

IN THE MATTER

Of the Resource Management  
Act 1991

AND

IN THE MATTER OF

Proposed Southland Water and  
Land Plan

BY

Environment Southland

Submitter No: 279

Submitter Name: Forest & Bird

Date Received: 27/9 /17

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Submissions by Susan Elizabeth Maturin  
On behalf of the Royal Forest and Bird Protection Society

27 September 2017

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Royal Forest and Bird Protection Society  
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## Introduction

1. My name is Susan Elizabeth Maturin. I am the Otago/Southland Regional Manager for the Royal Forest and Bird Protection Society. I represent the National Office Forest and Bird Protection Society.
2. I have an MSc Hons in Natural Resource Management, specialising in ecology and over 20 years experience working in ecological management, resource management, planning and conservation in Canterbury, Waitaki, Otago and Southland. I have been involved in rapid ecological assessments of the Ecological Districts in Otago, high country tenure reviews, and river and wetland wildlife surveys.
3. Forest and Bird is a national organisation comprising over 80,000 supporters and members in 56 branches throughout New Zealand. My submissions today begin by an overview of the state of Southland's water bodies. I will then focus on our key concerns in response to the Officers Report. In doing so I do not resile from our original submission unless specifically stated.
4. Forest and Bird congratulates the Council on the excellent technical and monitoring reports, and the Section 32 and 42 A reports that have informed this proposed Plan and upon which we base our responses.
5. Forest and Bird has "Freshwater for Life" as one of our key campaigns, as our members have asked us to work towards achieving high water quality standards through-out New Zealand.
6. Forest and Bird recognises that the FMU planning process will set catchment limits and that the measures in this document are in effect interim measures to maintain or improve water quality prior to the development of catchment specific provisions in line with the NPSFW. Due to the ongoing deteriorating trends in many of Southlands water ways, the continuing expansion and intensification of farming and the time proposed to fully implement the NPSFW, the SLWP must have strong objectives policies and rules to prevent further deterioration, maintain existing water quality and improve those that are degraded.
7. Southland Communities wanted a 10% improvement in their water ways by 2020. This is unlikely to be achieved, given the number and extent of rivers that are unswimable, and the trends described in the water quality and ecosystem health section of the Report.
8. The impact of changing nutrient concentrations on the health of aquatic ecosystems is best measured with bio-indicators – MCI. The figure below shows changes in MCI in rivers between 2000 and 2010. You can see that the presence of red dots in South Canterbury and Southland indicates a decline in river health.
9. In the State and Trends Report of Southland 28% of sites with sufficient data for trend analysis had decreasing MCI trends, with no sites showing an improving trend.

A median degrading trend magnitude of 0.37% per year was observed for MCI of all 72 sites in Southland.<sup>1</sup>

10. The recent PCE update on water quality report found that losses of nitrogen and phosphorus are, being changed by farming practices and on dairy farms the changes have broadly gone in two opposing directions. The focus on growing productivity has led to higher stocking rates and greater use of inputs, driving up nutrient losses. But 'standard' mitigation practices struggle to keep nitrogen losses, in particular, from rising.
11. The Section 42A Report (The Report) indicates that Council is seeking to reduce the effects of farming practices primarily through non-regulatory approaches, such as education and advice through catchment support groups.
12. The fact that Southland's water quality has deteriorated and continues to deteriorate under the existing Water Plan, which in effect largely relies on voluntary methods with very limited regulatory controls, is testament to the need for a stronger regulatory regime that provides for the holistic management of risks to water quality. The current methods have not proved effective in achieving the Water Plan's Objectives, and tax payer funds are now needed to help clean up some of the regions waterways.
13. The Auditor General in her 2011 report endorsed your Council's moves to introduce a stronger regulatory approach to managing dairy farm effluent.<sup>2</sup>
14. The Environment Court has recognised that the non regulatory approach may not be the best way of meeting the Part II RMA obligations:
15. Royal Forest and Bird Protection Society of NZ v Northland Regional Council A33/98. There the concern was to ensure the Regional Policy Statement adequately dealt with the adverse effects to significant vegetation and habitat from animal and plant pests.
16. The Court preferred a "regulatory" approach as "better serving the sustainable management of natural resources."
17. In our view regulations put everyone on an equal footing as they will not affect those who voluntarily perform well and do not necessarily affect profitability. Large reductions in nitrate leaching can be achieved while remaining profitable as shown by the Lincoln University Dairy Farm. This farm is close to achieving a 30 per cent reduction in nitrate leaching, while maintaining its profitability.

