Policy Committee - 30 January 2019 Attachments

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Minutes of a meeting of the Policy Committee held in the Council Chamber at Philip Laing House, Dunedin on Thursday 29 November 2018, commencing at 11:12 am

Membership

Cr Gretchen Robertson	*(Chairperson)*
Cr Michael Laws	*(Deputy Chairperson)*
Cr Graeme Bell	
Cr Doug Brown	
Cr Michael Deaker	
Cr Carmen Hope	
Cr Trevor Kempton	
Cr Ella Lawton	
Cr Sam Neill	
Cr Andrew Noone	
Cr Bryan Scott	
Cr Stephen Woodhead	

Welcome

Cr Robertson welcomed councillors, media, public forum speakers, members of the public and staff to the meeting.

1. APOLOGIES

No apologies were received. Cr Woodhead in attendance, via Skype.

2. LEAVE OF ABSENCE

No Leave of Absence advised.

3. ATTENDANCE

Sarah Gardner	*(Chief Executive)*
Nick Donnelly	*(Director Corporate Services)*
Tanya Winter	*(Director Policy, Planning and Resource Management)*
Gavin Palmer	*(Director Engineering, Hazards and Science)*
Ian McCabe	*(Executive Officer)*
Lauren McDonald	*(Committee Secretary)*
Tom de Pelsemaeker	*(Senior Policy Analyst) - Items 11.3 and 11.4*
Rachel Ozanne	*(Acting Manager Resource Science) - Item*
Jean-Luc Payan	*(Manager Natural Hazards) - Item 11.4*
Kylie Galbraith	(*Acting Manager Consents)- Item 10.2*
Anita Dawe	*(Acting Manager Policy) - Items 10.1, 10.3, 10.4*
Ben Mackey	*(Manager Resource Science)*
Deborah Mills	*(Scientist) - Item 10.1*
Charles Horrell	*(Senior Consents Officer) - Item 10.2*
Sylvie Leduc	*(Senior Policy Analyst) - Item 10.1*
Lisa Gloag	(Manager Communications)
Emma Schranz	*(Senior Media Advisor)*
Rachael Brown	*(Senior Policy Analyst) - Item 10.3*
Julie Briggs	*(Policy Analyst) - Item 11.2*

4. CONFIRMATION OF AGENDA

Resolution
To re-order the Matters for Council Decision items, to be taken in the order of Item 10.1, 10.2, 10.4 and 10.3.

Moved: Cr Scott
Seconded: Cr Hope
CARRIED

5. CONFLICT OF INTEREST

No conflicts of interest were advised.

6. PUBLIC FORUM

Mr Nigel Paragreen, Environmental Officer, Otago Fish and Game spoke to Items 10.2 (Deemed Permits Process) and 10.4 (Options for Resolution on Priority Catchments Minimum Flow).

Mr Paragreen commented on the National Policy Statement for Freshwater Management (NPSFM) policy implementation and the fit with the deemed permit replacement and minimum flow allocation. He advised he believed there was a lot of work required to move forward and was concerned that the 2021 deadline, may not be achieved and that reviews did not provide effective or a transparent process . He stated the importance of certainty for the overarching policy for managing catchment plan changes and requested that Council provide clarity to landholders and also for other regions,

No questions of clarification were sought by councillors.

Mrs Susie McKeague and Mr Matt Hickey, McKeague Consultancy, spoke on behalf of the Otago Water Resources Users Group (OWRG) to the technical aspects of Item 10.2 Deemed Permits and 10.4 Options for Resolution on Priority Catchments Minimum Flow.

Mrs McKeague restated her view of the urgent need for the plan change to remain in line with the NPSFM for catchments, without minimum flow sites and for deemed permit replacement. She felt that the reports tabled did not explain adequately the impact on the community and the environment. She felt that the focus was on regulatory matters rather than the efficiency of transfer of deemed permits and the impacts of delay. She concluded by requesting that the FMUs be set at the regional level at the same time as the catchment level and for Council to be consistent with the NPSFM.

Mr Hickey spoke in regard to aspects of the Deemed Permit Process report (Item 10.2) and commented that he considered it would add a layer of complexity to the consenting process and that applying a standardised statistical approach to the rate of water takes was not well reasoned. He considered it should be based on a case by case approach, due to water availability in the Central Otago being significantly different from assured takes in other catchments. He commented that he felt Council should encourage takes during high flow and expressed his concern that analysis of costs for establishing flow sites needed to be addressed.

Mrs McKeague and Mr Hickey responded to questions of clarification from councillors.

Public Forum closed at 11:36 am.

7. PRESENTATIONS

No presentations were held.

8. CONFIRMATION OF MINUTES

Resolution

That the minutes of the meeting held on 17 October 2018 be received and confirmed as a true and accurate record.

Moved: Cr Noone
Seconded: Cr Bell
CARRIED

9. **ACTIONS** Status report on the resolutions of the Policy Committee.

Amendment 2 (National Environmental Standards for Plantation Forestry) to the Regional Plan: Water for Otago	13/06/2018	*b) Make Amendment 2 (NES Plantation Forestry) operative from 1 July 2018.* *c) Publicly notify Amendment 2 (NES Plantation Forestry) on Saturday 30 June 2018*	OPEN Completed
Air Quality Strategy	13/06/2018	*c) That a paper on implementation be brought to the Policy Committee in the next 2-3 months*	CLOSED Item 10.1 of agenda.
Draft Biodiversity Strategy - Feedback	13/6/2018	*c) That a paper on implementation be brought to the Policy Committee in the next 2-3 months*	Strategy out. Reference Group meeting to be held before end of year and to bring the next stage to Policy Committee in 2019
Director's Report on Progress to 13 June 2018: Minimum Flow Plan Change Manuherikia, Arrow and Upper Cardrona catchments	13/6/2018	a) *That 31 August is confirmed for notification subject to Minimum Flow figures and missing section 32 components being completed and brought to the Council and brought to the communities.*	Resolution revoked. Remove from action list.
Minimum Flow Plan Change Update	1/8/18	That the CEO engage an appropriately qualified facilitator to help consultation associated with Priority Catchments Minimum Flows and Residual Flow Plan Change. (Mrs Gardner advised this action was in process, with a facilitator to be appointed.	In process. Facilitator has been arranged for community engagement. Further discussion to be held in Item 10.4 of the agenda.
Biodiversity Action Plan	17/10/18	***Approve*** *the draft Biodiversity Action Plan in Attachment 2 for consultation with iwi and key stakeholders before a final draft is brought back to this committee for approval on 28 November 2018.*	
South Dunedin Collaboration	17/10/18	*That through the Chairperson and Chief Executive that ORC initiate discussion around forming a governance group on South Dunedin, including councillors.*	Mrs Gardner advised a meeting being arranged with DCC and in the interim, Dr Bidrose agreed sponsor the work undertaken for South Dunedin,
Director's report on Progress – Waste Plan	17/10/18	*That a paper be brought to this table detailing issues or gaps of the Waste Plan that need to be addressed. The report to include comment on the statutory responsibility as regard to waste for ORC.*	CLOSED initial overview in Director's report.

10. MATTERS FOR COUNCIL DECISION
10.1. Air Quality Strategy Implementation

The report sought Council decision for the preferred option for implementation of the Air Quality Strategy, adopted in June 2018. The report presented three options, and implications in terms of effectiveness, costs and benefits.

Staff in attendance: Deborah Mills, Sylvie Leduc, Anita Dawe. Also, in attendance Joydana White (Cosy Homes Trust)

Ms Leduc outlined the work programme adopted in June 2018 and the three key options of the report. She confirmed the staff recommendation was for Option 2 - earlier implementation with primary focus on non-regulatory methods, with the implementation of the strategy to commence with Arrowtown.

Discussion included:

- use of best technology available (such as low emission burners to improve air quality)
- Arrowtown township as pilot for implementation of the strategy (as community is ready for change and would provide good opportunity for learning, ahead of introduction to other townships).
- role of the Cosy Homes Trust
- community engagement
- education to support behavioural change (compliance)

Resolution

a) That the Policy Committee approves an early implementation of the Air Quality Strategy focusing on non-regulatory methods (Option 2 of this report)

b) That the Policy Committee approves the proposed work programme attached in Appendix 1

c) That the Policy Committee notes that a review of the proposed work programme in upcoming annual and long-term plan processes will be required

Moved: Cr Lawton
Seconded: Cr Kempton
CARRIED

10.2. Deemed Permits Process

The report outlined a high-level summary of the current process for the replacement of Deemed Permits into Water Permits under the Resource Management Act 1991 (the Act), in response to concerns raised by Council about the replacement process, including when those permits are in a fully allocated catchment, while continuing to provide for the Deemed Permit authorised take, and also having regard to the National Policy Statement for Freshwater Management 2014 (amended in 2017) (NPS-FM).

Staff in attendance: Mr Charles Horrell, Senior Consents Officer, Ms Kylie Galbraith, Acting Manager Consents.

Mrs Winter, Director Policy Planning and Resource Management introduced paper and outlined the process being used under the RMA.

Mr Horrell and Ms Galbraith responded to questions in regard to the deemed permit replacement application process, including considerations given for efficient use of water (on a case by case basis) against the provisions of the Water Plan.

Resolution

That the Council:

a) Receives this report.

Moved: Cr Woodhead
Seconded: Cr Scott
CARRIED

The meeting adjourned at 12:39 pm for lunch and resumed at 1:07 pm.

10.3. Final regional swimming targets

The report sought the Committee's approval of the final Otago regional swimming targets for publication, as required by the National Policy Statement for Freshwater Management 2014 (NPSFM) for 80 percent of specified rivers and lakes will be swimmable by 2030, and 90 percent by 2040.

Staff in attendance: Ms Rachael Brown, Senior Policy Analyst and Mrs Anita Dawe Acting Manager Policy and Planning.

Ms Brown outlined the National Policy Statement (NPS) requirements to set regional swim targets to contribute to national swim targets, which would be publicly notified by the end of 2018. She advised that online consultation had been completed.

Resolution

That the Council:

a) Publish the following final regional swimming targets for Otago on the Council website by 31 December 2018:

- *90 percent of rivers and 98 percent of lakes are swimmable by 2030; and*
- *95 percent of rivers and 100 percent of lakes are swimmable by 2040.*

Moved: Cr Kempton
Seconded: Cr Neill
CARRIED

10.4. Options for Resolution on Priority Catchments Minimum Flow

The report outlined the three options available to implement Council's resolution from the 26 September 2018 meeting with regard to setting objectives and limits for the three priority catchments – the Manuherikia, Cardrona and Arrow.

Staff in attendance: Anita Dawe, Acting Manager Policy and Planning

Cr Robertson commented on the report detail expressing that the completion of some FMUs in the current financial year was a positive but that the expiry of deemed permits in 2021 required Council to provide certainty to the process. She did not support Council approving the options tabled in the report until there had been targeted community consultation, specifically looking at the mechanisms for the development of a preferred option.

Councillors supported the need for targeted consultation with stakeholders in advance of endorsing any option.

