as Land Use Capability (LUC) units 6e17, 6e19, 7e1 - 7e10, 8e1 - 8e3, and 8s1.	Currently only earthworks and land preparation rules apply

We're considering new rules limiting vegetation clearance, cultivation and earthworks in areas of **high** erosion risk, with tighter controls applied to these activities in areas with **severe** erosion risk.

We're also considering new rules requiring stock to be excluded from both these areas.

New draft maps and rules			
Map	**Area (ha)**	**Basis for maps**	**Summary of draft rules**
Highly Erodible Land 1	155,548 (12.25% of land in the region)	Land with a slope between 25 degrees and 35 degrees	Draft rules: Moderate controls on earthworks, land preparation and vegetation clearance. We are seeking feedback on whether stock exclusion rules should be applied on Highly Erodible Land 1 by 2040.
Highly Erodible Land 2	91,120 (7.2% of land in the region)	Land with a slope greater than 35 degrees	Draft rules: Tighter controls on earthworks, land preparation and vegetation clearance.

			We are seeking feedback on whether stock exclusion rules should be applied on Highly Erodible Land 2 by 2035.

We are interested in your views on the draft maps of highly erodible land and whether stock exclusion rules should apply.

The current Erosion Prone Land maps and draft Highly Erodible Land 1 and 2 maps can be viewed here: www.nrc.govt.nz/mapviewer

What would it cost?

We estimate the cost of excluding stock from land with **severe** erosion risk (Highly Erodible Land 2) to be between $400 million and $600 million over 30 years ($13 million to $20 million per year). We estimate between 70% and 75% of the costs will be in the first five years.

The estimated cost is broken down into:

- fencing (70% of total)
- operating profit loss (30%).

For an average sheep and beef farm[8] the extra cost would be:

- $9,200 to $13,700 per year (over 30 years)
- 8% to 12% of farm operating profit before tax.

We estimate the cost of excluding stock from land with **high** erosion risk (Highly Erodible Land 1) to be between $720 million and $1,1080 million over 30 years ($24 million to $36 million per year). For an average sheep and beef farm, the extra cost would be:

- $16,500 to $24,700 per year (over 30 years)
- 14% to 21% of farm operating profit before tax.

However, the cost of keeping stock off highly erodible land can be offset by planting the land in permanent forest and claiming the carbon credits. How far the carbon revenue stream can offset stock exclusion costs depends on the price of carbon. For example, if all severely erodible land were to be planted in pine, at a price of $35 tonne the returns from carbon would fully offset the estimated stock exclusion costs[9] .

What does the science say?

Human activities, especially clearing native forest and draining wetlands for agriculture, have worsened erosion in Northland and increased sedimentation in our rivers and

[8] We did not do an estimate for dairy because there is unlikely to be much dairy on highly erodible land.
[9] On 24 July 2023 the spot price was $47.25.

estuaries. For example, sediment accumulation rates in the Bay of Islands are around 14 times higher than 150 years ago[10] and about six times higher in the Kaipara harbour compared to pre-human times[11].

In the Kaipara catchment, a large proportion of the land-based sediment comes from highly erodible pastureland, producing an estimated 77% of the land-based erosion. In the Bay of Islands it equates to around 60%[12].

Modelling[13] indicates that afforestation of highly erodible land, either into permanent forest cover or plantation forests, is an effective way to reduce sediment – estimates range from about 30% for permanent forest cover, 25% for plantation forest (space planting achieved about a 12% reduction).[14]

Summary

We think there is a good case for applying stock exclusion rules to our most highly erodible land and encouraging stabilisation of these areas with trees. It would be effective at reducing sediment runoff and make slips less likely and less severe.

Furthermore, some of the costs of excluding stock from this land can be recouped by planting in carbon forestry or permanent forests that are selectively logged.

[10] Swales, A., Gibbs, M., Hewitt, J., Hailes, S., Griffiths, R., Olsen, G., Overden, R., Wadhwa, S. (2012). Sediment sources and accumulation rates in the Bay of Islands and implications for macro-benthic fauna, mangrove and saltmarsh habitats. Report prepared for Northland Regional Council.

[11] Green, M.O. and Daigneault, A. (2018). Kaipara Harbour Sediment Mitigation Study: Summary. Report NRC1701–1 (minor revision), Streamlined Environmental, Hamilton, 64 pp.

[12] Swales et al., (2012); Green & Daigneault, (2018). *Op cit.*

[13] Semadeni-Davies, A; Whitehead, A. and Elliott, S. (2021). Water quality modelling for Northland to support NPSFM implementation, NIWA client report prepared for Northland Regional Council; and Semadeni-Davies, A. (2022). Water quality modelling to support NPS-FM implementation Further scenarios. NIWA client report prepared for Northland Regional Council.

[14] These figures were estimated based on planting of the whole area of highly erodible land in Northland.

Pātai 3: Me pēhea nei ngā ture mō te aukati i ngā kararehe pāmu mai i ngā repo?

Question 3: What should the rules be for excluding stock from wetlands?

Wetlands are important habitats. They also trap sediment and other contaminants and reduce how much gets into streams and rivers. Furthermore, wetlands soak up water during floods and release water during droughts. Excluding stock from wetlands improves habitat value and their ability to trap contaminants and manage water flows.

The current rules require:

- dairy stock and pigs to be excluded from wetlands greater than 500 square metres.
- beef, dairy support cattle and deer to be excluded from wetlands greater than 500 square metres on low-slope land.

The current rules do not require beef, dairy support cattle and deer to be excluded from wetlands in hill country areas. However, there are important wetlands in Northland's hill country, and wetlands higher up in catchments effectively reduce contaminants entering waterways.

We think there is a gap in the current rules for excluding non-dairy stock from hill country wetlands.