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<http://www.es.govt.nz/Document%20Library/Presentations/Science%20Conference%20Posters%202016/State%20and%20Trends%20in%20Freshwater%20Macroinvertebrate%20Community%20Health%20in%20Southland.pdf>

<sup>2</sup> Auditor General, 2011. Managing freshwater quality: Challenges for regional councils  
<http://www.oag.govt.nz/2011/freshwater>

18. The Lincoln University Dairy Farm has reduced stock numbers by 11 per cent and at the same time is nearly matching the financial performance of high-profit farms against which it is benchmarked.
19. The results have been achieved by a combination of a reduced stocking rate, less imported feed, less applied nitrogen, a changed grazing rotation and different pasture species and applicable across New Zealand.<sup>3</sup>

### **Best Management Practice**

20. Forest and Bird supports and encourages the adoption of Best Management Practice, but we are also aware that the adoption of BMP is unlikely to result in the scale of improvements that are needed to maintain water quality, or enhance those that are degraded. The study of trends in water quality from five dairy farms including the Bog Burn in Southland found that although there was an overall downward trend in SS with generally improved water quality, TN increased in the Bog Burn as did E coli. Stream bank fencing helped reduce sediment loss and input of faecal matter and may have improved habitat quality. However despite these changes the concentration of TN, TP and E coli still exceeded the guidelines for ecosystem protection and contact recreation, and the authors noted that an uptake of a wider range of BMP would be need to achieve further reductions. The authors also noted that *"Commodity process and farmer's revenue affect their ability or willingness to undertake non-productive actions (e.g. adoption of BMP's) unless on farm benefit is perceived."*

### **Protection of Indigenous Biodiversity**

21. The protection of indigenous biodiversity is a critical issue for Forest & Bird and the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna is a matter of National Importance in S6 (C) RMA. and the maintenance of indigenous biodiversity is a function of Regional Councils. The Biodiversity provisions of the proposed Southland Regional Policy Statement have now been settled by consent order in the Environment Court dated 19 December 2016.
22. Policy BIO 2 Protect Significant areas – provides that these will be protected, and particular regard is to be had among other things, to the reduction in extent, loss of, or damage to buffering of significant ecosystems or significant habitats of indigenous fauna and loss or reduction of rare or threatened indigenous species populations or habitats; Policy Bio. 4 concerns the maintenance of indigenous biodiversity and includes having regard to the same above potential adverse effects.

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1. <sup>3</sup> <https://www.stuff.co.nz/business/farming/97071476/demonstration-dairy-farm-cuts-nitrate-leaching-30-per-cent-and-stays-profitable> 21 sept 2017

23. Method BIO.6 provides that provisions need to be made in regional plans to provide for case by case assessments to determine whether an area of indigenous vegetation or habitat of indigenous fauna is significant and warrant protection and for the control of vegetation clearance or modification of significant indigenous vegetation and sig habitats of indigenous fauna associated with wetlands, and lakes, rivers and their margins, and significant indigenous coastal ecosystems and significant habitats.
24. Forest and Bird considers that the pSWLP largely needs to better provide for the protection and maintenance of indigenous biodiversity, as required by the RMA, the Proposed Southland Regional Policy Statement, or the National Policy Statement for Freshwater Management 2014, updated in 2017.
25. The Report recommendations for additions to Appendix One – Regionally Significant Wetlands, are supported however these are not likely to be the only ones that should be added and there remains a requirement to ensure that all areas of significant indigenous vegetation and significant habitats of indigenous fauna, particularly wetlands, rivers, lagoons and lakes are identified and protected through the pSWLP.
26. In the p SLWP, Objective 14 deals with the maintenance of indigenous biodiversity and policy 32 deals with the protection of significant indigenous vegetation and habitat. Forest and Bird’s submission sought that there be an objective that provided for the protection of significant indigenous vegetation and their habitats. Given the structure of the proposed SWLP we thought this could best be included in Objective 9 as this deals with S6 matters but only in relation to the quantity of water. Objective 6 deals with maintaining and improving water quality but does not deal with safeguarding the life supporting capacity of ecosystems or the protection of indigenous species and their habitats.
27. The S42 Report (The Report) does not appear to have analysed our submission in relation to Objective 9. Forest and Bird is particularly concerned with the habitats of native fish and wetlands.
28. Areas of significant habitats for native fish have not been identified and the proposed plan does not include a process for identifying them. Most of our native fish are riverine.
29. Forest and Bird sought that there be a schedule identifying the habitat of threatened native fish species, and we understand that the Department of Conservation may be able to assist with this.