Cr Scott moved an amendment to the staff recommendation to replace (b) and C) of the recommendation:

b) *Identify a preferred option; and*

c) *(i) Either commence work on the preferred option; or*

(ii) Undertake a targeted community consultation meeting on the preferred option.

to:

That Council

1. *note the report*
2. *undertake a Targeted community consultation meeting regarding the 3 options listed in the report.*

Seconded: Cr Deaker

Resolution

That Council:

1. *Note the report;*
2. *undertake a targeted community consultation meetings regarding the 3 options listed in the report.*

Moved: Cr Scott
Seconded: Cr Deaker
CARRIED

11. MATTERS FOR NOTING

11.1. Director's Report on Progress

The report outlined emerging issues, such as central government legislative changes, policy/planning project updates and contribution to the Strategic Priorities from the Long-Term Plan 2018 -2028.

Staff in Attendance: Mr Tom De Pelsemaeker, Senior Policy Analyst

<u>Environment Court Hearing Plan Change 5A (Lindis: Integrated Water Management)</u>

Mr De Pelsemaeker advised in addition to the report detail, that the Environment Court had scheduled another week of hearings from 28 January 2019. He advised it was hoped that the Environment Court decision would be released in the first half of 2019.

Resolution

a) That this report be noted.

Moved: Cr Noone
Seconded: Cr Hope
CARRIED

11.2. Summary of Reports – Regions Implementing NPSFM

The report provided a summary of four Ministry for the Environment funded research papers, in support of the implementation of the National Policy Statement for Freshwater Management (NPSFM).

Staff in attendance: Ms Julia Briggs, Policy Analyst, Mrs Anita Dawe, Acting Manager Policy and Planning.

A workshop was requested to discuss through the regional implementation of the National Policy Statement for Freshwater Management (NPSFM). Ms Winter, Director Policy, Planning and Resource Management to action.

Resolution

That the Committee:

a) Notes this report.

Moved: Cr Bell
Seconded: Cr Noone
CARRIED

11.3. Implications of NPSFM Announcement

The report outlined the six key actions under "Essential Water: Healthy Water, Fairly Allocated" policy and the current implications for Council. It was advised that the implications were minimal as Council's Progressive Implementation Programme (PIP) was broadly aligned with the Government's timetable.

Cr Laws moved an amendment to the staff recommendation (b), to: adopt staff recommendation to continue with the Proposed Implementation Programme and where any inconsistency of government direction or announcement, report back on these inconsistencies to this committee.,

Ms Winter was requested to provide a programme of action for six months and the information to include resourcing, capacity across ORC, and basic structure for next six months to the 12 December 2018 Council meeting.

Resolution

That the Committee:

a) Notes the report.

b) Adopt the staff recommendation to continue with the Proposed Implementation Programme, and where any inconsistencies of government direction or announcements, for report back to the Policy Committee.

Moved: Cr Laws
Seconded: Cr Deaker
CARRIED

11.4. Clutha Natural Character and Recreation
The report summarised the key findings from technical studies undertaken in support of the development of minimum flows, lake levels and allocation limits for the main stems of the Clutha, Kawarau and Hawea Rivers, the hydro lakes and source lakes. It was confirmed that in April 2018 ORC commissioned technical studies to assess the

Staff in attendance: Mr Tom De Pelsemaeker, Senior Policy Analyst.

Mr De Pelsemaeker spoke to the report outlining the scope, intent of the work, and its fit into the work programme at ORC. He confirmed the scope of the work was being completed by commissioned consultants to assess: recreational values; natural character; riverscape and visual amenity values. He advised the recreation assessment value would assist flow preferences. He commented that value would be added through baseline data on water quality to assist inform for water setting and resource consenting.

Resolution

a) *That this report is noted.*
b) *That the following reports are made publicly available:*

- *Clutha River/Mata-au Catchment Recreation Values Assessment (RG&A)*
- *Natural Character, Riverscape & Visual Amenity Assessment (BM Ltd).*

Moved: Cr Bell
Seconded: Cr Hope
CARRIED

12. NOTICES OF MOTION
No Notices of Motion were advised.

13. CLOSURE

The meeting was declared closed at 2:29 pm.

Chairperson

Report of the Biodiversity Collaborative Group

Incorporating:

- Background Report for the Biodiversity Collaborative Group's Draft National Policy Statement for Indigenous Biodiversity
- The Biodiversity Collaborative Group's Draft National Policy Statement for Indigenous Biodiversity
- The Biodiversity Collaborative Group's Complementary and Supporting Measures for Indigenous Biodiversity

Embargoed until 25 October 2018

BIODIVERSITY COLLABORATIVE GROUP
New Zealand

Embargoed until 25 October 2018

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Foreword

Aotearoa New Zealand's indigenous biodiversity is unique. Millions of years of geographic isolation have resulted in a vast assemblage of plants and animals found nowhere else in the world. Humans, however, have caused widespread extinctions and massive reductions in extent of habitats in a very short period since their arrival between 700 and 800 years ago. Today, 80 per cent of native birds, 88 per cent of lizards, and 100 per cent of frogs are threatened with extinction. Between 1996 and 2012 there was a net loss of 71,000 hectares of indigenous habitat, mostly in areas of lowlands, wetlands and coastal habitat, habitats which have been most reduced by human actions. Predators and weeds introduced by humans wreak havoc. These effects are ongoing. The decline in our country's indigenous biodiversity on land, in freshwater and in the surrounding seas is our most insidious environmental problem.

New Zealanders have a strong attachment to the country's landscapes and natural heritage. It is one of the features that defines us as a nation and as a people. A very large effort is being made to nurture our indigenous biodiversity and halt its decline. However, the overall national policy framework for this effort is not comprehensive or robust. There is a strong system for legal protection of public conservation areas, but this represents only a third of the country, mainly in mountainous areas. We tend to think nature is looked after because we have these protected areas. But it isn't. Increased effort is needed to manage areas already protected. More importantly, better direction is required to ensure that indigenous biodiversity outside protected areas is allowed to thrive.

Improving our country's indigenous biodiversity policy framework has been a goal of successive governments for over 20 years. But they have been unable to achieve consensus on how to do this, especially outside protected areas. An obvious tool to create consistency across the country is a national policy statement (NPS) under the Resource Management Act. Government first began to discuss the prospect of an NPS for biodiversity in 1999 and there have been a number of attempts to produce one since that time. Their failure to come to fruition is the product of the intense debate that this issue creates, and the government's subsequent response (to step back from progressing the instrument). In the meantime, New Zealanders' attachments to nature and efforts to halt the decline in indigenous biodiversity have grown. New Zealand promotes itself in the world as a place of unspoiled nature. Many of our overseas markets are demanding proof of our protection of the environment as part of their willingness to support our products. And while these trends gather pace, we continue to have an unsettled framework, resulting in division, costly debates, and litigation.

This report is the result of those with a major stake in looking after indigenous biodiversity – industry, landowners, tangata whenua and environmental non-government agencies (NGOs) – coming together and agreeing on an NPS that will work for our country's interests. But the report also covers something equally important. An NPS of itself will not be the complete solution. What is required is stronger and clearer leadership and coordination of effort at a national level; better support for landowners and managers; alignment and coherence of policies and institutions of government; and improved knowledge, monitoring and compliance. We set these measures out in an accompanying document. The combination of an effective NPS for indigenous biodiversity and well-resourced complementary and supporting measures will ensure our country finally achieves an effective overall framework for halting the decline in indigenous biodiversity, regardless of whether land is held in private, public or lease-hold tenure.

The Biodiversity Collaborative Group

The Biodiversity Collaborative Group (BCG) is a stakeholder-led group that was established by the Minister for the Environment to develop national level policy for indigenous biodiversity (native plants and animals and their ecosystems) in the face of ongoing decline and an urgent need for action to reverse this. This report and the accompanying draft NPS comes at the culmination of the process, which has run over 18 months since April 2017.

The BCG has developed a draft National Policy Statement on Indigenous Biodiversity (NPSIB) and recommendations to the Government on complementary and supporting measures to maintain indigenous biodiversity. To achieve this, the BCG has drawn on technical advice as well as input from government departments, tangata whenua, landholders, infrastructure providers, industry groups, environmental groups, academics and others, to ensure the Government has a robust evidence-based approach to policy with outcomes that are inclusive, effective and enduring.

The core members of the BCG are the Royal Forest and Bird Protection Society of New Zealand Incorporated, Federated Farmers of New Zealand Incorporated, the New Zealand Forest Owners Association, Environmental Defence Society Incorporated, a representative of the Iwi Chairs Forum through the Pou Taiao Iwi Advisors Group, and representatives from infrastructure industries. Local and central government representatives were involved as active observers and two targeted workshops were held with territorial authority representatives. The BCG was facilitated by an independent facilitator and supported by a small secretariat.

Members of the BCG, secretariat, observers and advisors at Te Mānuka Tūtahi Marae, Whakatāne.

Although some sectors and interests were not represented on the BCG, or were only represented for part of the process, participants took care where possible to ensure a range of perspectives were included in deliberations. Members of the BCG connected regularly with their wider networks – including with organisations outside the group's membership – to check draft content and to seek feedback.

A collaborative approach to biodiversity policy was favoured because of the failure of previous attempts to create national regulation to halt biodiversity decline due to dissatisfaction on all sides with the proposed measures. The opportunity to commission and consider advice as a group, absorb other parties' perspectives and workshop alternative options has been critical to reaching a high level of agreement on the content of the draft NPS. All members of the BCG have negotiated and compromised to reach agreement on what it believes is a pragmatic package. The BCG's recommendations have been reached by consensus. Where consensus could not be reached, the parties' respective positions have been recorded.

The next stage of the process will involve consideration of this report by officials and ministers including a cost-benefit analysis followed by a full consultation process in accordance with the Resource Management Act 1991 (RMA) before it is considered by the government for final approval.

Through this suite of recommendations we have provided the pre-conditions to halt the decline of Aotearoa New Zealand's indigenous biodiversity and to ensure it will thrive. It will be necessary that the recommendations are implemented in full and given priority by current and successive governments, and supported by industry, hapū, iwi, landowners and all New Zealanders.

Embargoed until 25 October 2018

Part 1: Background Report for the Biodiversity Collaborative Group's Draft National Policy Statement for Indigenous Biodiversity

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Introduction

This background report provides the rationale for the BCG's draft National Policy Statement for Indigenous Biodiversity (NPSIB). It sets out the intent of the BCG in structuring the NPSIB as it is. As such, it is meant to assist officials, ministers, and those who may be affected by the NPSIB to understand the intention of the objectives and policies.

The overall reason for an NPSIB is to improve the way regional and territorial local government provide for indigenous biodiversity in plans. The RMA requires councils to maintain biodiversity. How they do this at present, however, is highly variable and has resulted in uncertainty, debate, and significant and costly litigation. Meanwhile, indigenous biodiversity continues to decline. A more settled and agreed regime to address the serious environmental problem of biodiversity decline is needed. An agreed NPSIB (with supporting and complementary measures) will do this.

This background report is structured the same way that the NPSIB is structured, beginning with comment on the scope and domains which the NPSIB applies to, followed by the rationale and intent for each of the six objectives:

1. Hutia Te Rito
2. Te Tiriti o Waitangi
3. Maintaining indigenous biodiversity and enhancing ecosystems
    i. Identifying Significant Natural Areas
    ii. Maintaining indigenous biodiversity
    iii. Enhancing ecosystems
    iv. Climate Change
4. Integrated and evidence-based management
5. People and partnerships
6. Wetlands.