To address this, we are considering a phased approach requiring beef, dairy support cattle and deer to be excluded from hill country wetlands greater than 2000 square metres in the interim and from all wetlands larger than 500 square metres in the longer term.[15]

We do not see the need for setbacks from wetlands as riparian buffers are less important for wetland health and they are typically not as sensitive to sediment or nutrients compared with other waterbodies.

[15] Examples of indicative dates could be 2030 for the interim requirements and 2035 for the longer-term requirements.

What would it cost?

We estimate the cost of excluding non-dairy stock from wetlands greater than 2000 square metres in hill country areas would be between $50 million and $70 million over 30 years ($1.7 million to $2.3 million per year). We estimate 65% of the costs would be in the first five years.

The estimated cost is broken down into:

- fencing (78% of total)
- operating profit loss (22%).

For an average sheep and beef farm the extra cost would be:

- $1,100 to $1,600 per year (over 30 years)
- between 1% and 1.4% of farm operating profit before tax.

The cost of excluding non-dairy stock from wetlands greater than 500 square metres but less than 2000 square metres in hill country areas is estimated at between $20 and $30 million over 30 years ($0.7 to $1 million per year). This includes fencing costs and lost production. We estimate 65% of the costs would be in the first five years.

For an average sheep and beef farm the extra cost would be:

- $700 to $1000 per year (over 30 years)
- between 0.4% and 0.6% of farm operating profit before tax.

What does the science say?

Excluding stock improves the quality of wetland habitats and their ability to filter contaminants – they are more effective at trapping sediment when they are not grazed. It is difficult to estimate the exact reduction in contaminants as a result of excluding stock from wetlands. However, we know hill country wetlands filter contaminants before they enter waterways and reduce downstream impacts.

As an example, modelling shows constructing new wetlands around the small tributaries in headwater catchment areas could reduce the total amount of sediment in waterways across Northland by up to 18%.[16]

Modelling shows constructing wetlands in headwater catchments could effectively reduce *E. coli*. Therefore, fencing off existing wetlands will reduce faecal contamination in waterways — particularly wetlands directly connected to waterways.

[16] Semadeni-Davies, A. (2022). Water quality modelling to support NPS-FM implementation Further scenarios. NIWA client report prepared for Northland Regional Council.

What we think

Hill country wetlands are important habitats and contaminant filters. We think there is a good case to require non-dairy stock to be excluded from hill country wetlands. We recognise this will be costly, so a phased approach would be more practical.

What do you think?

Pātai 4: Me whānui atu te aukati kararehe pāmu kia kuhu mai ko ngā kararehe pāmu kē atu?

Question 4: Should stock exclusion be extended to apply to other animals?

The current rules apply to dairy cattle, pigs, beef cattle, dairy support cattle, and deer.

However, other farmed animals can impact water quality. For example, sheep excrete high concentrations of *E. coli* in their faeces, so even small amounts deposited into streams will have an impact[17]. *E. coli* concentrations in Northland's waterways are high and impact on freshwater activities such as swimming and collecting mahinga kai.

Animal access to waterways can also disturb or damage freshwater habitats, increase sediment, and reduce the effectiveness of riparian vegetation by grazing.

Given that all animals can impact water quality, increase sediment loss from highly erodible land and damage freshwater habitats, there is a case for all stock to be subject to exclusion rules.

We recognise that this is likely to mean costs will be higher. For example, fencing to exclude sheep or goats costs more than fencing to exclude cattle. This can be mitigated somewhat by allowing sufficient lead-in time, but even so the costs would be significant.

[17] Moriarty, E., Gilpin, B. (draft). Sheep as a Potential Source of Faecal Pollution in Southland Waterways. Report prepared by ESR for Environment Southland; and Muirhead, R., Hudson, R., Cookson, A. (2023). A review of river microbial water quality data in the Northland region. Report for the Northland Regional Council Client Report Number: RE450/2023/029 prepared by AgResearch Ltd.

Pātai 5: He aha te roa o te wā e tika ana i mua i te whakauruhi ture aukati kararehe pāmu hou?

Question 5: What timeframes are feasible for any new stock exclusion rules?

We need your feedback on when any new stock exclusion rules should apply. The longer the timeframe, the more time for people to adapt – but the longer it will take for the health of freshwater to improve.

The government requires we be ambitious but reasonable in setting timeframes for improving freshwater. The draft Freshwater Plan Change includes targets to improve water quality over time (see Appendix H.12 of the draft Freshwater Plan Change) with improvement in water quality and waterbody health by 2035.

The current rules require non-dairy stock (beef and dairy support cattle and deer) to be excluded from lowland rivers and wetlands of 500 square metres or more by 2025, and no new requirements would apply after this date. As outlined above, we do not think these rules will provide the improvement needed.

We think we need to build on existing rules by phasing in new stock exclusion requirements over the next 10 years or so. For example:

- New requirements for stock exclusion from hill country rivers and wetlands for non-dairy stock to address the gap in current rules.
- Extending stock exclusion rules to apply to more stock types and widen setbacks around waterways.
- Applying stock exclusion rules to highly erodible land.

This staged approach would allow time for landowners to make the changes needed but ensure we make progress on improving our freshwater. We think this would be the best balance between giving landowners lead-in time and the need to act to improve the health of freshwater.

What do you think?

Te kimi mōhiotanga anō
How to find out more

Find information online

Read more about the draft Freshwater Plan online at wai-it-matters.nz

Read about the National Policy Statement for Freshwater Management at https://environment.govt.nz/acts-and-regulations/national-policy-statements/national-policy-statement-freshwater-management/

Come to a hui/meeting

We are holding a series of hui to kōrero about the draft Freshwater Plan and answer your questions. Visit wai-it-matters.nz for details, or contact:

Northland Regional Council
0800 002 004
freshwater@nrc.govt.nz

Te tono kōrero mai
How to have your say

Whether you prefer online, print, or kanohi-ki-te-kanohi, there are lots of ways to tell us what you think.

