Assessing the effectiveness of on-farm mitigation actions

WHO IS THIS RESEARCH BRIEF FOR?

Primary industry bodies

Catchment groups

Farm advisors

Farmers and growers

Central government

NGOs

Rural lenders

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PROJECT TIMELINE

October 2016 – December 2019

Key points

Our rivers would be in much worse condition today if farmers had not adopted better practices between 1995 and 2015.

Significantly more nitrogen (45% more) and phosphorus (98% more) would have entered rivers from dairy-farmed land between 1995 and 2015 if farmers hadn't changed their practices.

On sheep and beef farmed land, 30% more sediment would have entered rivers between 1995 and 2015 if farmers hadn't changed their practices.

Researchers estimated that if all known and developing mitigation actions were implemented by all dairy and sheep and beef farmers by 2035, potential loads of nitrogen and phosphorus entering rivers might decrease by one-third, and sediment by two-thirds, compared to 2015. For many catchments, this will be enough to meet current water quality objectives.

How can this research be used?

On dairy-farmed land, this research found that the most effective nitrogen and phosphorus mitigation practices used between 1995 and 2015 were stock exclusion, improved effluent management and better irrigation practices.

On sheep and beef farmed land, the most effective sediment mitigation practices used over the period were planting more trees, excluding stock from waterways, and soil conservation works.

If all known and developing mitigation actions were implemented by all dairy and sheep and beef farmers by 2035, the potential load of contaminant entering rivers would decrease by 34% (nitrogen), 36% (phosphorus) and 66% (sediment).

Additional research from Our Land and Water has enabled the identification of where reductions in nitrogen emissions are required to achieve the requirements of existing national regulations, and the amount by which this is necessary (Snelder et al, 2020). An interactive map of New Zealand showing total nitrogen in excess of current regulatory criteria and reduction potential has been created (**tinyurl.com/OLW-map**).

Adopting all known, established mitigation measures will enable most New Zealand catchments to meet current water quality objectives.

For some catchments and farms, applying all known and emerging mitigations may be less pragmatic than some change in land use or land use intensity.

Why is this issue important?

Farmers have been taking action to improve water quality for years. Despite much hard work and investment, some New Zealand rivers still aren't meeting community expectations for purity, swimmability and mahinga kai (food and resources). There is a risk of losing motivation to take further action without a measure of the overall impact of this work on New Zealand's water quality.

Expansion and intensification of the dairy sector (a 160% increase in production, with a 40% increase in dairy-farmed land area) has continued to put pressure on freshwater by increasing total nitrogen and phosphorus loss. This has made it harder to make improvements in water quality through actions. Nevertheless, improvements have been made and accelerating the adoption of mitigation actions will lead to significant further improvement in water quality.

What did we do?

Researchers connected to the Sources and Flows research programme undertook a national-scale assessment of the impact on water quality of adopting better practices on dairy, sheep and beef farms.

The researchers combined data on geographic and mitigation efficacy to model the total losses of N, P and sediment for around 130 farm typologies (depending on the contaminant), which considered landscape attributes (such as soil, topography and climate factors) and land use pressures (such as farm inputs and feed and stock management practices) that influence contaminant transport to water.

The research team estimated nitrogen (N), phosphorus (P) and sediment losses in 2015, and compared these to potential contaminant loads in scenarios including:

1. 2015, assuming the practices of 1995 were still in use (*Figure 1*)
2. 2035, assuming the full implementation of all regularly used and developing on-farm mitigation actions (*Figure 2*)
3. Introduction of national limits for dissolved reactive phosphorus (0.018 mg DRP/L) and dissolved inorganic nitrogen (1 mg DIN/L) – note this is not current policy (*Figure 3*)

What did we find?

Significantly more nitrogen (45% more) and phosphorus (98% more) would have entered rivers from dairy-farmed land between 1995 and 2015 if farmers hadn't changed their practices. On average over Aotearoa between 1995 and 2015:

- Dairy N losses increased from 46 to 49 kg N/ha/yr – but would have increased to ~72 kg N/ha/yr if farmers had not adopted better practices.
- Dairy P losses decreased from 1.7 to ~1 kg P/ha/yr – but would have increased to 2.1 kg P/ha/yr if farmers had not adopted better practices.
- Dairy sediment losses decreased from 350 T/km^2/yr to 260 T/km^2/yr – but would have decreased to about 320 T/km^2/yr if farmers had not adopted better practices.
- Sheep and beef N losses increased from about 11 to 13 kg N/ha/yr – but would have increased to 14 kg N/ha/yr if farmers had not adopted better practices.
- Sheep and beef P losses decreased from 0.9 to 0.75 kg P/ha/yr – but would have decreased to 0.8 kg P/ha/yr if farmers had not adopted better practices.
- Sheep and beef sediment losses decreased from 840 T/km^2/yr to about 700 T/km^2/yr – a similar decrease to that expected if farmers had not adopted better practices.