For each objective, the report sets out what the issues are and how the NPSIB aims to address them. Where key complementary and supporting measures will be needed to ensure an objective is met, these are noted. Detailed explanation of the complementary and supporting measures is provided in Part 3 of this document.

This background report sets out where there were differences and concerns that individual sectors wanted to draw to the attention of officials when considering the next steps in the process. Some provisions in the NPSIB were unable to be agreed. Those provisions are shown in grey text. Other matters that require further consideration are shown in italicised text. There are some matters of detail, for example, in the section dealing with scope, which the BCG feels need further consideration by officials.

This is not the last word in creating a NPSIB. From here, the report produced by the BCG will be subject to review by officials and ministers, a cost-benefit analysis, and then consideration as part of Cabinet deliberations. Following that, if it is so decided, a draft NPS would be subject to formal public submissions, a section 32 analysis under the RMA, and then another final consideration by the Minister for the Environment and by Cabinet consideration deciding whether to promulgate (gazette) the NPS. So, to quote Winston Churchill: 'this is not the end. It is not even the beginning of the end. But it is, perhaps, the end of the beginning'.

Scope

The RMA applies to land, freshwater and marine domains, including its requirements to safeguard the life-supporting capacity of ecosystems, identify areas of significant indigenous vegetation and habitat of indigenous fauna, and to maintain biodiversity. Regional councils also have a specific obligation to control the use of land for the purpose of maintaining or enhancing ecosystems in water bodies and coastal water. The BCG has approached the application of policy to freshwater and marine domains with caution. The BCG's caution on the freshwater and marine domains is partly due to the majority of information received being terrestrially focused, and partly due to not having the right stakeholders in the room. The freshwater and marine domains are as complex as the terrestrial environment, and policy development needs to be treated with equivalent care. There is already directive, effective national policy direction in respect of both in the National Policy Statement for Freshwater Management (NPSFM) and New Zealand Coastal Policy Statement (NZCPS). There are also other mechanisms for indigenous biodiversity protection in freshwater and marine environments, such as water conservation orders and marine protected areas. As a result, gaps relating to indigenous biodiversity identified by the BCG are tightly focused, principally around terrestrial environments (including wetlands).

Freshwater

The BCG agrees that section 6(c) RMA applies to fresh water. Many section 7 matters are also relevant to the freshwater domains, such as kaitiakitanga, intrinsic value of ecosystems, and the protection of the habitat of trout and salmon. Salmon and trout are introduced species but there are management issues that interact with indigenous biodiversity; the BCG received information that introduced species, including trout and salmon, are a threat to many indigenous species due to predation or competition. The NPSFM identifies a number of broad 'national' values that apply to fresh water, of which the compulsory ones are ecosystem health and human health for recreation. It also requires protection of outstanding freshwater bodies and wetlands, although it provides no direction on how to identify these or on the overlap with section 6(c) significant areas. There are other statutes that have a role to play in management of fisheries such as the Fisheries Act 1996 (tuna fishery), Freshwater Fisheries Regulations 1983 (fish passage), Conservation Act 1987 (whitebait fishery), and Biosecurity Act 1993 (pest fish and pest aquatic plants), but the mechanisms for management are not necessarily well coordinated with RMA functions.

Given this context, addressing freshwater indigenous biodiversity, in particular section 6(c) matters is multifaceted and complex, and requires specific attention to develop appropriate policy.

Identification of areas of significant indigenous vegetation and habitat of indigenous fauna

The BCG considers that further work to confirm the most appropriate method for identifying areas of significant indigenous vegetation and habitat of indigenous fauna in the freshwater environment is required and should be a high priority workstream. The BCG understands that this has been on the central government agenda for some time and that there is a base level of information available but that this has yet to be fully developed.

The BCG has not recommended using the assessment criteria in **Appendix 1** of the NPSIB to identify areas of significant indigenous vegetation and habitat of indigenous fauna in the freshwater domain because it has not received sufficient ecological advice to confirm it is suitable for that purpose. There is a concern from some of the BCG members that applying a spatial identification system for section 6(c) significant areas to a fluid environment, in the literal sense of the term, presents challenges. These members have suggested there may be other methods that can be used such as relating identification of section 6(c) significant freshwater areas to river classifications (River Environment Classifications (REC) or similar) and classifying the respective habitat values for indigenous fauna. The BCG has not investigated or received advice on this.

Recommendation

1. As a matter of priority, the Ministry for the Environment in conjunction with the Department of Conservation (DOC) and freshwater ecology experts should:
   (a) Initiate an urgent work programme to develop and consider a range of approaches for identification of section 6(c) areas of significant indigenous vegetation and significant habitats of indigenous fauna for application in the freshwater domain.
   (b) Assess as one possible approach whether the proposed Appendix 1 criteria in the draft NPSIB is suitable or could be amended so as to be suitable for use in the freshwater domain.
   (c) Trial identified approaches, or a short list of approaches, to determine their ecological appropriateness and ability to be practically applied.
   (d) Consider how the preferred approach should be incorporated into national policy and whether the NPSIB or the NPSFM is the most appropriate instrument. Amend the NPS that is identified as most appropriate to include necessary direction on identification.

Effects on freshwater indigenous biodiversity

The BCG has agreed any provisions in the NPSIB should not relate to water quality and quantity because that is covered by the NPSFM. In response to questions regarding what, if anything, the NPSFM did not cover that was necessary for maintenance of indigenous freshwater biodiversity, the BCG received expert advice confirming there are gaps in current national policy that need to be filled. These are:

- Protection of indigenous freshwater fauna itself (as opposed to the water it lives in), particularly threatened species.
- Consideration and protection of physical habitat and connectivity between systems, including feeding and refugia habitats, spawning habitat and connections between systems that will enable successful reproduction and juvenile recruitment into adult populations.
- Methods to examine cumulative effects and stressors on fish and other threatened indigenous freshwater species and habitats.

This policy gap is compromising the survival of Aotearoa New Zealand's freshwater fauna; around three-quarters of indigenous fish, a third of indigenous invertebrates, and a third of indigenous plants are threatened with, or at risk of, extinction.[1] The likelihood of extinction of some species is high if the current trend of decline continues.

Activities identified in the advice received by the BCG (other than nutrient discharge) as potentially having a negative impact on indigenous freshwater species and habitats include:

- Diversion, piping and channelisation of streams
- Drainage and reclamation
- Flood management schemes (including stopbanks that separate streams from wetlands)
- Gravel extraction
- Other disturbance to beds and banks (such as drain 'cleaning', stock trampling, or recreational vehicles)
- Motorised activities on the surface of water bodies (and associated disturbance)
- Loss of riparian vegetation or planting of inappropriate riparian vegetation
- Structures that inhibit fish passage
- Earthworks
- Activities or effects that may increase the risk of aquatic habitats being colonised by pest plants and animals.
- Stormwater and other point source discharges
- Predation by introduced fish species

Unfortunately, due to time constraints, the BCG has not been able to draft and propose a policy to address impacts of human activities on indigenous freshwater fauna and their habitat and recognises this needs to be linked to the approach taken to identifying (and potentially separately managing) ecologically significant freshwater environments. It considers that such national policy direction is urgently required. An integrated approach to managing effects on indigenous freshwater biodiversity is required, taking into account the interplay between RMA functions, the NPSFM's objectives, policies, and national values for freshwater, and fishery and biosecurity functions of councils and other agencies. The BCG expects that this will involve measures for inclusion in an NPS (either the NPSIB or NPSFM), but may also include other complementary measures that may prove more effective in determining fishery management priorities or dealing with issues such as pest fish.

The advice provided to the BCG is an important and useful starting point for this work. The Group has no set view as to whether this issue should be addressed in the NPSIB or the NPSFM.

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1 Ministry for the Environment & Stats NZ (2017). *New Zealand's Environmental Reporting Series: Our fresh water 2017*. Retrieved from www.mfe.govt.nz and www.stats.govt.nz.

Recommendation

2. As a matter of priority the Ministry for the Environment, in conjunction with DOC, regional councils and freshwater ecology experts, should:
   (a) Develop the policy needed to control adverse effects as necessary to protect section 6(c) matters and indigenous freshwater biodiversity more generally, and include such policy in the NPSIB or NPSFM.
   (b) When developing this policy focus on matters that are currently not controlled under the NPSFM.
   (c) Consider a range of options or mechanisms when developing policy.
   (d) Consult with national stakeholders when developing this policy.

Marine

Identification

The BCG agrees that section 6(c) applies to the marine domain. Identification of marine SNAs is slowly starting to occur. Bay of Plenty Regional Council and Marlborough District Council are leading the charge as councils with responsibility for coastal-marine areas subject to significant pressure from both land and sea based activities. The Group considers it is important that continuation and expansion of this occurs as it is a crucial starting point for a strategic, region-wide approach to maintaining marine indigenous biodiversity. What constitutes an area of significant indigenous vegetation or habitat of indigenous fauna in the marine domain, and an approach for their identification, is not set out in the NZCPS, although there is likely to be some overlap with NZCPS Policy 11 factors.

The identification criteria in **Appendix 1** of the NPSIB are proposed to apply to the terrestrial and marine environments. The criteria were subject to review by marine ecologists with experience in SNA identification and developed to be able to be able to be applied in both the marine and terrestrial contexts. In the marine environment the scale of at which the criteria are applied is that of marine biogeographic regions. Refer to the Section on *Identifying Significant Natural Areas* in this report for additional discussion.

Management

The BCG has not considered the policy framework for protecting marine section 6(c) SNAs because key stakeholders were not part of this collaborative process (as identification of stakeholders did not focus on the marine domain). The BCG considers development of such policy is important because SNAs in the marine environment are being identified, Aotearoa New Zealand's coastal marine habitats and ecosystems are becoming increasingly degraded, and our indigenous species are at significant risk of extinction.[2] The NZCPS already provides strong and effective protection for indigenous biodiversity through Policy 11, and through Policies 13 and 15 as an attribute of natural character and landscape. It is critical that any policy developed for the specific purpose of protection of section 6(c) SNAs areas builds on and does not compromise the positive contribution these policies make to maintaining our indigenous marine biodiversity.

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2 Ministry for the Environment & Statistics NZ (2016). *New Zealand Environmental Reporting Series: Our marine environment 2016*.

Recommendation

3. That the Ministry for the Environment with the support of the Department of Conservation and the Ministry for Primary Industries/New Zealand Fisheries draft policy for protecting marine Significant Natural Areas for inclusion in the draft NPSIB that is released for public consultation.