You can share your views in te reo, English or New Zealand sign language (let us know if you might need an interpreter)

Online

Visit wai-it-matters.nz to give us your feedback online or email us at freshwater@nrc.govt.nz

Print and in-person

Fill out our printed feedback form. If you need a printed form or you would like to speak to someone in person at one of our offices, please contact us at:

Northland Regional Council
Private Bag 9021
Te Mai, Whangārei 0143

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Or drop by one of our offices:

Whangārei
36 Water Street
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32 Hokianga Road
9am to 4pm, Monday to Friday

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192 Commerce Street
8:30am to 4pm, Monday to Friday

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A costing of the options to support “The draft Freshwater Plan Change: Have your say on stock exclusion” report

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Northland REGIONAL COUNCIL
Te Kaunihera ā rohe o Te Taitokerau

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1. Introduction

Northland Regional Council (council) is preparing a draft Freshwater Plan Change to implement the requirements of the National Policy Statement for Freshwater Management (NPS-FW) 2020. As part of the process, council is consulting on various options for the extension of existing rules and regulations regarding the exclusion of stock from three areas: waterways, highly erodible land and wetlands. For the exclusion of stock from waterways, four different riparian setback lengths are being considered: three, five, ten and thirty. For the exclusion of stock from highly erodible land (HEL), two options based on slope are proposed: land of severe erosion risk (HEL2) defined as land steeper than 35°; and land of high erosion risk (HEL1) defined as land steeper than 25° but less than 35°. For the exclusion of stock from wetlands, there are two options based on the size of wetland area: wetlands greater than 2000m^2, and wetlands greater than 500m^2 but less than 2000^2.

The purpose of this report is to estimate the costs, at the regional level, for the various options being considered for each of the three stock exclusion areas. The task involved collecting, assessing and discounting the various costs associated with the options over a 30-year period. Part 2 describes the general methodology. Part 3 contains the sources and assumptions for estimating the cost per unit values, e.g., dollars per metre or dollars per hectare, for each of the cost components considered including fencing, stock water reticulation, opportunity cost, and planting. These cost per unit values are multiplied by the appropriate unit data to estimate the total cost for the stock exclusion options. The estimation of the total cost for each of the three areas from which it is proposed that stock be excluded are discussed in Parts 4, 5 and 6.

2. Methodology

The costing analysis is based on using average values estimated from regional and national sources and not on a per farm case methodology. The analysis was built on several primary inputs and underlying assumptions. Calculations were done in Excel MS..

Pricing data was collected from previous research conducted on a national and regional level, and internal council sources. Careful consideration was given to align the prices used in this study with the price information used by the Kaipara Moana Remediation (KMR) Programme[1] as well as information incorporated into Auckland Council's Fresh Water Management Tool.[2,3]

The base date for all prices is set to 2023 New Zealand dollars (2023 $NZD) and are GST (goods and services tax) exclusive. Where costs are utilised from older sources they are inflation adjusted using the Farm Expenses Price Index, All Farms – All inputs excluding livestock index.

Costs per unit were estimated over a 30-year period with 2023 being the start year. On-going costs have been discounted by using a default discount rate of 5% as recommended by the New Zealand

[1] Kaipara Moana Remediation (KMR) – Schedule of Prices (October 2023), https://kmr.org.nz/wp-content/uploads/2023/10/KMR-Schedule-of-Prices_Oct23.pdf

[2] Muller, C., Stephens, T. (2020) *Riparian area management scenarios for inclusion in Auckland Council's Fresh Water Management Tool – Stage 1*. Final report for Auckland Council [Accessed: 25 May 2021].

[3] Muller, C., Ira, S. & Stephens, T. (2020) *Incorporating cost and benefit information for rural sector mitigations into Auckland Council's FWMT – Stage 1*. Perrin Ag Consultants & Koru Environmental Consultants, prepared for Auckland Council. [Accessed: 10 July 2021].

Treasury guidelines.[4] Capital costs are allocated in the first year with renewal / replacement costs incurred in future years as applicable. Ongoing maintenance costs are allocated from Year 2 to Year 30. Opportunity costs from reduced operating cash surplus are considered on an annual basis from Year 1. The value of carbon credits generated was the only positive benefit included in the estimation.

Costings are differentiated, where applicable, depending on land use: dairy, and sheep and beef; and topography: lowland (<15^{o}) and upland (>15^{o}). Average costs were used to calculate the base values from which upper and lower bound estimates were calculated using a margin of plus/minus 20%.

All scenarios within this report require assumptions for simplification and to ensure the limitations of existing evidence are respected. Some of the important assumptions include:

- Costs associated with earthworks, culverts, subdivision of paddocks and resource consents that may be necessary have not been included unless stated otherwise.

- Farmers do not apply for a resource consent that would allow stock within the area from which they are being excluded, i.e., the options are costed as if the exclusion of stock was a prohibited activity. The one exception is for space planting poplars on highly erodible land where livestock grazing is assumed to continue under a resource consent provision.

- There are no borrowing costs associated with capital works.

- No environmental benefits of the ecosystem services provided by the implementation of the mitigation options such as amenity, biodiversity and cultural health values have been considered.

3. Costing of components

The purpose of this section is to outline the major sources and assumptions used to estimate the cost per unit values for each of the four cost components: fencing, stock water reticulation, opportunity cost and planting.