Note: Despite lower per hectare emissions, sheep and beef accounts for about three-quarters of national N, P and sediment losses, because much more land is in sheep and beef (8.3 million hectares) than dairy (2.3 million hectares).

The effect of on-farm mitigations 1995–2015

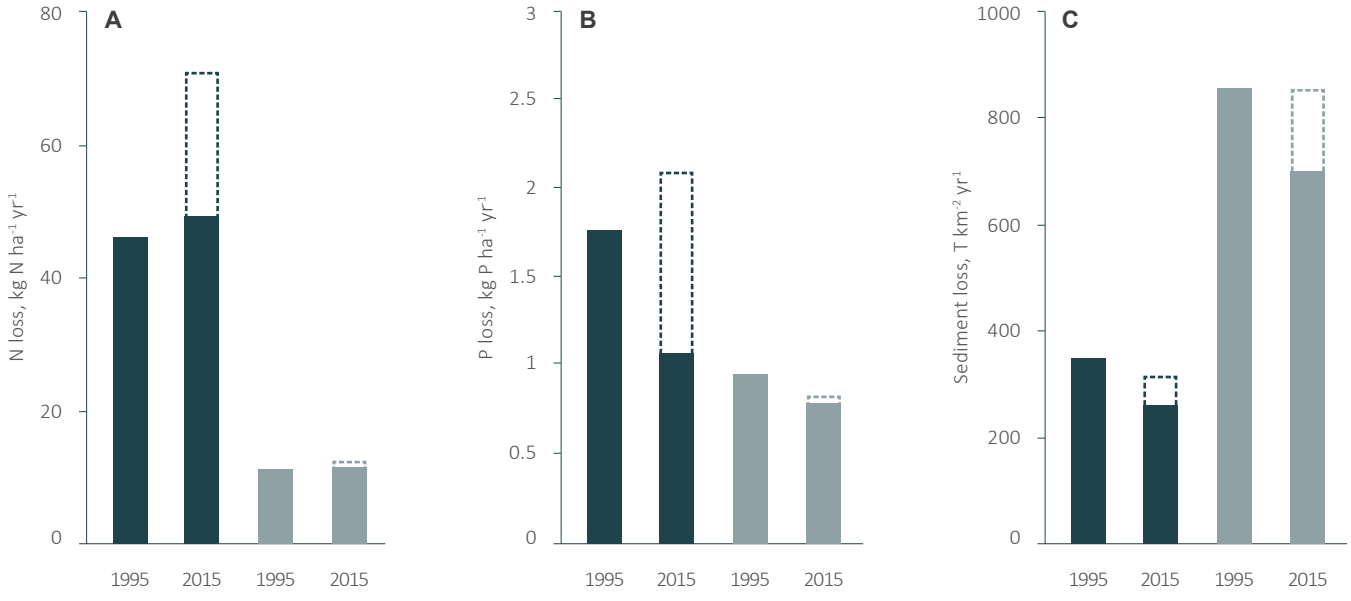
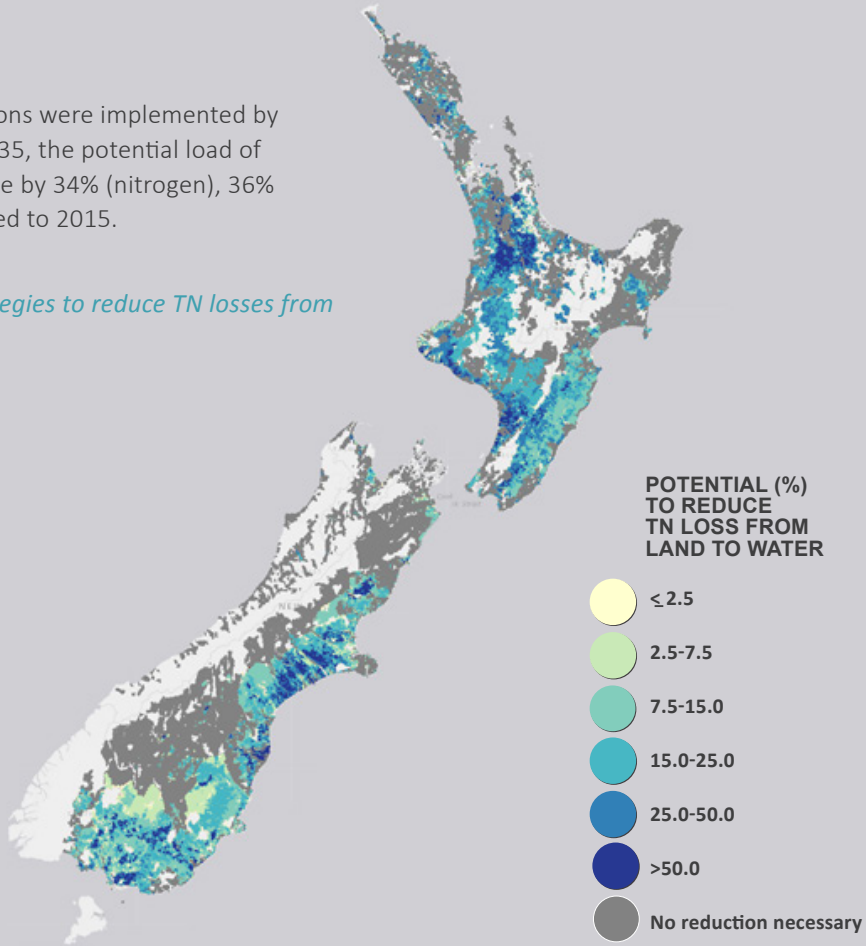