1. Hutia Te Rito

The NPSIB presents a unique opportunity to begin to transition Aotearoa New Zealand's environmental management system to one in which te ao Māori, mātauranga, and tikanga Māori, sit on an even footing with western environmental management as the system's philosophical underpinning. Hutia Te Rito (literally, 'to pluck out the centre shoot of flax') recognises the environment's intrinsic value, the importance of relationships and connections between people and the natural environment and the responsibilities they create, and peoples' dependence on a healthy environment. The step change offered by the Hutia Te Rito approach is the explicit recognition of the importance of familial relationships and connections between people and the natural environment. As stated by the Waitangi Tribunal in 2011:[3]

> In te ao Māori, all of the myriad elements of creation – the living and the dead, the animate and inanimate – are seen as alive and interrelated. All are infused with Mauri (that is, a living essence or spirit) and all are related through whakapapa...The people of a place are related to its mountains, rivers and species of plant and animal, and regard them in personal terms. Every species, every place, every type of rock and stone, every person (living and dead), every god, and every other element of creation is united through this web of common descent, which has its origins in the primordial parents Ranginui (the sky) and Papa-tu-a-nuku (the earth).[4]

This transition is intended to be achieved through having Hutia Te Rito as the NPSIB's underlying framework, and the ultimate reference point for decision-making. This is achieved through policy requiring Hutia Te Rito be recognised and provided for in planning instruments in and of itself, and through integrated policy that requires decision-makers to protect mauri, retain connectivity, and have it guide their region's indigenous biodiversity enhancement and restoration vision.

As with Te Mana o Te Wai in the NPSFM, the concept of Hutia Te Rito cannot be distilled into a single, short definition. It is built upon the foundation of the whakataukī of the same name and described in the NPSIB:

> … Hutia Te Rito provides a framework to achieve the integrated and holistic well-being of the natural environment. It recognises that the health and well-being of our natural environment, its ecosystems and unique indigenous flora and fauna, is vital for the health and well-being of our land, our freshwater, our coast, and our communities.
>
> Upholding Hutia Te Rito acknowledges and protects the mauri (life force) of our indigenous biodiversity. This requires that in using the natural environment and its resources and providing for te hauora o te tangata (the health of the people), we have a responsibility to provide for the te hauora o te koiora (the health of indigenous biodiversity), te hauora o ngā taonga (the health of taonga species and ecosystems) and te hauora o te Taiao (the health of the wider environment). Resource use and development which degrades the mauri and hauora of our indigenous biodiversity will also degrade the hauora of our people.

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[3] Waitangi Tribunal (2011). *Ko Aotearoa Tēnei: a report into claims concerning New Zealand law and policy affecting Māori culture and identity*.

[4] Waitangi Tribunal (2011). *Ko Aotearoa Tēnei: a report into claims concerning New Zealand law and policy affecting Māori culture and identity*, p. 267.

> Hutia Te Rito incorporates the values of tangata whenua and the wider community in relation to indigenous biodiversity and the natural environment. The engagement promoted by Hutia Te Rito will help regional and district councils to develop meaningful, tailored responses to maintaining and enhancing indigenous biodiversity that work within their region.
>
> By recognising and providing for Hutia Te Rito as the framework for managing indigenous biological diversity, it is intended that the health and well-being of indigenous biodiversity is front of mind in decision making about the natural environment, including the identification and protection of Significant Natural Areas and of taonga, restoring and enhancing depleted ecosystems as part of achieving landscape-scale ecosystem restoration, and halting the decline of our indigenous biodiversity to ensure it is maintained for the health, enjoyment, and use of all New Zealanders now and for future generations.

Using Hutia Te Rito as the underlying framework and ultimate reference point for decision-making is consistent with other emerging environmental policy and Treaty settlement legislation, like the NPSFM's Te Mana o Te Wai, which represent a convergence of Māori and non-Māori world views. Its adoption is intended to reflect the value that Te Ao Māori perspectives bring to the environmental management system for the benefit of te taiao (the environment) and all who reside in Aotearoa New Zealand.

2. Te Tiriti o Waitangi

As discussed under **Objective 1**: Hutia Te Rito, Māori perspectives in relation to indigenous biodiversity are founded upon familial relationships borne out of a shared ancestry from atua (gods, the children of Rangi and Papa). These relationships are confirmed by Te Tiriti o Waitangi and there are a range of supporting provisions and mechanisms within natural resource and settlement legislation that also recognise and give effect to relationships of tangata whenua with te taiao.

Within the RMA those provisions and mechanisms include section 6(e) RMA which requires decision-makers to recognise and provide for protection of relationships with taonga (treasures); section 7(a) which introduces the tikanga value of kaitiakitanga in relation to environmental management; section 8 which references the principles of Te Tiriti; sections 33 and 188 and the Mana Whakahono a Rohe provisions which provide opportunity for tangata whenua involvement in decision-making.

The implementation of many of these mechanisms has been ad hoc, unmonitored, and in some cases non-compliant with legislation. This was documented in the criticism and recommendations for change made by the Waitangi Tribunal's report on the Wai 262 claim.[5] The Tribunal noted that future legislative reforms should be capable of delivering the following outcomes to kaitiaki:[6]

- Control by Māori of environmental management in respect of taonga where it is found that the kaitiaki interest should be accorded priority.
- Partnership models for environmental management in respect of taonga.
- Effective influence and appropriate priority to kaitiaki interests in all areas of environmental management when the decisions are made by others.

Barriers to incorporating mātauranga and tikanga Māori into legislation and to ensuring effective and meaningful engagement identified by Wai 262 and others reports include:

- Mātauranga and tikanga are not a defined part of the foundation of legislation, but rather additional considerations within the legislative framework.
- Decision-makers, including the judiciary, have struggled with understanding the meaning and importance of Māori interests, and also how to interpret evidence focused on Māori considerations.
- No process of identifying and then managing taonga has been developed.
- Existing mechanisms for Māori influence in environmental management and partnerships between kaitiaki and the Crown are underutilised.
- There has been a failure to recognise the unique limitations that apply to Māori land.

The BCG's intention is for the NPSIB to represent a significant shift in the role of tangata whenua in decision-making in respect of Aotearoa New Zealand's indigenous biodiversity, through the incorporation of tikanga and mātauranga Māori into the management of our indigenous biodiversity.

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5 Waitangi Tribunal, (2011). *Ko Aotearoa Tēnei* (Report on the WAI 262 claim). Wellington: Waitangi Tribunal.

6 Waitangi Tribunal, (2011). *Ko Aotearoa Tēnei* (Report on the WAI 262 claim). Wellington: Waitangi Tribunal.

A core component of this shift is the incorporation of the concept of Hutia Te Rito which is intended to underpin decision-making. Facilitating meaningful engagement for tangata whenua in resource management and securing opportunities to exercise kaitiakitanga and for kaitiaki to jointly 'hold the pen' in decision-making is another. It is through **Objective 2** and **Policy 2** that this will be achieved. It is intended that local authorities will initiate consultation early to ensure that Māori perspectives are considered when pen is first put to paper to draft plans and policies; not as an afterthought. This will help to ensure that local authorities have the information and relationships to work with tangata whenua to incorporate mātauranga and tikanga Māori into the core of the planning framework, in environmental monitoring, effects management (for example through what effects are controlled, how they are assessed, and through tikanga tools like rāhui), and to ensure indigenous biodiversity management is through the lens of hutia te rito. Regional biodiversity strategies, a new planning document introduced by the NPSIB, are also a key mechanism through which this can occur.

Another equally critical component is the direction to identify and protect taonga in **Policy 11**. Elements of indigenous biodiversity that may be taonga include ecosystems, geographical areas, species, or even a specific individual tree or creature. Consistent with Article 2 of Te Tiriti o Waitangi and sections 6(e) and 7(a) of the RMA, this is intended as a way of recognising and providing for the relationship of Māori and their culture and traditions with their ancestral lands, water sites, waahi tapu, and other taonga, and to provide an opportunity to take the lead as kaitiaki in how those areas should be managed in order to ensure their protection.

Taonga species require active management. Kiwi tracking in Omataroa, Te Teko.

Māori also have an interest in resource use as well as protection. This 'use' interest is unique, first because it is underpinned by the concepts of mauri, whanaungatanga, and kaitiakitanga which mean the right to use the natural environment sits with a corresponding obligation to ensure it remains healthy, and second because of the barriers to the full and optimal use of Māori land.

Large tracts of land were taken from Māori after European colonisation of Aotearoa New Zealand, and what now remains in Māori ownership is often remote and difficult to develop or utilise productively. This is compounded by barriers to use of Māori land which include fragmented ownership, restrictions on sale, lack of access to bank lending, inefficiencies of legal processes relative to general land, and difficulties in accessing land information. Māori land plays an extremely important role in maintaining Aotearoa New Zealand's biodiversity for future generations. Analysis undertaken for the BCG reveals that together, Māori land and general private land have the highest proportions of acutely threatened environments (environments with less than 10 per cent indigenous cover) with forest cover remaining. There is also a higher proportion of indigenous forest that is chronically threatened (10–20 per cent remaining vegetation cover) and at risk (20–30 per cent remaining cover) on Māori land than on other non-Crown land (approximately 1.8 per cent and 3.1 per cent of total land area respectively). More generally, around 33 per cent of land cover on Māori land is comprised of indigenous vegetation compared with 8 per cent of other non-Crown land. This gives rise to a risk that any limitations on the use and development of land that has significant biodiversity values could disproportionately impact on Māori and could exacerbate the disadvantages created by the historic confiscation of land. In order to address this, **Policies 7 and 8** take a unique approach to development on Māori land by:

- Treating development of marae, papakāinga, and ancillary community facilities as a 'locationally constrained' activity to which a more lenient effects management approach applies in respect of section 6(c) areas of significant indigenous vegetation and habitat of indigenous fauna with 'medium' attributes.
- Directing decision-makers to specifically look for opportunities for the development of Māori land and to use planning incentives to encourage the protection or enhancement of indigenous biodiversity. This is supported by the Complementary and Supplementary Measures (CSM) Report, which recommends that new incentive opportunities such as payments for ecosystem services, tax incentives, and refinements to current schemes like the Emissions Trading Scheme (ETS) be urgently investigated.

3. Maintaining indigenous biodiversity and enhancing ecosystems

Identifying Significant Natural Areas

Under section 6(c) of the RMA, all persons exercising functions and powers under the RMA must recognise and provide for the protection of significant indigenous vegetation and significant habitat of indigenous fauna as a matter of national importance. Areas that section 6(c) applies to are often referred to as Significant Natural Areas ("SNA"), significant ecological areas, or areas of significant conservation value. Implementing the section 6(c) obligation requires an understanding of which natural resources within a district or region are 'significant'. That term is not defined in the RMA, but significance criteria are usually specified in planning instruments, and over time the uncertainty (and consequently, litigation) over what constitutes ecological significance has decreased and there is now a large measure of agreement on this issue, at least in relation to terrestrial ecology. However, provision of nationally consistent criteria for identification of Significant Natural Areas is essential to ensure that SNAs are objectively and robustly identified, both to assist in their protection and management and to provide a measure of certainty to land owners/managers, local authorities and the community.

There are a range of approaches to SNA identification. Many territorial authorities identify SNAs in district plans. Some districts have identified SNAs only on public land, and others only on private land. Others do not identify SNAs at all, but will assess significance when they receive an application for resource consent for an activity that will affect indigenous vegetation or habitat. The drawbacks in the last approach are that councils do not have a comprehensive view of which areas in the district are significant or oversight of the impacts of activities that do not require consent, and stringent general vegetation clearance rules tend to be required, to ensure that impacts on *potentially* significant areas are assessed. Implementation of the NESPF is also hampered by a lack of SNA identification, given its reliance on rules that permit activities where specified standards are met, including standards relating to SNAs. It is difficult to apply this type of rule if there is no clarity as to whether areas are SNAs.