Fencing costs

The type of fencing required to exclude stock varies depending on the stock type and terrain. The analysis assumes that best practices are being implemented that enable a lifespan for fencing to be set at 25 years. Therefore, fencing capital costs are applied in the starting year (Year 1) and Year 25 of the project. Per metre fencing capital and maintenance costs were based on costs estimated by the KMR Programme. These estimates include material, labour and site preparation costs. Maintenance costs are calculated as 1% of the capital cost for fencing on lowland and 2% for fencing on upland.[5] It is assumed that maintenance costs are held constant across the years in real terms. The difference between the costings for lowland and upland reflects higher labour and site preparation costs.

[4] https://www.treasury.govt.nz/information-and-services/state-sector-leadership/guidance/financial-reporting-policies-and-guidance/discount-rates

[5] Ministry for Primary Industries (2016), National Stock Exclusion Study: Analysis of the costs and benefits of excluding stock from New Zealand waterways, https://www.mpi.govt.nz/dmsdocument/16513-National-Stock-Exclusion-Study-Analysis-of-the-costs-and-benefits-of-excluding-stock-from-New-Zealand-waterways-July-2016#:~:text=To%20help%20with%20the%20development,cattle%20and%20deer%20from%20waterways.

Costings are built on the assumption that an electric 2-wire is used for the exclusion of stock on dairy farms and an electric 4-wire fence for sheep and beef farms. Although there are more fencing types available, they are not incorporated in this work. Notably, the material cost for a non-electric 8-wire fence is nearly twice as high as the material cost for an electric 4-wire.

Table 1 summarises the total present value of fencing costs over a 30-year period by land use and topography. For each of the land use types, the cost of fencing upland areas is about twice as high as for lowland areas. These costs are for fencing one side of the stream only.

Table 1: Total present value for fencing capital and maintenance costs, $ per metre (one side)

Fencing cost type	Dairy – 2 wires lowland	Dairy – 2 wires upland	S&B – 4 wires lowland	S&B – 4 wires upland
Capital	$15.72	$28.82	$20.31	$36.68
Maintenance	$1.82	$6.66	$2.35	$8.48
Total	$17.54	$35.48	$22.65	$45.16

Stock water reticulation costs

The exclusion of stock from waterways by fencing may require the landowner to provide stock water reticulation when the waterway was providing the source of drinking water for stock. The cost of stock water reticulation follows the methodology and pricing set out in the National Stock Exclusion Study (MPI, 2016). The capital cost for a stock water reticulation system capable of supporting a 50-hectare area is $13,574, equivalent to $271/ha or $0.03/m^2.[6] To convert this to a per metre value, it is assumed that every metre of waterway supports a 350-metre wide "buffer" of pasture. This gives a reticulation capital cost of $9.50 per metre of stream (one-side only). Since these are 2016 prices, an adjustment for inflation using the Farm Expenses Price Index results in a price of $12.77 per metre. The on-going maintenance cost of stock water reticulation is calculated as 1.5% of the capital costs and is assumed to increase at a rate of 1% above inflation for every following year. Discounting the capital and maintenance costs provides a present value of $16 per metre (one side) for stock water reticulation.

Opportunity cost

Opportunity cost is an on-going annual cost based on forgone production, as represented in the analysis by the loss of operating profit.[7] The analysis estimates separate operating profit values for both topology (lowland and upland) and land use types (dairy, and sheep and beef). Data is drawn from industry sources: Dairy NZ Economic Surveys and Beef+Lamb NZ Economic Service, Sheep and Beef Farm Surveys.[8] Three-year averages (2020/21-2022/23) were used. For sheep and beef, the Northern North Island Class 5 finishing data was used for lowland and the Northern North Island Class 4 hill country data used for upland.[9]

[6] This includes the cost of five concrete troughs, 1km of alkathene pipe, a culvert, ram pump and a 25,000-litre water tank.

[7] Defined as revenue minus farm working expenses. Farm working expenses do not include costs such interest and rent and is calculated before tax and drawings.

[8] Dairy NZ Economic Surveys are available at https://www.dairynz.co.nz/publications/dairy-industry/ and the Beef+Lamb Economic Service farm survey data by farm classes are available at https://beeflambnz.com/industry-data/farm-data-and-industry-production/sheep-beef-farm-survey.

[9] Note that the B&L Northern North Island region covers Northland, Waikato and Bay of Plenty. Separate regional data for Northland is not available.

For dairy, only a Northland average is available covering all slope classes.[10] To calculate separate lowland and upland values for dairy, it is assumed that the operating profit for dairy farming on upland is 60% of the average for all slope classes.[11] Accounting for the proportion of dairy farming that takes place on upland (28%), the operating profit on lowland is calculated to be 115% of the average for all slope classes. For example, the average operating profit for owner-operators in Northland is $2,905/ha for the three-year period 2020/21 to 2022/23. From this, an annual operating profit of $3,350/ha and $1,743/ha for lowland and upland respectively is estimated.

Table 2 summarises the total present value of the opportunity cost over a 30-year period by land use and slope class. For both land use types, the opportunity cost of land taken out of production in upland areas is about half that of lowland. For both slope classes, the opportunity cost of dairy is about three times that of sheep and beef.

Table 2: Total present value of the opportunity cost by land use and slope class, $ per m^2

Cost component	Dairy lowland	Dairy upland	S&B lowland	S&B upland
Opportunity cost (operating profit)	$3.73	$1.94	$1.32	$0..73

Planting costs

Two different types of planting costs were estimated: riparian planting along the waterways from which stock are being excluded and tree planting regimes for highly erodible land. Neither of these are proposed rule requirements. However, they are included to supplement the analysis by indicating what the costs may be of planting the area from which stock are excluded. In the case of riparian planting, this may be for the purpose of maximising the environmental benefits, such as increasing the nutrient runoff or improving the biodiversity value. In the case of highly erodible land, this is provided to give an indication of the economic incentives for alternative land uses if livestock are excluded.