Figure 1. *Area-weighted estimates of (A) N, (B) P and (C) sediment yields from dairy (black bars) and sheep-beef (grey bars) farms with and without (including dashed bars) mitigation actions calculated for the period between 1995 and 2015.*

Best-case scenario for 2035

If all known and developing mitigation actions were implemented by all dairy and sheep and beef farmers by 2035, the potential load of contaminant entering rivers would decrease by 34% (nitrogen), 36% (phosphorus) and 66% (sediment) compared to 2015.

Figure 2. *The potential for mitigation strategies to reduce TN losses from land to water by 2035.*



See zoomable interactive map at tinyurl.com/OLW-map

Potential future national thresholds

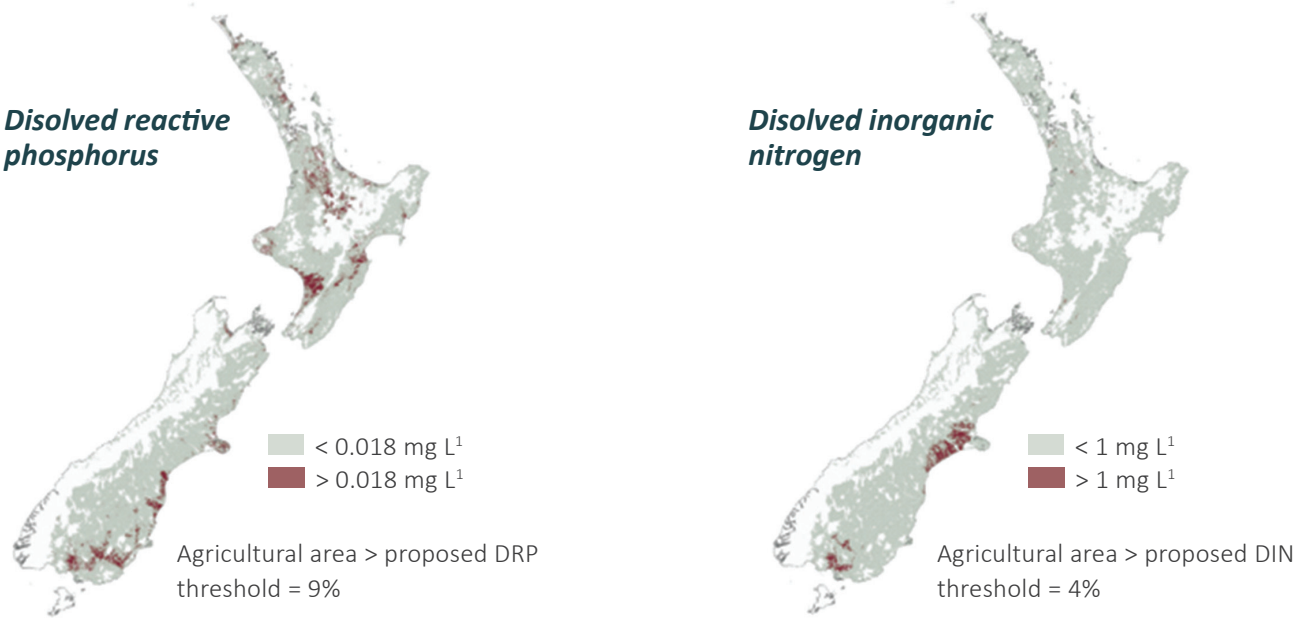


Figure 3. *Catchment areas in excess of potential new national limits for dissolved reactive phosphorus (0.018 mg DRP/L) and dissolved inorganic nitrogen (1 mg DIN/L) if all known and developing mitigations were applied by 2035*

Why isn't water quality better?

Despite the efforts of many farmers to care for our water, at the same time on other farms land use changed and farming intensified.

Land area used by dairy expanded 40% between 1995 and 2015, and together with changes on farm, total dairy production increased by around 160%. The land area occupied by sheep and beef contracted, but the intensity of production per hectare increased.

This increased food production continued to put pressure on freshwater by increasing total nitrogen loss. Mitigations were not sufficient to offset these increased nitrogen loads.

Next steps

The 2035 scenario considered by this research assumes that actions are implemented 100%. However, we know that this is often not the case. To improve the level and rate of implementation, Our Land and Water is funding research to record efforts to improve water quality within catchments (Register of Land Management Actions), and research to identify how to best monitor the water improvement from those management actions (Environmental Catchment Monitoring). We hope this will help farmers and catchment groups learn from each other and instill confidence to act.