In some districts, SNA identification has been very contentious. Landowners have been concerned that identification of an area of privately owned land as SNA means that it is 'locked up' and cannot be used, or that the public may be given access to SNAs on private land. As discussed in the next section of this report, effects on SNAs must be managed, but new and existing activities are provided for, within appropriate constraints, and there is no intention to provide for public access to private land. In many districts, territorial authorities report that the SNA identification process has been a positive one that has forged better relationships between the council and landowners. This suggests that the quality of the SNA identification process is critical.

District-wide SNA identification takes time, requires a high level of expert input, and is resource-intensive. It is beyond the capacity of some councils that have a small ratings base and large land area, unless support is provided.

Identification of Significant Natural Areas in the coastal marine area and for fresh water are discussed in the *"Scope"* section in this Report.

One of the ways in which **Objective 3** proposes to maintain indigenous biodiversity is by identifying and protecting Significant Natural Areas. That objective is implemented by:

- **Policy 4** – Identification of Significant Natural Areas; and
- **Appendix 1** – Criteria for identifying Significant Natural Areas

Protection of Significant Natural Areas is a critical part of the framework for biodiversity management. There needs to be an understanding of the biodiversity values across all tenures, and mapping SNAs across both public and private land will assist in this understanding. **Policy 4** therefore requires territorial authorities to identify terrestrial SNAs throughout their districts and regional authorities to identify marine SNAs within the portion of the territorial sea under their jurisdiction.

Routeburn Track.

The BCG considered allocating responsibility for identifying SNAs across all domains to regional councils given their greater capacity, but on balance considered that we did not have enough information about the potential implications to be confident in recommending a shift away from the status quo of territorial authorities identifying SNAs on land. This role also sits well with territorial authorities given their functions relating to land use control. Similarly, the role of identifying marine SNAs fits with regional council functions. Nonetheless, we anticipate the need for regional and territorial authorities to work together, and also with the Department of Conservation and other government agencies, so that the process is cost-effective, timely and practical, and to ensure consistency between districts within a region (as per Recommendation 1.8 in the CSM section of this report).

The identification of Aotearoa New Zealand's SNAs needs to be completed so that informed and effective decisions on protection and enhancement can be made, such as identifying a landscape-scale restoration project focused on 'building on what we've got' by connecting existing SNAs. It is also critical for monitoring overall environmental state and trends. In short, tenure neutrality across public and private land is crucial for effective biodiversity management.

Principles for good practice are laid out in proposed policy as matters to be applied in the assessment process. These principles were informed by evidence of what has worked well, and what has not. They are most applicable to SNA identification on private land, while different approaches may be appropriate on conservation land.

Standardised significance criteria for identifying significant natural areas, developed on the basis of expert terrestrial and marine ecological advice, are provided in **Appendix 1** of the NPSIB. The Group has approached identification and management as distinct, independent steps. Identification of significant natural areas is the first step and is a technical, scientific question dependent on ecological analysis of the ecological attributes of an area. The second step is determining how activities in significant natural areas are managed which is a policy question (addressed below under Maintaining indigenous biodiversity). This approach is supported by the Courts. It is also underpins development of the NPSIB's definitions, with management being addressed through policy, not through including exceptions in definitions.

The BCG members agree with the criteria, subject to the following reservations:

- The BCG has sought advice from a range of ecologists with different areas of expertise and geographic knowledge in developing the significance criteria, but recognises that further input through the public submission process will be valuable. Federated Farmers and FOA are concerned that the criteria may inappropriately cover an overly broad amount of indigenous vegetation and habitat in non-indigenous vegetation. However the advice we have received is that the criteria are similar to second generation plan/regional policy statement criteria (and the Department of Conservation Guidelines) and are not unduly wide. If that is the case, that is consistent with the BCG's intention for the criteria.
- Notwithstanding, FOA and Federated Farmers are concerned that the criteria could potentially result in the majority of plantation forests being identified as SNA and that this could prevent the ongoing productive use of this land, including through the varying management approaches that could be adopted by councils. This would create significant uncertainty for existing and future forest owners. It is proposed by the Group to address this issue via: (1) **Policy 7(2)** which seeks to clarify that where plantation forestry is identified as SNA, plantation forestry activities in that area are able to be carried out in accordance with the provisions of the NESPF and (2) through complementary recommendations in the CSM Report regarding Regulation 93 of the NESPF and clearance of indigenous vegetation in significant natural areas, and measures to address adverse effects on indigenous fauna.

  Despite this agreed intent and the resulting measures that have been included, FOA has remaining concerns due to its view that the entire NESPF was drafted on the assumption that SNA vegetation would be indigenous forest remnants only, not the productive forest estate. FOA considers that to achieve an outcome consistent with the intent of Policy 7(2), amendment to numerous regulations within the NESPF would be required and that such amendments would have to be very carefully drafted to ensure they achieved that intent (protection of indigenous forest remnant SNA's but not the production forest itself). FOA is not confident this can be achieved without introducing confusion and undue complexity.

  The Group considers that the impact of production forestry being identified as SNA due to either understory indigenous vegetation or presence of indigenous fauna is a matter that could be addressed through considering this in the context of these provisions as part of the review of the NESPF.

  FOA has expressed the view that this needs to be resolved by way of amendment to Appendix 1 or associated policy guidance to provide an exception for plantation forestry (to the effect that plantation forests established in exotic conifer or eucalypt species intended for production thinning and selective or clearfell harvesting cannot be designated SNAs, regardless of the presence of indigenous fauna or understory). This is not agreed by the rest of the BCG members for the reasons set out under *identifying significant natural areas*.

The criteria and direction to identify SNAs also applies in the coastal marine area, for which the framework is the marine biogeographic area.

The BCG recognises that financial and technical support will be required to support the mapping of SNAs in districts and regions where there are resource constraints due to their large geographical areas and/or small ratepayer base. The BCG also considers that the cost of SNA identification on Crown land should be borne primarily by central government. These matters are addressed in CSM Report recommendations **1.7 and 1.10**.

Transitional provisions are also provided within the NPSIB (**Policy 22**). The intention is that councils that have recently completed mapping of SNAs in a way that substantially meets the requirements of the NPSIB will not need to repeat the process as a result of the promulgation of this NPS. A specific transition period is provided for other councils to undertake the SNA identification exercise.

Maintaining indigenous biodiversity

Many species and ecosystems in New Zealand are continuing to decline (become more threatened). This is primarily due to the impacts of pest species and other human activities with habitat loss and degradation being the key driver of biodiversity loss. Change in land cover, both historic and recent, is a significant pressure on ecosystems, particularly in coastal and lowland areas. Remaining indigenous vegetation cover is mostly in hilly and mountainous areas, with only small fragments in lowland and coastal environments. This distribution is not representative of the full range of indigenous ecosystems and habitats.[7] Nearly 83 per cent (285 of 344 taxa) of land vertebrates classified in the threatened species system are either threatened with or at risk of extinction, and the status of 11 species declined in the most recent census.[8]

Maintenance of indigenous biodiversity is a mandatory function of district and regional councils under the RMA, but there is lack of clarity about what that means, and how the function ought to apply. There is ongoing biodiversity decline despite first generation regional and district plan provisions that address the biodiversity function of local government. There is a lack of recognition of the cumulative effects of activities on Aotearoa New Zealand's flora, fauna and ecosystems. Some decisions under the RMA give inadequate regard to the impact of activities on ecological values and the implications for biodiversity maintenance. This is exacerbated by inadequate monitoring and enforcement.

Maintenance of indigenous biodiversity is required under the RMA.

Protection of SNAs and maintenance of biodiversity beyond SNAs is critical, but what does 'protection' mean when many existing activities occur within SNAs, and some new activities will seek to establish there? How are those matters to be reconciled where new activities are particularly important to New Zealanders' social, cultural and economic wellbeing? What are the attributes of ecosystems beyond SNAs that need to persist to maintain biodiversity?

The RMA requires that positive measures proposed by an applicant to compensate for adverse effects are taken into account in resource consent decision-making, but this is 'subject to Part 2'. This creates uncertainty about how such measures should be taken into account where the natural resources affected by the consent application are required to be protected under Part 2, or other Part 2 values are also applicable.

Maintenance of biodiversity means ensuring that there is no loss of variability among living organisms, and the ecological complexes of which they are a part, including diversity within species, between species, and of ecosystems. The question of what this means in practice, and how we know whether it is being achieved, was a key issue investigated by the BCG.

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7 Ministry for the Environment & Stats NZ (2018). *New Zealand's Environmental Reporting Series: Our land 2018.* Retrieved from www.mfe.govt.nz and www.stats.govt.nz.

8 Ibid., p 98.

The BCG considers it appropriate to use regulatory direction in the NPSIB as the preferred means to 'maintain what remains'. Enhancement of ecosystems, however, is to be achieved primarily through non-regulatory complementary and supporting measures, supported by target setting, alignment and prioritisation of actions discussed in the next part of this report.

The NPSIB uses four attributes that contribute to indigenous biodiversity:

- species occupancy
- indigenous character
- ecosystem representation[9]
- ecosystem connectivity, buffering, resilience and adaptability.

In **Objective 3**, maintenance of indigenous biodiversity means that there is no reduction in those attributes from their state at gazettal of the NPSIB. This is to be achieved by identifying and protecting SNAs, and by safeguarding the life supporting capacity of ecosystems and their biodiversity, functioning and adaptability. To assess whether this is being achieved will require good baseline data, and in some cases will require a significant step forward by councils and landowners, including the Crown.

The maintenance of the indigenous biodiversity objective is achieved through **policies 5, 6, 7, 8, 9 and 12** of the NPSIB, supported by **Appendices 2 and 4**. These policies address managing effects of subdivision, use and development within and beyond Significant Natural Areas.

The BCG wished to provide clear direction on effects management, and so commissioned advice on the particular effects that must be avoided to maintain indigenous biodiversity and the effects that could be remedied or mitigated.[10] The BCG also received advice from many other experts on the key human threats to biodiversity.[11] The effects that were consistently identified throughout the advice as key effects to avoid were fragmentation, loss of extent, disruption to sequences, mosaics and processes, loss of buffering or connectivity and reduction in population size of threatened or at risk species. In setting these environmental bottom lines, the BCG anticipates that activities with minimal effects (such as the establishment of maimai or bird-watching huts) and sensitively located activities that do not cause those specified effects, will be consistent with the bottom lines. Other effects that must be managed as necessary to protect the ecological integrity of the SNA include degradation of mauri or ecosystem quality, pest plant or animal incursions, disruption of indigenous fauna by people, pets and livestock, loss of people's connection with nature and cumulative adverse effects on ecosystems. These effects are controlled by **Policy 6** (within SNAs).

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9 Attributes 1 – 3 are based on the 'ecological integrity' framework established in Lee, W., McGlone, M., Wright, E. (2005). *Biodiversity Inventory and Monitoring: a review of national and international systems and a proposed framework for future biodiversity monitoring by the Department of Conservation.* Landcare Research Contract Report LC0405/122 for the Department of Conservation. The BCG preferred the term 'indigenous character' to 'indigenous dominance' (used in Lee, 2015), as the latter could be understood to mean that the indigenous component must dominate any exotic component (i.e., be more than 50 per cent) in terms of cover or species composition, whereas the attribute that is to be maintained is the extent of indigenous character, regardless of whether it is presently 'dominant' or not.