## **Native Fish**

30. New Zealand has 77 native fish species. New Zealand is one of the centres of diversity for the Galaxiidae. A distinctive feature of our freshwater fish fauna is that nearly half of the fish species migrate to and from the sea, probably more than in any other country, according to McIntosh and McDowall...

31. Unlike whitebait, which migrate to sea, some non-migratory galaxiid species live out their entire life in the stream or river in which they hatched. *Non-migratory galaxiids belong to an ancient, scale less fish family called Galaxiidae – for the galaxy-like gold flecks and patterns on their backs.*
32. Over millennia, these populations of galaxiids were isolated by geological events such as earthquakes and glacial movement. They evolved into distinct species, each with their own individual features and stories.
33. Southland has 3 non migratory threatened galaxiids., 1 Nationally endangered species *Galaxias pomahaka*, 2 nationally vulnerable species *Gollum galaxias*, *Alpine galaxias*.
34. Just over half of our fish (40 species or 52%) were classified as either at risk or threatened with extinction in 2013. Southland is home to one Nationally endangered species, 4 nationally vulnerable species, and eight species classified as threatened – *At Risk, Declining*. Only 6 native fish species found in southland are not classified as threatened.
35. Threats to native fish include, invasion of pests and weeds, habitat loss, habitat degradation and poor water quality.
36. It is particularly important that habitats of threatened species are protected from such instream works as weed and sediment removal in Rule 78, and Rule 73 Gravel extraction, and discharge rules especially in relation to sedimentation and turbidity.
37. Elevated levels of suspended sediments can physically damage tissues and organs of fish, or by decreasing light penetration and visual clarity which can cause changes in behaviours. Some species are more tolerant than others, thus suspended sediment concentrations could change the composition of fish fauna, for example Kokopu, smelt and redfin bully have likely to be intolerant species, whilst common bully, inanga, torrent fish and bluegill bully may be more tolerant. Turbidity can affect growth length of some species.<sup>4</sup>
38. The accumulation of fine sediment has the potential to alter the quantity and quality of physical habitat to the detriment of invertebrate and fish communities. Specifically, sediment smothers invertebrates and the stream bed and may clog the gills of fish. Infilling of spaces between stream bed gravels reduces the availability of habitat for invertebrates and prevents the movement of oxygenated water through the stream bed to support larval fish.<sup>5</sup>
39. I turn now to addressing some key rules.

### **Rule 13 Discharge from installed subsurface drainage systems**

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<sup>4</sup> Rowe DK et al: 2009. Lethal concentrations of suspended solids for common native fish species that are rare in New Zealand rivers with high suspended sediment loads – NZ Journal of Marine and Freshwater Research 24:1029-1038

<sup>5</sup>(<https://webcache.googleusercontent.com/search?q=cache:jaJ6aOihq6YJ:https://api.ecan.govt.nz/TrimPublicAPI/documents/download/1929584+&cd=5&hl=en&ct=clnk&gl=nz>)

40. Subsurface drainage is known to be a significant source of contaminants including nutrients, sediment and faecal micro organisms, as noted in The Report. An Otago Regional Council's study on the effects of land use on water quality in the Pomahaka catchment found that tiles draining dairy farms were typically well above the effects based water quality guidelines values for nutrients, and that sediment is an all year round issue at all flow levels. Sediment control is critical as it can smother habitat, harbour bacteria and bind phosphorous, which can then be released back into the system during low flows, potentially increasing algal growth. Ecoli can similarly be harboured and released.<sup>6</sup>
41. The permitted activity standards for the discharge of subsurface drainage systems are unlikely to meet the basic objective of maintaining water quality where it is not degraded and improving water quality where it is degraded. Forest and Bird seeks that these discharges be treated in the same manner as other discharges and be subject to meeting the standards set in Appendix E at least in the interim. These standards include measurable standards for visual clarity as well as faecal coliforms and other parameters.
42. Given that sedimentation can contribute to the deterioration of water quality and adverse effects on aquatic life, the permitted standard needs to have a standard for both suspended sediments and sedimentation. Discharges should not cause a noticeable increase in local sedimentation in the water way.
43. The proposed standard also fails to fully address the RMA requirements for rules about discharges, S70, as it fails to include 70 (1) (c). Before including a permitted activity rule for discharges the Council must be satisfied that the discharge will not result in the production of conspicuous oil or grease films, scums or foams, or floatable or suspended materials:

#### **Rule 22 New or Expanded dairy farms**

44. The Old Matura and Peat Wetlands physiographic zones, due to their predominant flow pathways, are more susceptible to contaminant loss compared to other physiographic zones, and The Report identifies that the Oxidising, Central Plains and Riverine Zones are similarly highly susceptible to nutrient loss, and water quality degradation. Given these factors Forest and Bird considers that Council needs to adopt a precautionary approach and in order to have more certainty of maintaining water quality and improving degraded water quality, new dairy farms in all these zones should be non complying

#### **Rule 23 Intensive Winter Grazing**

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<sup>6</sup> <http://webcache.googleusercontent.com/search?q=cache:oNM-usZug18J:www.orc.govt.nz/Documents/Publications/Research%2520And%2520Technical/surface-water-quality/Pomahaka%2520water%252>

45. As noted in the Report intensive winter grazing contributes significant amounts of contaminants to waterways, river systems and eventually, estuaries. The Report also notes that there is scientific rationale for intensive winter grazing in the Riverine and Oxidising physiographic zones to be treated the same as in the Old Maitava and Peat Wetlands zones.
46. Forest and Bird seeks that Rule 23 be amended so that From 1 May 2018 the use of land for intensive winter grazing in the Riverine and Oxidising physiographic zones is a non complying activity in the same manner as Old Maitava and Peat Wetlands.
47. The proposed vegetated riparian setbacks/buffers should be increased in width. Riparian margins are often considered to be costly in terms of lost land and fencing costs, when in fact there are likely to be economic benefits from wider restored riparian margins. Landcare Research recently investigated the potential environmental benefits and economic costs of riparian management. A summary of the paper is attached. They found that regardless of the type of restoration, the estimated reductions in N leaching and P loss are of similar magnitude at each buffer width, ranging from 50% reductions for the 5m width to 90% reductions for the 50m widths, however additional benefits of increasing riparian margins beyond 20m decrease, and this is 5m for soil loss. To compare the costs and benefits of a national riparian margin restoration policy the author's monetised the welfare gains from reduced GHG emissions, N leaching, P loss and sedimentation. Net benefits vary between \$2.1 billion and 5.2 billion annually depending on the cost scenario, and the benefits typically outweigh the costs by between 2:1 and 20:1.<sup>7</sup>

## **Rule 70 Stock Exclusion from Water Bodies**

48. Forest and Bird sought the exclusion of Sheep from various categories of water bodies. We recognise that sheep are not recommended for exclusion in the Government's Next Steps for Freshwater; however as The Report notes a regional council may need to adopt a more stringent approach to managing sheep due to individual circumstances and water quality issues.
49. The Report also states at Parra 10.300 that "...monitoring shows that five Southland catchments exceed the National Objectives Framework (NOF) E.coli secondary contact bottom line of 1000 E.coli/100 ml. All five of these locations have a positive sheep E.coli signature." The Report notes that 3 other streams do not meet bottom line contact recreations standards; Otatau Stream at Waikouro; • Opouriki Stream at Tweedie Road; • Winton Stream at Lochiel.
50. Fencing sheep out of the above water ways is needed to meet the objective of maintaining water quality and enhancing water quality where it is degraded. This needs to happen regardless of what the FMU process yields.

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<sup>7</sup> [https://www.landcareresearch.co.nz/\\_\\_data/assets/pdf\\_file/0014/125150/Policy-Brief-15-Restoring-riparian-margins.pdf](https://www.landcareresearch.co.nz/__data/assets/pdf_file/0014/125150/Policy-Brief-15-Restoring-riparian-margins.pdf)



## **Rule 78 Weed and sediment removal for drainage maintenance**

51. Allibone and Dare (2015) in their assessment of the effects of drain clearance in the Waihopai Catchment found that drain clearance can have negative impacts on instream communities, including threatened fish species such as the longfin eel (*Anguilla dieffenbachii*) and giant kokopu (*Galaxias argenteus*). Giant kokopu declined in numbers between the first and second surveys, and any remaining fish were found in areas where macrophytes were left untouched. The 'one year post clearance' survey found that longfin eel and giant Kokopu had declined further, and in particular, the giant kokopu catch had declined to a single fish.<sup>8</sup> These surveys also found at least 7 threatened species living in the drains, including the nationally vulnerable Lamprey.
52. Forest and Bird's submission is that drain maintenance in habitats where threatened fish are found be discretionary and that a schedule of threatened fish be added.
53. A discretionary status would allow consideration of how to mitigate, remedy or avoid impacts to threatened species which could include avoiding spawning reaches and seasons, leaving refugia and untouched areas, and practices that minimise disturbance to the banks.<sup>9</sup>

## **Rule 74 Gravel Extraction**

54. Gravel extraction can result in the loss of native fish habitats including spawning sites. Gravel bars are an important source of gravels for downstream river habitats and should be avoided.