Riparian planting by waterways

The riparian planting costs are based on an average spacing of 1.33 metres between plants. This is a simple average weighting of the KMR Programme recommended per metre spacings of 1, 1.5 and 1.5 in Zones A, B and C.[12] An average cost of $1.80 per plant is used as per the October 2023 KMR schedule of prices. Adding in the cost of site preparation and planting, varying as to whether it is taking place in lowland or upland, results in a planting cost of $2/m^2 for lowland waterways and $2.30/m2 in upland waterways. The planting cost includes plant, labour and site preparation costs but excludes fertiliser, weed matting and plant guard expenses.

Ongoing maintenance costs are then added and include general maintenance as well as replacement plant costs. The analysis assumes that replacement costs are incurred in the next three years following the initial planting. Costs for Year 5 and onwards are based on a general maintenance medium cost of $0.05/m^2.

[10] Data is for owner-operator ownership class.

[11] Praat, J. (2011) *Farming by land type: An approach to building resilient Northland sheep and beef farms*. Hamilton, Landcare Trust. Available at: www.carbonfarming.org.nz/wp-content/uploads/articles/Farming-by-Land-Type_-final.pdf. [Accessed: 15 August 2021].

[12] https://kmr.org.nz/wp-content/uploads/2023/02/KMR-Planting-Guide-Feb-2023.pdf

Table 3 summarises the total present value of riparian planting over a 30-year period by slope class. It makes no difference as to the land use type, noting that the opportunity cost of lost operating cash surplus associated with the land used for riparian planting differs and is covered above in Table 2. These costs are for planting one side of the stream only.

Table 3: Total present value of riparian planting costs by land use and slope class, $ per m^2

Cost component	Dairy lowland	Dairy upland	S&B lowland	S&B upland
Riparian planting	$3.52	$3.82	$3.52	$3.82

Tree planting on highly erodible land

Four alternative tree planting regimes are costed for the situation where livestock are excluded from highly erodible land: (i) an indigenous forest, (ii) a permanent *pinus radiata* forest, (iii) a *pinus radiata* clearfell production forest and (iv) space-planting of poplar trees. The cost input for each afforestation option includes capital and maintenance costs for forest establishment such as land preparation, tree costs and planting. Forest planting density ranges between 1000 to 2000 stems per hectare for most permanent plantation. The analysis assumes 1500 stems/ha for an indigenous forest and 1000 stems/ha for *pinus radiata*. Poplars are planted at 100 poles/ha. Average seedling costs of $3.50, $0.80 and $2.30 per plant are used for indigenous, *pinus radiata* and poplars respectively.

Cost information for a *pinus radiata* clearfell production forest regime was drawn from Satchell 2021.[13] The regime follows an approach of single waste thin at Year 9 to 450 stems per hectare with no pruning and harvest at Year 28. The harvesting costs include roading, logging, transport to port and harvesting and marketing agent services to organise the tree crop harvest. An average log volume of 656.5 m^3 per hectare has been assumed. In terms of the harvest returns, this was estimated based on a price of $150/$m^3$. This is a weighted average of annual export and domestic prices (weighted two-thirds/one-third) over the five years 2019-2023.

Table 4 summarises the total present value of costs over a 30-year period by tree planting regime. The negative value for the clear fell harvest regime indicates a positive return of almost $9,000 per hectare rather a cost, with harvest returns exceeding planting and harvesting costs. The cost of planting an indigenous forest is three times the cost of planting a permanent *pinus radiata* forest.

Table 4: Total present value of planting costs by tree planting regime, $ per ha

Cost component	Indigenous	Pinus radiata permanent	Pinus radiata clearfell harvest	Space planting poplars
Planting costs	$11,252	$3,452	-$8,952	$630

[13] Satchell D, 2021, Land Use Options and Economic returns for Marginal Hill Country in Northland, Northland Regional Council, Available at: https://www.nrc.govt.nz/media/chij2gop/land-use-options-and-economic-returns-for-marginal-hill-country-in-northland-final.pdf

Carbon stock

Although this analysis focuses on the costs of the stock exclusion options, it also considers the economic gains generated from carbon sequestration in forestry systems on highly erodible land to help better inform decisions on land use change. The economic returns of a forested area could help offset the total cost of its establishment.

As a forest grows, it stores carbon and landowners that have registered their forest under the New Zealand Emissions Trading Scheme (NZ ETS) earn units for that carbon storage. Under stock change landowners keep earning units as long as the change in carbon stock is positive when they submit an emissions return. In the case of permanent forests, landowners can keep earning units until the forest reaches a steady state. The carbon stock market is expected to grow rapidly as New Zealand adjusts to the targets set by the Climate Change Commission.

This work assumes that each forested area is registered under the NZ ETS. Data on the carbon stock per tree species (expressed as tonnes of carbon dioxide per hectare) have been drawn from the Climate Change (Forestry Sector) Regulations 2008. [14] For the clearfell *pinus radiata* production forest costing, it is assumed that averaging applies under which the carbon sequestration credits are earned for the first 16 years growth only. No carbon stock value was estimated for the space planting costing. In line with the recent announcement by MPI, an annual charge of $30.25 per hectare of ETS registered land was included.[15]

The carbon stock price is held constant (real terms) at $35 per unit for the 30-year period which aligns with the Ministry for the Environment's 2021 emissions reduction plan discussion document.[16] This is likely to underestimate the economic benefit gained from carbon storage under the NZ ETS, considering the forecasts for an increasing trend in the carbon stock price.[17] Using this price and the growth in carbon stock per tree species, Table 5 summarises the total present value of the carbon revenue stream for the three tree planting regimes, net of MPI annual charges. The carbon returns from a permanent *pinus radiata* plantation are around four times that of the indigenous forest.