10 Walker, S., Lee, W., Bellingham, P., Kaine, G., Richardson, S., Brown, M., Greenhalgh S. and Simcock R. (2018). *Critical factors to maintain biodiversity: what effects must be avoided, remediated or mitigated to halt biodiversity loss?* Manaaki Whenua/Landcare Research Contract Report LC4001.

11 As discussed in the BCG's Evidence Synthesis Report.

'Disruption to fauna' refers to examples such as new subdivisions (with concomitant people and pets) close to areas with important flightless bird or lizard habitat, motorised vehicles or people with dogs in important shorebird nesting areas, and livestock in wetlands. The reference to human connection with nature refers to the historical, cultural, scientific and natural character values of indigenous flora and fauna, and is not intended to be used to enable public access to or across privately owned land.

The BCG agrees that environmental limits are important. There is uncertainty about the impact of these limits in terms of controls and restrictions on activities on the ground, particularly given that the BCG is also recommending nationally applicable significance criteria and mapping. The risks are large and cut both ways. Limits that apply too broadly, risk unduly constraining viable economic opportunities and social benefits. Limits that are too narrowly applied may fail to meet the goal of protecting SNAs and the broader goal of maintaining biodiversity.

Parts of the country present particular challenges. Federated Farmers has identified the West Coast of the South Island as one such area due to its unique character, significant proportion of public land, and consequent reliance upon use and development of remaining privately owned land. Another challenge is areas subject to tenure review where there are sometimes conflicting expectations following tenure review as to the landowner's ability to develop land transferred to the former leaseholder as freehold title. An underlying reason for this lack of clarity is poor integration between tenure review and RMA processes.

The BCG considers that the inclusion of a precautionary principle in regard to effects on indigenous biodiversity that are uncertain, unknown or little understood, will be able to be fully assessed by the Government, following consideration of the suite of effects management policies and in light of the foregoing matters. Reasons for including the precautionary principle are gaps in information about biodiversity pressures, states and trends, acknowledged decline in many species despite management effort, and to enable consistency with both the management of effects in the coastal environment (where a precautionary principle applies under the NZCPS), and international obligations under the Convention of Biological Diversity. Reasons for not including it would be an assessment that precaution is already inherent in the proposed NPSIB and uncertainty as to how it is implemented, in particular in the consenting context where it can result in unreasonable requirements for information and assessment.

Opportunities exist across Aotearoa New Zealand's productive landscape.

Beyond SNAs, the effects management framework encompassed by the draft NPSIB is less directive in terms of how effects are to be managed, and is focussed on the outcomes sought across regions and districts: control of cumulative effects on biodiversity attributes, control of pest plants and animals, and opportunities to incentivise restoration or enhancement (**Policy 11**). The types of controls envisaged on pest plants and animals might include controls:

- on earthworks to mitigate the risk of kauri dieback spread
- on planted species to mitigate wilding conifer spread (e.g., tree plantings for shelterbelts)

- on domestic or stock animal species (e.g., goats in areas where there is a high risk of them becoming feral).

Some activities have the potential to impact on SNAs even if they occur outside them. An example is subdivision for urban and rural-residential purposes which, if it occurs close to vulnerable fauna habitat, can have adverse effects through increased pressure from people, their pets and vehicles. New subdivisions should avoid increasing the risk of harmful disturbance to fauna within SNAs. The BCG has included a 'placeholder' for this to be considered in **Policy 11** but has not provided specific wording due to this issue being identified at a late stage.

The Group has considered the use of development incentives to achieve positive outcomes for indigenous biodiversity. Development incentives provide a 'reward' for protection, enhancement, or restoration of indigenous biodiversity typically through either an easier consenting pathway or by providing development opportunity over and above what is generally available in the area. There are two types of development incentive; insitu development incentives which provides the development in the same area or proximate to where protection, enhancement, or restoration is to occur, and transferrable development right whether the development opportunity is transferred from the location where protection, enhancement, or restoration is to occur to an area earmarked for development. Evidence before the BCG revealed that insitu development incentives (for example increased subdivision opportunity as a reward for protection) have resulted in poor environmental outcomes across the country because they have the paradoxical effect of increasing development and human use pressures in direct proximity to the environment being protected, and because the protection or enhancement part of the bargain is often not followed through. On the other hand, transferrable development rights relieve development pressure and support other community objectives such as focusing development on existing urban areas. The Group concluded it did not have sufficient information to recommend cessation of insitu development incentives however through **Policy 20** it has directed that use of transferrable development rights should be preferred and that any proposal to include insitu development incentives should be approached with caution. **Policy 20** also included specific direction on the components of a transferrable development right regime, the ecological elements of which are equally applicable to an insitu development regime.

The BCG recognises that some fauna species that are important to protect because of their rarity are highly mobile and can be difficult to detect (e.g., bats), and are therefore likely to rely on areas that are not identified as an SNA. Failing to recognise these species' vulnerability means they are unlikely to persist in those areas. **Policy 14** envisages that councils will consider where these species may be present in their district or region and take steps to protect them by mapping their likely habitat where practicable, educating people about the species' needs and incorporating into measures to avoid, remedy or mitigate adverse impacts in relevant plans as necessary to ensure the persistence of these species across their natural range.

The proposed effects management framework is informed by ecological advice and consideration of how to provide for activities that are important to New Zealanders' social, cultural and economic wellbeing, informed by presentations and the experiences of group members (and their wider networks). In response, **Policy 7** provides for particular activities associated with existing uses, immediate risks to health and safety, natural features that are ecologically significant but which were established for other reasons (e.g., artificial wetlands created to manage nutrient discharges), and plantation forestry as provided for in Regulation 93 of the NESPF. In addition, **Appendix 2** distinguishes between high and medium value ecological attributes, and **Policy 7** provides for certain activities that are spatially constrained (such as important infrastructure, mineral or aggregate extraction or certain developments on Māori land) to establish in a manner that avoids, remedies, mitigates, offsets or compensates for their effects. To provide for the reasonable use of land and avoid a 'goldrush' of subdivisions, **Policy 7** provides for a single dwelling on an allotment created before the NPSIB, where that dwelling would not be able to avoid adverse effects.

Policy 7 (1)(h) and (2) were late additions to the draft NPSIB and require further consideration. The intent of the BCG is that the NPSIB needs to provide a management framework to enable plantation forestry including harvesting, re-establishment (but not afforestation) and associated activities to be managed in accordance with the NESPF even if the plantation forest itself is an SNA (which FOA opposes). The BCG also agrees that the NESPF would need to be amended to provide a management regime for vegetation clearance in circumstances where the plantation forest is identified as a SNA. The BCG also agrees that the NESPF's provisions relating to fauna will need to be reviewed. As noted FOA remains concerned that considering the specific issues identified by FOA as part of the NESPF review, as suggested by the rest of the Group, will be complex given the large number of regulations in the NESPF that make reference to SNAs. FOA believes it will be difficult to achieve this without creating very complex wording and confusion in the interpretation of the NESPF. The other members of the Group do not agree for reasons already expressed.

FOA is of the view that Appendix 1 should be amended to specifically exclude plantation forests established in exotic conifer or eucalypt species intended for harvesting, regardless of the presence of indigenous fauna or understory. The agreed intent for the management of plantation forests would then be achieved by way of the NESPF and through Policy 14, which will in turn link back to fauna rules in the NESPF. This would remove the need for complex amendments to the NESPF and importantly would avoid the perverse outcomes associated with planted vegetation becoming SNA over time (deterring planting, the planting of longer rotation species and predator control). The rest of the BCG do not agree with this approach and amending Appendix 1, for the reasons expressed above.

The BCG did not agree on whether **Policy 7** should make further provision for renewable electricity generation activities, the electricity transmission network and identified geothermal systems.

- The infrastructure representatives on the BCG consider that:
  - Renewable electricity generation by necessity must be located where the renewable resource exists. Additional renewable generation is necessary to meet New Zealand's growing energy needs, to further decarbonise New Zealand's electricity system and to decarbonise other forms of energy use – especially transport and industrial energy. This is a crucial cost-effective opportunity for Aotearoa New Zealand to respond to climate change and transition to a low emission economy.[12] The National Policy Statements for Renewable Electricity Generation and Transmission set out

[12] The Productivity Commission report on a Low Emission Economy found that one of three shifts that must occur to transition New Zealand to a low carbon economy is to 'stop burning fossil fuels and switch to using electricity and other low-emission energy sources'. The report estimates that an increase in new renewable generation equivalent to approximately 50 per cent of current electricity generation will be required by 2050. The report is available at www.productivity.govt.nz/inquiry-content/3254?stage=4. Transpower estimate in their report 'Te Mauri Hiko' that in increase of more than 100 per cent will be required over that timeframe. This report is available at www.transpower.co.nz/about-us/transmission-tomorrow/te-mauri-hiko-energy-futures

objectives that need to be reconciled case-by-case based on an assessment of all relevant considerations.

  - Effects of new renewable generation facilities on biodiversity and other values are thoroughly assessed and managed under resource consent processes. However it is not feasible that all actual and potential adverse effects on biodiversity can be avoided. Accordingly, policy wording is sought that allows for resource consent applications to be made and determined according to their overall merits. For geothermal generation there is a well-established regional resource approach to the management of that resource and its biodiversity in those locations that ought to be reflected in the policy approach.

- The environmental NGO representatives consider that:
  - it is important that the NPSIB establishes biophysical bottom lines to implement the 'protection' element of sustainable management. This means ensuring that the most egregious effects are avoided in the highest value areas. Generation and transmission of electricity should occur in a manner that is consistent with maintaining indigenous biodiversity. The NPSIB already makes provision for activities to affect Significant Natural Areas, contrary to ecological advice that these effects must be avoided. Making further provision for these effects to occur carries a significant risk of failing to meet the NPSIB's objectives.
  - climate change is a critical issue but care needs to be taken to ensure it is not relied on as a justification for effects beyond biophysical bottom lines. The continued loss of indigenous biodiversity, for its intrinsic value and the ecosystem services it provides will have negative consequences. New Zealand's transition to net zero must occur in a way which protects and respects our natural environment if it is to be sustainable and avoid repeating the losses associated with past eras of significant industrial development. The wording supported by the environmental NGO representatives in **Policies 6 and 7** is intended to strike this balance between protecting the most significant parts of our natural environment, and providing for new infrastructure, including renewable energy, to achieve New Zealand's climate mitigation targets.
  - we do not have sufficient information to agree to a separate approach for geothermal features.

The NPSIB provides for some effects on ecological values to be offset or compensated for. These biodiversity-related intervention measures address residual adverse effects on ecological values by providing a positive effect to counterbalance the adverse effects of a particular development. The NPSIB includes biodiversity offsetting principles in **Appendix 4**. The BCG did not agree on whether biodiversity offsetting and compensation should be applied to 'significant' residual adverse effects:[13]

- infrastructure representatives, Federated Farmers and Forestry Owners' Association consider that 'significant' is an appropriate level of adverse effect to focus offsetting and compensation measures on. It is a threshold that has either been agreed or determined by decision-makers as being appropriate in various regional policy statements and plan provisions relating to biodiversity management.
- the environmental NGO representatives consider that offsetting should apply to all more-than-minor adverse effects. They note that the Government Guidance on Good Practice

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[13] Appendix 4, principle 1.