## **Rule 79 – High Country Burning**

55. Forest and Bird agrees in part with the recommendations in The Report. We support the addition of consideration of the adverse effects on areas of significant indigenous vegetation and habitat, but not restricting that to those which are in proximity to wetlands, lakes and rivers and their margins. We consider that burning of indigenous vegetation should be a restricted discretionary activity in all the Fire Hazard Zones and prohibited above 1000m.

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<sup>8</sup><http://www.es.govt.nz/Document%20Library/Research%20and%20reports/Various%20reports/Science%20reports/Assessment%20of%20two%20drain%20clearance%20methods%20in%20the%20Waihopai%20Catchment.pdf>

<sup>9</sup><https://webcache.googleusercontent.com/search?q=cache:jaJ6aOihq6YJ:https://api.ecan.govt.nz/TrimPublicAPI/documents/download/1929584+&cd=5&hl=en&ct=clnk&gl=nz#16>

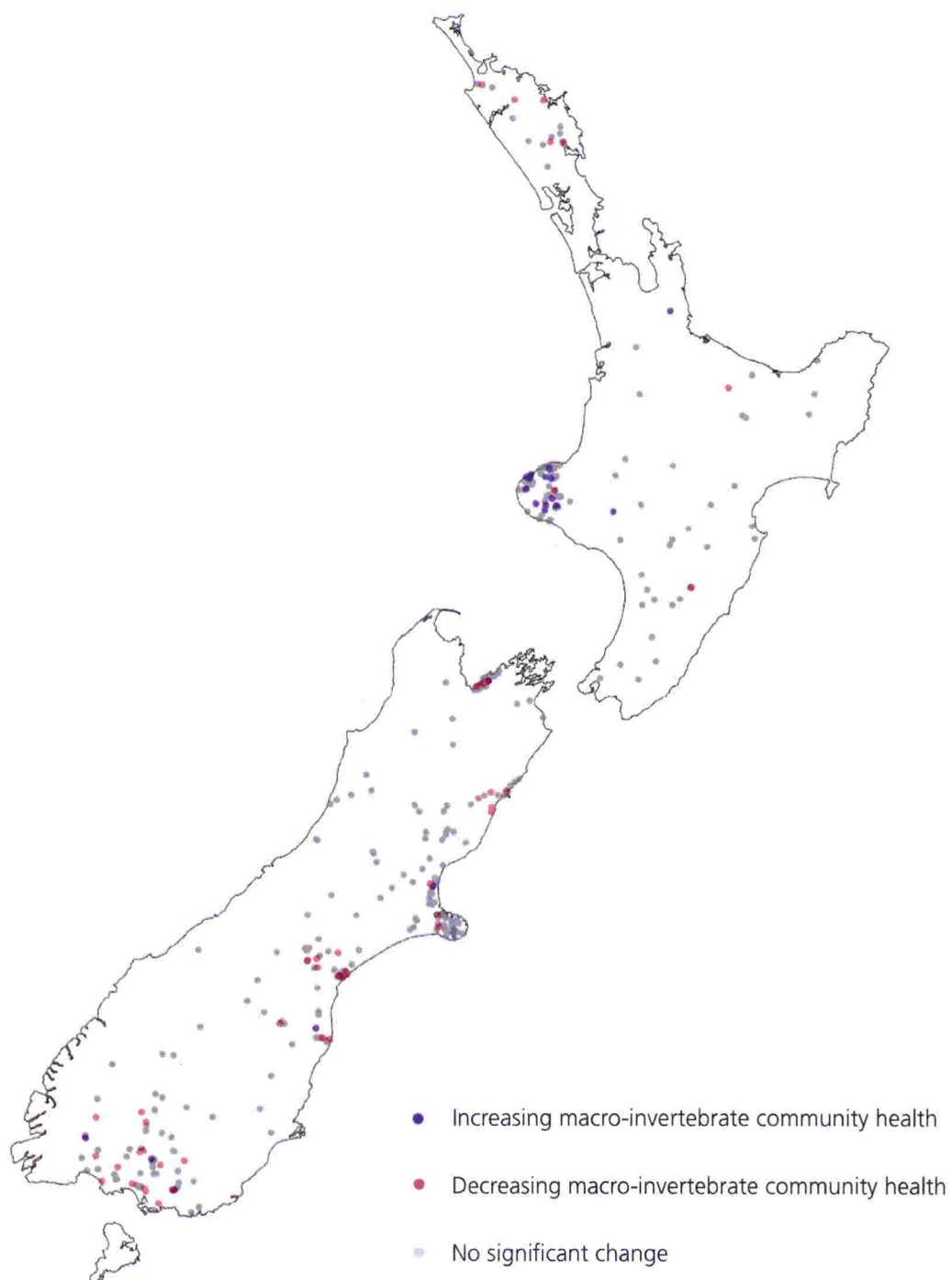
56. The NZ Mountain Lands Institute suggested that snow and red tussock should not be burnt above 1000m.<sup>10</sup> A 1000m represents the transition zone between the medium altitude and alpine environments
57. There is a large body of science that suggests that inappropriate burning and grazing management has resulted in the degradation of the tussock grassland ecosystems, the soil resource, including contributing to long term reduction in soil nutrients, organic carbon, soil microbial biomass and contributed to invasion and spread of weeds.
58. Tall tussock grasslands contribute to water quantity, and their conversion to pasture can reduce low flows. The structure of the tussock leaf makes these grasses highly efficient at capturing water; from rain, snow, and fog. Water is transferred directly into the soil where it flows into rivers and catchments<sup>11</sup>. These grasslands also play a role in mitigating flood events--providing invaluable ecosystem services.
59. There are scientific papers by a range of authors, which agree that the tall tussock ecosystem does not fully recover until 15 – 20 years following a burn, e.g., Payton and Mark (1978) Payton, Lee, Dolby and Mark, (1986), Gitay et al., (1992). Similarly there are a similar number of papers that agree that a years spell from grazing is the minimum required.
60. While there are many land users who practice precautionary principles there are those who possibly because of differing economic circumstances are not able or willing too. However the role of the Council is to achieve the purpose of the RMA and to promote sustainable land management. Our contention is that the bulk of the science suggests that burning unimproved tussock grasslands, at intervals less than 20 years, followed by grazing within 1 year of the burn and not followed by fertiliser applications, is unsustainable.
61. Proposed Rule 79 does not enable Council to control the use of fire and post fire management to meet the policies and methods of the proposed RPS, or part II of the RMA.