Table 5: Total present value of carbon returns by tree planting regime, $ per ha

Cost component	Indigenous	Pinus radiata permanent	Pinus radiata clear fell harvest	Space planting poplars
Carbon returns	$3,439	$13,211	$8,094	Not considered

[14] New Zealand Legislation, 2008, Tables of carbon stock per hectare for post-1989 forest land, Schedule 6. Available at: https://www.legislation.govt.nz/regulation/public/2008/0355/latest/DLM1633733.html (Accessed: 28 August 2021)

[15] https://www.mpi.govt.nz/forestry/forestry-in-the-emissions-trading-scheme/ets-forms-fees-and-policies/service-fees-for-forestry-in-the-ets/

[16] Ministry for the Environment. (2021) *Te hau marohi ki anamata. Transitioning to a low-emissions and climate-resilience future: Have your say and shape the emissions reduction plan* (p.116). Wellington, New Zealand. Available at: https://environment.govt.nz/assets/publications/Emissions-reduction-plan-discussion-document.pdf

[17] ANZ, 2022, Insight Carbon Market, ANZ, Available at: file:///C:/Users/emmanouelag/Downloads/ANZ-Insight-Carbon-Market-20220201.pdf [Accessed: 23 May 2022].

4. Costing of options for excluding stock from waterways

Stock exclusion options

For the exclusion of stock from waterways, four different riparian setback lengths are being considered: three, five, ten and thirty. Waterways are defined as all permanent and intermittently flowing rivers and streams. The total length of waterways flowing through pastoral land in Northland is 11,373km.[18] Table 6 provides estimates by land use type and slope class.[19]

Table 6: Estimated total length of intermittent and perennial streams in Northland by land use and slope class, kilometres

Total length of waterway in pasture	Dairy lowland	Dairy upland	S&B lowland	S&B upland
11,373km	3,328km	1,271km	3,581km	3,194km

The per unit values in Tables 1 and 2 were multiplied by these unit values to obtain total estimates for each of the cost components: fencing, stock water reticulation and opportunity cost. While the first two cost components remain the same for each of the setback options, the opportunity cost varies by the width of the riparian margin. For both dairy and sheep and beef, in recognition that the buffer area is often not as productive as other effective farmed area, it is assumed that the operating cash surplus generated on the buffer area is lower than the average for that land use/slope class combination.[20] These are set out in Table 7 along with the assumptions around the applicability of the total cost components for fencing and water reticulation costs to the four setback options. The wider the setback option, the greater the costs imposed. As the extent of this requirement is not known, the analysis assumes that it is always required when livestock are excluded. Therefore, the total costs for the fencing mitigation options may overstate the actual cost if alternative water sources are already available.

Table 8 summarises the results of this calculation. In addition to the total cost of the option, it provides an estimate of the annual average cost for dairy and sheep and beef farms and as a share of cash operating surplus over the 30-year period. These averages are calculated using a total number of 720 dairy farms and 1,455 sheep and beef farms in Northland with average operating profits of $181,662 and $117,135 per farm respectively. For example, the five-metre setback option is estimated to cost each dairy and sheep and beef farm between $10,000 and $16,500 each year for 30 years. This represents an annual cost equivalent to 6%-8% of an average dairy farm profit and 9%-14% of an average sheep and beef farm profit.

[18] Estimated using council's recently Digital River Network (DRN) model and Manaaki Whenua's Land Cover Data Base (LCDB) version 5.

[19] The separation of the total into land use types and slope class is based on modelling work done by NIWA.

[20] Muller, C., Ira, S. & Stephens, T. (2020) *Incorporating cost and benefit information for rural sector mitigations into Auckland Council's FWMT – Stage 1*. Perrin Ag Consultants & Koru Environmental Consultants, prepared for Auckland Council. [Accessed: 10 July 2021].

Table 7: Major assumptions used to estimate cost components for various setback lengths

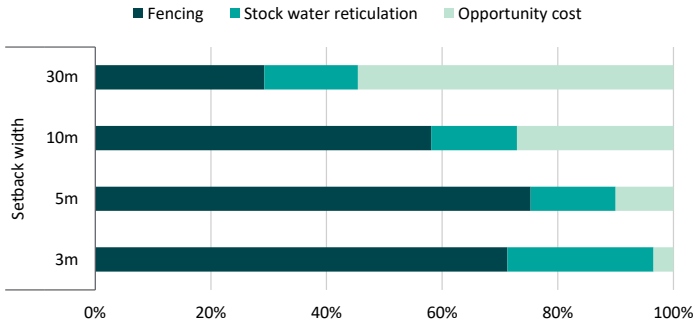
Riparian setback length	Application of fencing costs	Application of stock water reticulation requirements	Reduction in opportunity cost of margin
3 metres	Applies to S&B upland only as existing stock exclusion rules and regulations cover other three situations, and that 25% of S&B upland waterways are already fenced to this requirement	Stock water reticulation is needed for 75% of S&B upland waterways	25%
5 metres	Requires 100% new fencing everywhere	Stock water reticulation is needed for 100% of S&B upland waterways, and 10% of existing dairy and S&B lowland waterways	20%
10 metres	Requires 100% new fencing everywhere	Stock water reticulation is needed for 100% of S&B upland waterways, and 25% of existing dairy and S&B lowland waterways	10%
30 metres	Requires 100% new fencing everywhere	Stock water reticulation is needed for 100% of all waterways	No reduction

Table 8. Estimated cost of waterway stock exclusion options

Stock exclusion distance from waterway	Total cost	Average annual total cost over 30 yeats	Average annual cost per unit over 30 years		% average farm operating profit before tax		Proportion of total cost incurred in first five years
	$million	$million	$ per dairy farm	$ per S&B farm	% dairy	% S&B	% total costs
Three-metre setback	$240 - $360	$8 - $12	$0 - $0	$5500 - $8200	0% - 0%	5% - 7%	70%-80%
Five-metre setback	$700 - $1050	$23 - $35	$10200 - $15300	$11000 - $16500	6% - 8%	9% - 14%	
Ten-metre setback	$910 - $1350	$30 - $45	$16700 - $24500	$12600 - $18800	9% - 13%	11% - 16%	
Thirty-metre setback	$1800 - $2690	$60 - $90	$43500 - $65300	$19700 - $29300	24% - 36%	17% - 25%	

Figure 1 shows the breakdown of the total cost by cost component. Fencing costs account for the around 70% of the total costs incurred through three and five metre setbacks. As the setback width increases, the opportunity cost of lost production increases. At 30 metres, the opportunity cost of lost production represents almost two-thirds of the estimated total cost.