Biodiversity Offsetting refers to 'significant' residual adverse effects but goes on to clarify that this means 'ecologically meaningful' rather than a 'significant effect' as used in the RMA.

The BCG's proposed draft NPSIB also has a definition for biodiversity compensation. The BCG reached agreement on the definition, and the place of compensation in the effects management framework, subject to one point of disagreement – whether compensation should achieve no net loss of affected ecological attributes:

- infrastructure representatives, Federated Farmers and Forestry Owners' Association consider that environmental compensation is a more flexible management approach than offsetting and this is a distinct advantage. Calculating no net loss is a highly technical exercise, in various real examples it has proven to be expensive and contentious. Requiring environmental compensation to achieve a no net loss outcome for biodiversity would effectively create a 'no adverse effects' regime. Furthermore, there are various examples of compensation agreements that provide highly valued biodiversity outcomes[14] but where the outcome could not be considered to be no net loss. The inability to provide for such approaches as future options (subject to any development proposal being able to gain or renew a resource consent) may risk poorer outcomes overall.
- the environmental NGO representatives consider that when it comes to indigenous biodiversity, compensatory measures should only be a relevant consideration under the NPSIB where they achieve no net loss of relevant ecological values. Maintenance of indigenous biodiversity is a mandatory function under the RMA, and measures that do not maintain indigenous biodiversity (because they cause a net loss of species or ecosystems) are not consistent with achieving that function, and therefore should not be provided for in planning instruments under the RMA. That does not mean that there is no difference between biodiversity compensation and biodiversity offsetting. A biodiversity offset must meet all of the principles in **Appendix 4**, whereas biodiversity compensation measures only need to provide a positive, measurable outcome that achieves no net loss. They disagree that a requirement for no net loss means 'no adverse effects' are allowed. Under this approach, effects are allowed where they can be offset or compensated for in a way that maintains biodiversity. If a definition of compensation is adopted that does not require achievement of no net loss, the environmental NGO representatives do not support provision for biodiversity compensation in **Policy 7**.

The BCG sought to provide specific direction on how existing activities and replacement consents are to be managed and provided for. **Policy 8** distinguishes between activities and structures that could feasibly be required to cease at consent expiry or to operate in a different way (e.g., inappropriate wetland drainage) and those where it is not feasible that the activity and its effects would cease on consent expiry (e.g., a major hydropower dam). For the latter type of replacement consent, the policy seeks to ensure that reasonable steps are taken to mitigate existing and ongoing (in a 'more or less continuous manner') effects as far as practicable.

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14 'Project River Recovery', a compensatory agreement between Meridian Energy, Genesis Energy and the Department of Conservation. See https://www.doc.govt.nz/our-work/project-river-recovery/; 'Whio Forever Recovery Programme', agreement between Genesis Energy and Department of Conservation. See https://www.doc.govt.nz/about-us/our-partners/our-national-partners/genesis/; Waikato Catchment Ecological Enhancement Trust (WCEET) agreement between Mercury Energy and WCEET. See http://www.wceet.org.nz/partners/.

The NPSIB expressly recognises the contribution that existing activities make to social, cultural and economic wellbeing, and generally provides for existing activities to continue. However, there are situations where existing activities have effects that are inappropriate on biodiversity, and the effects should cease or change. The NPSIB envisages that these circumstances will be identified in regional policy statements.

As part of developing policy addressing existing activities the BCG has given particular consideration to the maintenance of improved pasture, which comprises a range of farming activities including grazing, oversowing, top-dressing, spraying with herbicide, direct drilling of seed, cultivation, and irrigation. Improved pasture exists on a spectrum from wholly exotic grass species, to mixed exotic-indigenous grasslands, or exotic grasslands interspersed with indigenous shrublands. As a result improved pasture may have no, or anywhere from low to high, indigenous ecological value.

Generally, continuation of farming practices to maintain improved pasture that (i) have occurred on site as part of cyclical farming practices and (ii) are carried out at the same intensity and scale, will be unlikely to have adverse effects. However, this is not always the case. For example, where improved pasture is in areas that historically supported indigenous grassland, and which continue to have indigenous grassland species present (because the site has never been cultivated or irrigated), persistence of the indigenous grassland component is important, and may not be compatible with all forms of improved pasture maintenance. Some indigenous vegetation may also require protection as habitat for indigenous fauna.

These are difficult issues to determine at a national level given the ecological differences between regions and districts. Some regions and districts already have improved pasture provisions in place, based on ecological factors specific to that region or district, that work well. Others have improved pasture provisions that are allowing intensification in areas with ecological value. Care needs to be taken to ensure that national policy direction supports good provisions but drives improvement of poor provisions.

Federated Farmers is concerned that some activities necessary to maintain improved pasture are not able to be carried out in a manner that avoids loss of indigenous vegetation. Forest & Bird and EDS are concerned to ensure that in areas of improved pasture that support an ecosystem of mix-exotic indigenous vegetation that has ecological value, the indigenous component is maintained.

Federated Farmers, Forest & Bird and EDS have spent a considerable amount of time working on this issue, with different formulations proposed and considered by each group. The policy wording proposed by Federated Farmers that is included in Policy 9 in grey text as not agreed was provided after much discussion, but nearing the end of the process and because of time constraints other members have not yet been able to consider it or associated definition requirements, or receive ecological advice. A definition of improved pasture will be required to support the policy. Extensive work on this has also been undertaken. Federated Farmers, Forest & Bird, and EDS consider that a solution is possible on both the policy and definition and remain committed to resolving this. It suggests that as part of the Ministry's NPSIB policy assessment phase, prior to public consultation, it convene a focus group for an intensive workshop on the issue, comprising Federated Farmers, F&B, EDS, and DOC and supported by a planner and ecological experts with expertise in the north and south island. This is an important issue to the three groups for certainty, clarity, and because of its implications both ways.

Additional considerations apply in respect of Māori land, as described in the section on *Te Tiriti o Waitangi* in this Report.

The specific effects management framework for wetlands is discussed in the section titled *Wetlands* in this Report. As discussed in the Scope section, the BCG has not included effects management policies for freshwater (other than wetlands) or marine domains in the NPSIB.

The BCG recommends that guidance on the implementation of these provisions is provided by the Ministry for the Environment.

Enhancing ecosystems

There has been widespread loss of biodiversity across Aotearoa New Zealand, particularly in lowland and coastal environments. There is now less than 10 per cent remaining indigenous vegetation cover (which can be used as a proxy for indigenous biodiversity) throughout most of the country's lowland zone. In the worst cases, the depletion of indigenous ecosystems and the loss of biodiversity is so great that the only prospect for maintenance of indigenous biodiversity is to reconstruct indigenous habitat.[15]

The BCG received advice that critical thresholds mark the line between decline or persistence of an ecosystem and its constituent species, with the most important threshold being the fraction of the landscape covered by indigenous ecosystems. Ecologically, it is generally accepted that when ecosystems persist at 10 per cent or less of their original extent, a decline in many species may be triggered, with severe fragmentation effects.

Vulnerable species like kiwi will not survive without targeted programmes to protect their habitat.

Currently, the remaining indigenous cover in nearly all of Aotearoa New Zealand's largest urban centres is well below 10 per cent and there is a wide range of variation in the peri-urban zone depending mainly on topography. New Zealand's towns and cities typically occur in the lowland zone and have urban cores and peri-urban areas that are drastically altered from original natural states. While the size and extent of remnant vegetation patches generally increase from the city centres to peri-urban and rural zones, only nine of the 20 largest urban centres exceed 10 per cent indigenous vegetation cover at approximately 5 km from the urban core. Applying a Land Environments of New Zealand (LENZ) analysis, the urban cores comprise 63 (of 158) acutely threatened land environments (which make up 66 per cent of the land area) and 13 chronically threatened environments. Only 10 of the 100 land environments in the urban core are classified as not threatened. This underscores the importance of urban areas to the national biodiversity picture. The high proportion of acutely threatened environments, while highlighting the major impacts of urbanisation on biodiversity loss, also indicates potential to contribute to the protection, restoration and reconstruction of threatened environments in cities. In addition, given that most New Zealanders now live in urban centres, the loss of indigenous biodiversity and opportunities to experience nature in day-to-day life has significant implications for people's wellbeing and connection to the natural environment.

Buffer or peri-urban areas are also critically important: 60 acutely threatened environments (38 per cent of all acutely threatened environments) have more than 10 per cent of their land area within a 20 km zone of urban areas, and 22 acutely threatened environments have more than 50 per cent of their area represented within those urban and peri-urban zones.

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15 Clarkson, B., Kirby C. and Wallace, K. (2018). *Restoration targets for biodiversity depleted environments in New Zealand*. The Environmental Research Institute, University of Waikato.

In addition to the reconstruction focus described above, enhancement or restoration and active management of Significant Natural Areas and ecological connections and linkages is often necessary to protect these areas' significant ecological values and safeguard the life-supporting capacity of ecosystems.

There are many positive actions underway in New Zealand aimed at enhancing and reconstructing indigenous ecosystems. Environmental and social gains can be magnified if these positive existing actions can be aligned to national priorities and expanded. As discussed in the CSM Report, it is important that new policy approaches support rather than cut across existing efforts. The BCG is aware of a number of barriers to expansion of enhancement and restoration initiatives, and received advice on the likely costs per hectare if restoration was focussed solely on acutely threatened LENZ environments. Given the challenge in achieving restoration targets (and then maintaining these targets once achieved), a balance will need to be struck between managing resources available to the community and regional councils to achieve restoration of a range of priority ecosystems.

It is more efficient and cost-effective to maintain existing indigenous ecosystems than to try and create new ecosystems. There are inherent difficulties and risks in seeking to recreate or reconstruct indigenous habitat in order to mitigate for continuing removal of indigenous habitat for development projects, and that mitigation may not result in an ecosystem of equivalent richness or function. However, advice received by the BCG is that it is possible to reconstruct or re-create high quality indigenous habitat to complement (rather than replace) measures to protect existing ecological values. This can bring indigenous nature back into urban centres, the peri-urban zone and other highly modified landscapes.

The BCG was advised that adoption of a formal target is important to provide a goal to inform and develop biodiversity protection strategies, and that for urban and peri-urban areas, that target should be at least 10 per cent indigenous cover. Urban centres would, on average, require 396 ha of additional indigenous cover to reach a 10 per cent target. The minimum top-up required is in New Plymouth (one per cent or 35 ha) and the maximum in Christchurch (9.5 per cent or 1365 ha). Achieving the target would require different combinations of protection, restoration and reconstruction depending on the different characteristics of each urban centre. The cost and time to achieve the target would vary dramatically.

The type of indigenous cover matters: the 10 per cent indigenous cover target needs to accommodate all of the major ecosystems naturally and formerly present in the area under consideration. A diverse as possible array of species should be restored to represent all elements of the functioning ecosystem that occurred before anthropogenic degradation. Connectivity is a key consideration, as biodiversity generally declines with greater degrees of fragmentation because small, isolated patches of indigenous ecosystems can support only small populations of species.