Sue Maturin

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<sup>10</sup> New Zealand Mountain Lands Institute (1992) Guidelines on burning tussock grasslands. *Tussock Grasslands and Mountain Lands Review* 49: 51 –63.

<sup>11</sup> Mark, A. F., Dickinson, K. J. M. (2008). Maximizing water yield with indigenous non-forest vegetation: a New Zealand perspective. *Frontiers in Ecology and the Environment* 6: 25–34.

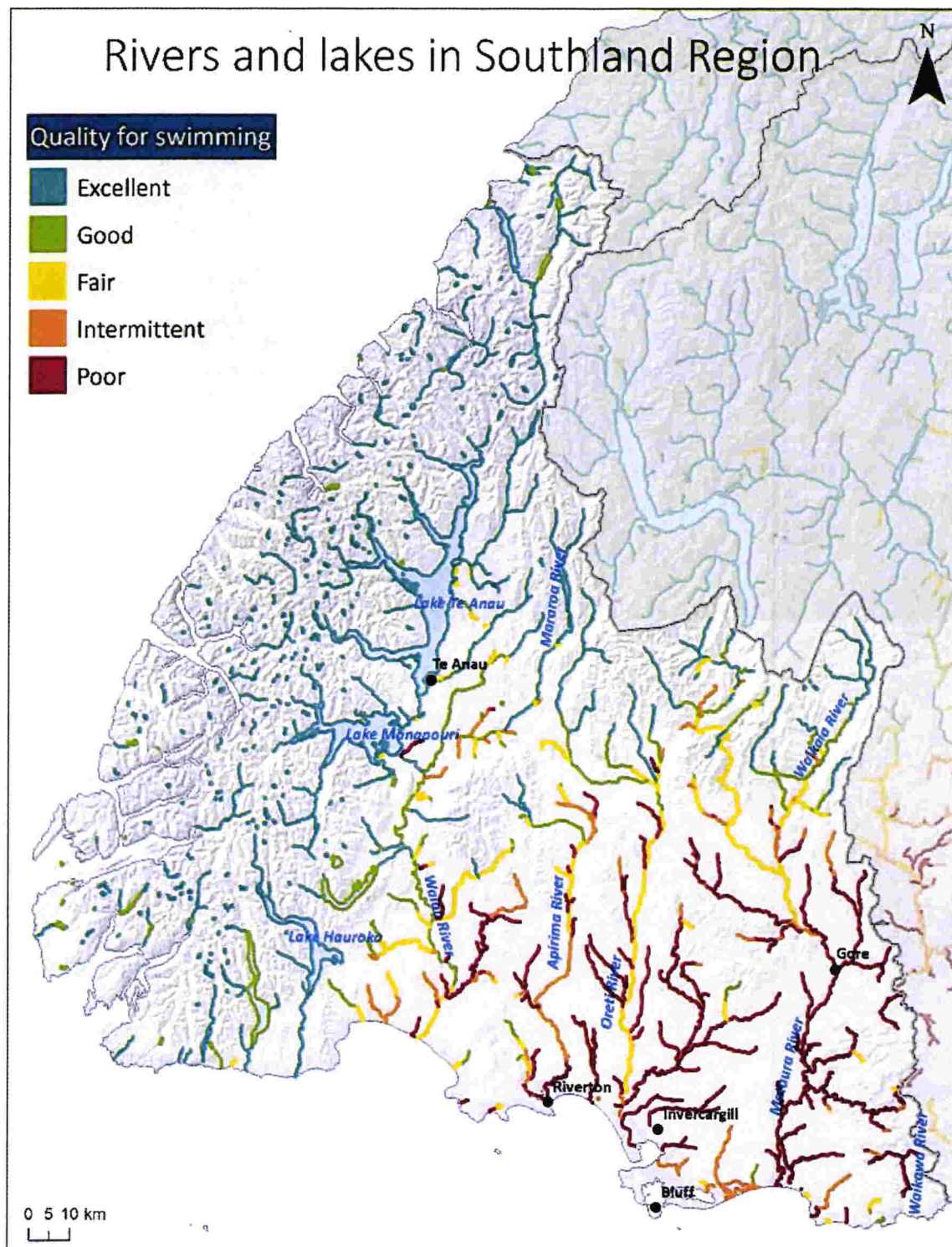


Data source: MfE website (Environment indicator for fresh water: River condition)

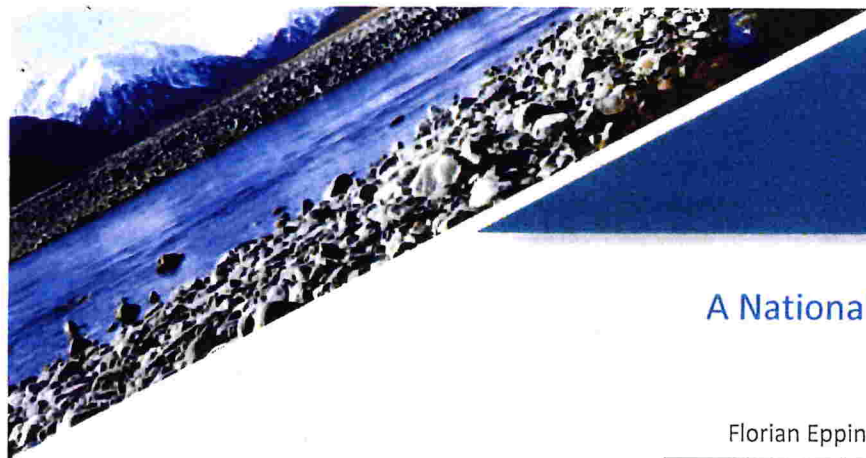
**Figure 5.3 Changes in macro-invertebrate community health between 2000 and 2010 at over 300 river sites monitored by NIWA and by regional councils.**

## Water Quality for Swimming

<http://www.mfe.govt.nz/sites/default/files/media/Southland.jpg>







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

Florian Eppink, Adam Daigneault, Suzie Greenhalgh and William Lee