Existing catchment management groups have helped farmers and others take collective responsibility to try to achieve desired water quality outcomes. With further leadership and engagement, this approach could evolve into a more accountable, innovative and effective vehicle for advancing environmentally sustainable agriculture. Our Land and Water's New Models of Collective Responsibility programme will produce recommendations for how government and the primary sector can most effectively support catchment collectives.

Key publications

Quantifying contaminant losses to water from pastoral land uses in New Zealand II. The effects of some farm mitigation actions over the past two decades Ross Monaghan, Andrew Manderson, Les Basher, Raphael Spiekermann, John Dymond, Chris Smith, Hans Eikaas, Richard Muirhead, David Burger, Richard McDowell. *Preprint available on request*

Quantifying contaminant losses to water from pastoral land uses in New Zealand III. What could be achieved by 2035? R.W. McDowell, R.M. Monaghan, L.C. Smith, A. Manderson, L Basher, D. Burger, S. Laurenson, P. Pletnyakov, Spiekermann R (New Zealand Journal of Agricultural Research, November 2020) **https://doi.org/10.1080/00288233.2020.1844763**

Implications of water quality policy on land use: A case study of the approach in New Zealand R. W. McDowell, P. Pletnyakov, A. Lim and G. Salmon (Marine and Freshwater Research, October 2020) **https://doi.org/10.1071/MF20201**

Nitrogen loads to New Zealand aquatic receiving environments: comparison with regulatory criteria Ton H. Snelder, Amy L. Whitehead, Caroline Fraser, Scott T. Larned & Marc Schallenberg (New Zealand Journal of Marine and Freshwater Research, May 2020) **https://doi.org/10.1080/00288330.2020.1758168**

Research Findings Brief: Quantifying excess nitrogen loads in fresh water, Our Land and Water (Toitū te Whenua, Toiora te Wai) National Science Challenge 2020

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National SCIENCE Challenges

Our Land and Water (Toitū te Whenua, Toiora te Wai) is working towards an agri-food and fibre system that enhances the vitality of te Taiao with a diverse mosaic of land uses that improve the health of land, water and people.

Our Land and Water is one of 11 National Science Challenges that focus on defined issues of national importance identified by the New Zealand public.

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