Figure 1. Cost components of waterway stock exclusion options by setback width



Virtual fencing

The costing analysis contained in the consultation document focused on traditional "hard" fencing as the method employed to exclude stock from waterways. An alternative method now available to farmers is virtual fencing. Virtual fencing enables livestock to be confined or moved using collars with coordinates, wireless technologies and sensors to control the location of livestock without the need for an actual fence. Information gathered indicates the following costs are associated with establishing a virtual fencing system on a New Zealand farm.

- Capital costs of $5,000 per farm for a base station and $350 per animal collar
- Platform subscription fee of $2 per month per animal
- Average life expectancy of a collar of 15 years.

Over a 30-year period the cost for the initial animal collar, annual platform subscription fee and collar replacement is estimated at just under $1,100 per animal. Using these costing it was estimated that installing virtual fencing systems on the estimated 2,175 farms in Northland containing 672,000 dairy and beef cattle would cost $600 -$900 million, slightly higher than the $520 - $790 million cost for hard fencing all water ways. While slightly higher in cost, virtual fencing can provide other benefits such as improved feed utilisation, reduced overgrazing, and better weed control and nutrient management.

The financial incentive to adopt virtual fencing at the farm level will depend on the length of stream on the farm required to be fenced under the proposed rules. Based on certain assumptions about the stocking rate and land type, a high-level estimate can be made of the minimum stream length required to be fenced after which virtual fencing may become the cheaper option, all other factors held constant. As an example, the Figure 2 shows that for the modelled dairy farm, if there was more than 9km of stream length requiring stock exclusion on the model dairy farm, it would be cheaper to establish a virtual fencing system rather than "hard" fence the stream length, all other things being equal. For the modelled sheep and beef farm it is 5.4km. The length of stream required is shorter for sheep and beef farms because of the high proportion of land assumed to be upland and thereby having higher fencing costs.

Figure 2. Comparison of "hard" fencing and virtual fencing costs on modelled dairy and sheep and beef farms

Notes:

1. Modelled dairy farm has 400 dairy cattle (cows in milk and replacements); and 70% of stream length is lowland, 30% hill country.
2. Modelled S&B farm has 415 animals; and 50% of stream length is lowland, 50% hill country.

Riparian planting

Although not a rule requirement, an estimate was made of the cost to plant the riparian margin by multiplying the per metre costs in Table 3 by the length of waterway length in Table 6 and the appropriate riparian buffer width, accounting for planting on both sides of the waterway. The results are presented in Table 9.

Table 9. Estimated riparian planting costs of waterway stock exclusion options

Stock exclusion distance from waterway	Total cost	Average annual total cost over 30 yeats	Average annual cost per unit over 30 years		% average farm operating profit before tax		Proportion of total cost incurred in first five years
	$million	$million	$ per dairy farm	$ per S&B farm	% dairy	% S&B	% total costs
Riparian planting							
Three-metre setback	$60 - $90	$2 - $3	n.a.	$1400 - $2100	n.a.	1% - 2%	55%-65%
Five-metre setback	$330 - $500	$11 - $17	$6000 - $9300	$4600 - $6900	3% - 5%	4% - 6%	
Ten-metre setback	$660 - $990	$22 - $33	$12000 - $18500	$9200 - $13500	7% - 10%	8% - 12%	
Thirty-metre setback	$1980 - $2970	$66 - $99	$36600 - $55100	$27300 - $40800	20% - 30%	23% - 35%	

5. Costing of options for excluding stock from highly erodible land

For the exclusion of stock from highly erodible land, two options based on erosion risk are proposed (HEL): land of severe erosion risk (HEL2) and land of high erosion risk (HEL1). Definitions and area of these two HEL options are set out in Table 10. A practical fencing factor is applied being the total area that needs to be fenced off to enable the practical fencing of the HEL area. For example, for HEL2, a practical fencing factor of four indicates an additional area equivalent to the three times the HEL2 area would be required to be taken out of production, i.e., a total of 37,268 hectares. The analysis also assumes that no dairy farming takes place on either highly erodible land definitions.

Table 10. Definition, area and practical fencing factor for HEL options

Highly erodible land	Definition	HEL area (ha)	Practical fencing factor
HEL 1	Land with slope between 25°-35°	33,581	2
HEL 2	Land with slop greater than 35°	9,317	4

The per unit values in Tables 1 and 2 were multiplied by these unit values to obtain total estimates for fencing and opportunity cost. To convert the fencing cost per unit values from metres to hectares it is assumed that it requires on average 200 metres of fencing for every one hectare of forest cover.[21] In terms of opportunity cost measured in terms of cash operating revenue, it is assumed that HEL land is 40% less productive than other areas of upland farming. Once livestock are excluded, the landowner has options for using that land for other purposes. The four alternative tree planting regimes set out in Table 4 along with the relevant carbon returns in Table 5 were applied to the total area fenced off. In the case of space planting, it is assumed that stock grazing can continue but at a slightly reduced

[21] 200 metres is the average length of fencing per hectare of forest in a four-hectare forest block fenced as a square.

rate, with an assumption of a 25% loss in cash operating revenue compared to a 100% loss assumed for the other regimes. Table 11 summarises the results of this calculation.