### 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 such an initiative 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 – \$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)<sup>1</sup> 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.<sup>2</sup>

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<sup>3</sup> and DairyNZ<sup>4</sup> emphasise the complexity of the interactions between agriculture and freshwater quality, and recommend or require excluding stock from waterways.<sup>5</sup> Stock exclusion is also part of the latest set of proposed national freshwater reforms.<sup>6</sup> 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.<sup>7</sup> 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<sup>8,9</sup> 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

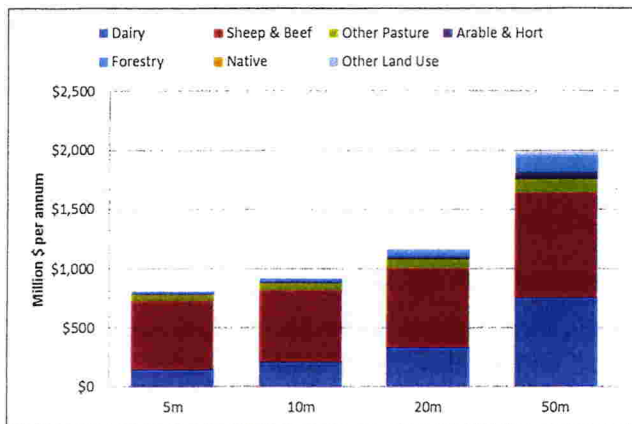


Figure 1. Sectoral cost of restoring riparian buffers nationally.