Table 11. Estimated cost of highly erodible land stock exclusion options

	Total cost	Average annual total cost over 30 yeats	Average annual cost per unit over 30 years		% average farm operating profit before tax		Proportion of total cost incurred in first five years
Land use options in HEL definitions	$million	$million	$ per dairy farm	$ per S&B farm	% dairy	% S&B	% total costs
HEL 1 (land with 25^0 < slope < 35^0)							
Fence off and leave	$720 - $1080	$24 - $36	n.a.	$16500 - $24700	n.a.	14% - 21%	70%-75%
Indigenous	$1140 - $1710	$38 - $57	n.a.	$26100 - $39200	n.a.	22% - 33%	90%-95%
Pinus radiata (permanent)	$200 - $290	$7 - $10	n.a.	$4600 - $6600	n.a.	4% - 6%	90%-95%
Pinus radiata (harvest)	$-200 - $-290	$-7 - $-10	n.a.	$-4600 - $-6600	n.a.	-4% - -6%	40%-50%
Space planting (poplar)	$580 - $870	$19 - $29	n.a.	$13300 - $19900	n.a.	11% - 17%	90%-95%
HEL 2 (land with slope > 35^0)							
Fence off and leave	$400 - $600	$13 - $20	n.a.	$9200 - $13700	n.a.	8% - 12%	70%-75%
Indigenous	$630 - $950	$21 - $32	n.a.	$14400 - $21800	n.a.	12% - 19%	90%-95%
Pinus radiata (permanent)	$110 - $160	$4 - $5	n.a.	$2500 - $3700	n.a.	2% - 3%	90%-95%
Pinus radiata (harvest)	$-110 - $-160	$-4 - $-5	n.a.	$-2500 - $-3700	n.a.	-2% - -3%	40%-50%
Space planting (poplar)	$320 - $480	$11 - $16	n.a.	$7300 - $11000	n.a.	6% - 9%	90%-95%

6. Costing of options for excluding stock from wetlands

For the exclusion of stock from wetlands, there are two options based on the size of wetland area: wetlands greater than 2000m^2, and wetlands greater than 500m^2 but less than 2000m^2. The options only apply to the upland area of sheep and beef farms as current rules require stock to be excluded from wetlands elsewhere. As detailed mapping of wetlands in Northland is not currently available, an estimate was made based on a detail wetland mapping exercise done by the Department of Conservation (DOC) in the Doubtless Bay and Waihou catchments. Based on this work, this analysis estimates a total of approximately 2,500 hectares of wetlands greater than 2000m^2 exist in upland areas of sheep and beef farms in Northland and around 300 hectares in the 500m^2-2000m^2 size option.

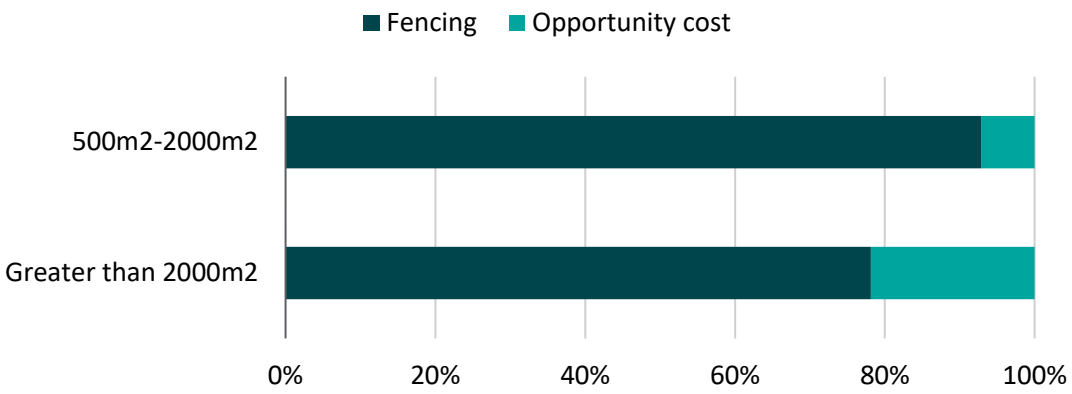
The per unit values In Tables 1 and 2 were multiplied by these unit values to obtain total estimates for two cost components: fencing and opportunity cost. It was assumed that the productivity of the wetland area was only 75% of the upland average. In terms of the length of fencing required, the DOC analysis indicated that across the two catchments, the average perimeter of wetlands greater than 2000m^2 was 860m per hectare, and 3,130m per hectare for wetlands 500m^2-2000m^2. Based on these assumptions, Table 12 summarises the results of this calculation.

Table 12. Estimated cost of wetland stock exclusion options

	Total cost	Average annual total cost over 30 yeats	Average annual cost per unit over 30 years		% average farm operating profit before tax		Proportion of total cost incurred in first
Wetland area options	$million	$million	$ per dairy farm	$ per S&B farm	% dairy	% S&B	% total costs
Wetlands greater than 2000^2	$50 - $70	$1.7 - $2.3	n.a.	$1100 - $1600	n.a.	0.9% - 1.4%	65%
Wetlands 500m^2-2000m^2	$20 - $30	$0.7 - $1	n.a.	$500 - $700	n.a.	0.4% - 0.6%	

The average cost of exclusion is estimated to be $25,000 per hectare for wetlands greater than 2000m^2 and $76,000 per hectare for wetlands 500m^2-2000m^2. The greater length of fencing required is the main factor driving the higher per hectare cost for the smaller sized wetlands. Figure 3 shows the breakdown of the total cost by cost component. Fencing costs account for the around 75% of the total costs incurred for larger wetlands but more than 90% for the smaller wetlands.

Figure 3. Cost components of wetland stock exclusion options by area



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