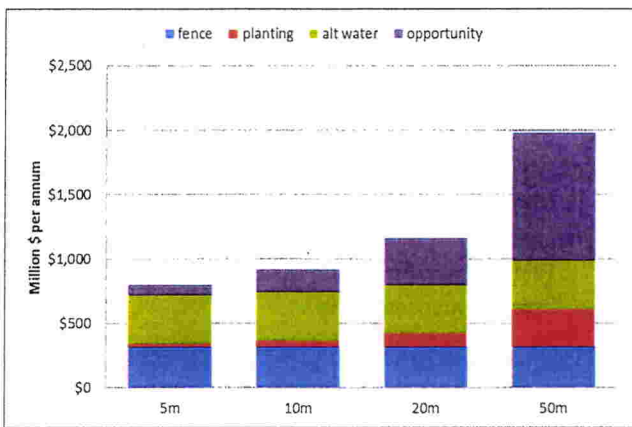


Figure 2. Cost components of restoring riparian buffers nationally.

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.<sup>12,13</sup> 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.<sup>14</sup>

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 (MtCO <sub>2</sub> e)*	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	-



## ACKNOWLEDGEMENTS

The Ministry of Business, Innovation and Employment for funded the study through the Core allocation to Landcare Research.

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<sup>1</sup> New Zealand Government 2014. National Policy Statement for Freshwater Management 2014.  
[www.mfe.govt.nz/publications/fresh-water/national-policy-statement-freshwater-management-2014](http://www.mfe.govt.nz/publications/fresh-water/national-policy-statement-freshwater-management-2014)

<sup>2</sup> Meurk CD, Swaffield SR 2000. A landscape ecological framework for indigenous regeneration in rural New Zealand-Aotearoa. *Landscape and Urban Planning* 50: 129–144.

<sup>3</sup> LAWF 2015. The fourth report of the Land and Water Forum.  
[www.landandwater.org.nz](http://www.landandwater.org.nz).

<sup>4</sup> DairyNZ 2013. Sustainable dairying: water accord.  
[www.dairynz.co.nz/media/3286407/sustainable-dairying-water-accord-2015.pdf](http://www.dairynz.co.nz/media/3286407/sustainable-dairying-water-accord-2015.pdf)

<sup>5</sup> Permanently flowing waterways and drains greater than one metre in width and deeper than 30 cm

<sup>6</sup> Ministry for the Environment 2016. Next steps for fresh water: consultation document. Wellington: Ministry for the Environment.

<sup>7</sup> MPI 2013. Situation and outlook for primary industries. Wellington, Ministry for Primary Industries.

<sup>8</sup> PCE 2013. Water quality in New Zealand: land use and nutrient pollution. Wellington, Parliamentary Commissioner for the Environment.

<sup>9</sup> PCE 2015. Water quality in New Zealand: land use and nutrient pollution: update report. Wellington, Parliamentary Commissioner for the Environment.

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<sup>10</sup> Daigneault A, Greenhalgh S, Samarasinghe O 2016. In press. Economic impacts of multiple agro-environmental policies on New Zealand land use. *Environmental and Resource Economics*.

<sup>11</sup> Daigneault A, Eppink FV, Lee W 2016. A national riparian restoration programme in New Zealand: is it value for money? *Journal of Environmental Management* (submitted).

<sup>12</sup> Mason NWH, Ausseil AGE, Dymond JR, Overton JM, Price R, Carswell FE 2012. Will use of non-biodiversity objectives to select areas for ecological restoration always compromise biodiversity gains? *Biological Conservation* 155: 157–168.

<sup>13</sup> Carswell FE, Mason NW, Overton JM, Price R, Burrows, LE, Allen RB 2015. Restricting new forests to conservation lands severely constrains carbon and biodiversity gains in New Zealand. *Biological Conservation* 181: 2016–218.

<sup>14</sup> Ibid 2.

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

<sup>16</sup> Ibid 6.