Having a minimum target of 10 per cent in depleted environments helps focus attention on the magnitude of enhancement required to reduce biodiversity decline across the wider landscape. But having the target on its own will be insufficient if it is not backed by a national and regional scale strategy and implementation plan to achieve the target.

Objective 3.2 of the NPSIB is to enhance the sustainability of indigenous biodiversity depleted environments through the restoration and reconstruction of a representative range of indigenous vegetation and habitats.

Indigenous biodiversity depleted environments are described in **Policy 19** as areas where indigenous cover is below 10 per cent of its original extent. **Policy 19** requires the adoption of targets for all such environments (which in urban and peri-urban areas must be at least 10 per cent and in other areas is set by the regional council), and requires that restoration and reconstruction objectives are set regionally that prioritise ecosystem representation, threatened ecosystem types and land environments, species richness, connectivity and ecological restorations. Regional councils must also set a timeframe for achievement of the target and objectives. Enabling regional councils to set their own target will allow them to take into account the scale of the task and the level of resourcing available within the council and community to meet the target and objectives, and set a timeframe that is meaningful and achievable for their region. The BCG has elected not to set a target for land beyond the urban/peri-urban area, because the threshold advice we received was focussed primarily on cities and towns and their surroundings. However, the target-setting concept should apply more broadly, with regional councils and communities determining the appropriate target and timeframe.

While **Policy 19** is focussed on indigenous biodiversity depleted environments, **Policy 18** applies to SNAs and other areas that provide important connectivity or buffering functions. It requires that objectives are set for the enhancement of ecosystem function and ecological integrity of these areas. **Policy 19** implements **Objective 3.3** which is to restore and enhance the ecosystem function and ecological integrity of degraded Significant Natural Areas, and areas that provide important connectivity or buffering functions.

The **Policy 18 and 19** objectives are to be achieved through Regional Biodiversity Strategies. Under **Policy 17**, regional councils are required to prepare a Regional Biodiversity Strategy in conjunction with territorial authorities, tangata whenua and the community, which has as its purpose the promotion of a landscape-scale enhancement and restoration vision for the region's indigenous biodiversity. Detail as to the content of the Regional Biodiversity Strategy is provided through a suite of principles contained in **Appendix 5**. The BCG intends that preparation and adoption of a Regional Biodiversity Strategy is mandatory, but that the content of the Strategy is non-regulatory. This recognises that achievement of enhancement and restoration objectives will require a whole-of-community approach that must be incentivised and supported by local authorities but cannot be required of people. In that light, the Strategy is primarily about:

- aligning the community behind a shared vision and set of priorities
- ensuring that careful consideration is given to how enhancement actions will be supported or encouraged and resourced
- providing a place to consider how co-benefits from existing or proposed actions to achieve other objectives (such as freshwater management, carbon sequestration) can be used to also achieve biodiversity objectives.

Enhancement, restoration, reconstruction and active management actions are wide-ranging, including predator control, weed management, and planting and habitat construction. In addition to the direct benefits to indigenous biodiversity, these actions can foster a connection between people and nature and provide for the exercise of kaitiakitanga.

Climate change

The BCG received advice that climate change has the potential to destabilise indigenous species' distribution and abundance patterns while affecting the physical drivers of many habitats. Increasing ambient temperatures, greater climate extremes, more frequent storms and generally drier climates in eastern areas are predicted to modify biodiversity processes and patterns. Sea-level rise is already affecting the extent and character of coastal ecosystems and their species.


The effects of vegetation clearance are exacerbated by climate change.

Although indigenous biodiversity has persisted through considerable environmental change in the past, these shifts in recent decades are having novel impacts, challenging the survival of species already compromised by other stresses. Fragmentation of populations and ecosystems may exacerbate declines associated with climate change. Increases in the diversity and abundance of plant and animal pests and diseases in response to expanding thermal envelopes will exacerbate threats for many indigenous species. The potential expansion of frequent fire regimes could destroy indigenous ecosystems, replacing them with more fire-tolerant and fire-prone habitats, largely occupied by introduced species. Storm events, particularly in tectonically active regions, will increase sediment loads in rivers, estuaries, and coastal marine ecosystems.

Future biosecurity protocols will be challenged in a world characterised by increased global trade, warmer climates, and greater disturbance. Under this scenario, it is likely disease and pathogen incursions will increase, with potential spill-over effects for indigenous biodiversity. Failures in border biosecurity are inevitable, so a resilient indigenous biodiversity will depend on maintaining the full range of environments, populations, species, and ecosystems available.

Under the RMA, all persons exercising functions and powers are required to have particular regard to the effects of climate change (section 7(i)). Direction is lacking about how to achieve this as part of planning and decision-making in a sustainable management framework, and in particular what that means for indigenous biodiversity maintenance.

At a national level, the BCG was advised that the most effective strategies for sustaining indigenous biodiversity in the face of climate change are to:

- continue to reduce the pressure from mammalian and plant pests and pathogens
- protect and buffer remaining areas of ecosystems and habitats of indigenous species and restore them, especially in more modified landscapes
- ensure connectivity between ecosystems and habitats to enable migrations and allow ecosystem adjustment in order to provide for species to find viable niches as the climate changes.

Objective 3.4 is to reduce the vulnerability of indigenous biodiversity of New Zealand to the effects of climate change.

That objective is achieved by all of the NPSIB policies relating to effects management and enhancement of ecosystems, and many of the recommendations in the CSM Report will also assist. However, **Policy 3** is particularly relevant. It requires regional and district councils to adopt a precautionary approach to management of indigenous biodiversity potentially vulnerable to effects from climate changes so that natural adjustments to maintain the ecological integrity of ecosystems, habitats and species are allowed to occur, restoration and reconstruction activities will persist, pressure from pests and pathogens is reduced, and connectivity between ecosystems and habitats is retained.

4. Integrated and evidence-based management

In order to maintain and enhance indigenous biodiversity in New Zealand, it is necessary to underpin the management framework with appropriate information across land, freshwater and coastal-marine environments. Ideally, biodiversity data collected by one council should be comparable to data collected by another council and should be able to be collated to provide a national picture. Improved coordination of conservation effort on the ground is also critical if we are to achieve a step change in biodiversity management.

At present, there is a need to ensure government policies are better aligned across agencies to achieve (or at least not undermine) biodiversity benefits or co-benefits, and to ensure decisions on non-biodiversity specific activities do not inappropriately or inadvertently result in biodiversity loss or degradation. Compartmentalised decision-making by territorial and regional authorities in relation to indigenous biodiversity is an issue, as both local authorities have functions relating to indigenous biodiversity. The undesirable outcomes of compartmentalised decision-making include impacts of activities on biodiversity not being fully recognised or not being addressed effectively.

Environmental monitoring is another key component to enable us to better understand the environment and involves the collection of long-term data that informs us about the condition of our environment. The information collected allows us to assess whether our indigenous biodiversity is improving, remaining the same, or becoming degraded. Decision-makers, as well as researchers, need better access to a national picture of the state of our indigenous biodiversity. A comprehensive national picture will enable improved decision-making, more efficient operational processes, opportunities for increased collaboration between organisations and new research opportunities that will further inform policy development.

An opportunity therefore exists to:

1. support co-ordinated, strategic leadership of the biodiversity management system and the work of those engaged in conservation work on the ground
2. improve the scope and detail of information collected on the state of biodiversity and the pressures on it
3. achieve decision-making by those exercising functions under the RMA based on relevant and accurate information on the actual and potential effects of activities on biodiversity.

To achieve these outcomes, the NPSIB includes an objective on integrated and evidence-based management (**Objective 4**) and a number of policies that either strengthen the information base for management or support greater integration of management decisions. These policies include:

- **Policy 4**, requiring that section 6(c) SNAs be identified and mapped
- **Policy 13**, which directs regional councils and territorial authorities to work with tangata whenua to identify species, populations and ecosystems that are taonga
- **Policy 14**, provisions on surveys and maps of the likely presence of highly mobile indigenous fauna.

- **Policy 15**, which outlines information requirements when assessing environmental effects on indigenous biodiversity
- **Policy 17**, which directs the preparation of Regional Biodiversity Strategies, to promote a landscape-scale enhancement and restoration vision for a region's indigenous biodiversity and empower multiple stakeholders to contribute to that vision
- **Policy 19**, provisions on the identification of indigenous biodiversity depleted environments as foci for restoration and reconstruction.

A placeholder exists within the NPSIB for a specific policy on integrating decision-making (which the BCG did not have time to develop), the intent of which is to ensure that decision-making on aspects of activities that relate to district and regional functions occur holistically (**Policy 16**).

Within the CSM Report, there are also a number of sections that deal in some way with integrated, evidence-based management of biodiversity. These include topics relating to:

- Consistent and comprehensive monitoring and reporting
- The development of an inventory of wetlands, to record their extent, location and significant values in a systematic and standardised way
- The facilitation of co-ordinated, integrated local conservation efforts, through regional community conservation hubs
- Development of a national biodiversity database, to address data deficiency and a lack of interoperable data that can be used and re-used by decision-makers and communities
- Improved compliance monitoring and enforcement.

In addition to the above, the BCG recognises the importance of a consistent approach to prioritisation, noting that some prioritisation is inherently encompassed by the NPSIB (e.g., restoration policies). We note that future review of the National Biodiversity Strategy will provide an opportunity to consider prioritisation in more detail.

5. People and partnerships

Promoting sustainable management under section 5(2) of the RMA includes a mix of duties towards the natural environment and the socio-economic conditions of people and communities. Specifically, it includes 'enabling people and communities to provide for their economic, social and cultural well-being…' while providing for section 5(2)(a)–(c). This concept of sustainable management is achieved through **Objective 5** of the draft NPSIB.

The intent behind **Objective 5** is to recognise the need to provide for these 'wellbeings', as it is people and partnerships that will ultimately help us meet the goal of thriving biodiversity. A number of BCG presentations from those who work in the community 'on the ground' implored the Group to ensure the NPSIB does not 'harm the good work going on out there'. The group attended two field trips, to Whakatāne (Omataroa forest) and Banks Peninsula, where we saw first-hand the important role people and partnerships play in improving biodiversity outcomes. **Objective 5** recognises that improved biodiversity outcomes will not be achieved without the critical link of empowering people.

A significant proportion of indigenous vegetation is on private land, and these owners respond better when they are respected and relationships are fostered. If they understand the issue (of declining biodiversity) they will care more about biodiversity and habitats on their land and will be more likely to act to protect it. We received advice that land and business owners are best engaged in ways that recognise their individual circumstances; they may be at different stages of their lives, with differing priorities, expectations and abilities to resource the protection of biodiversity on their land. Regulation needs to be evidence-based, carefully focussed, certain, and clear, so that it does not lead to perverse outcomes. An unnecessarily heavy focus on regulation may damage existing 'buy-in and goodwill' and unintentionally incentivise poor behaviour (such as landowners opting not to plant, manage, protect or restore indigenous vegetation).

Biodiversity will not thrive without community efforts.

Objective 5 recognises that there are sometimes conflicting values around existing and new activities and biodiversity. Express provision for existing use rights is key to implementing this objective. We recognise that generally, resource use and development is a key part of viable regional economies and communities in Aotearoa New Zealand.

As several presenters impressed upon us, you can enhance biodiversity within a 'working landscape'. The BCG recognises the significant commitment that many landowners make to protecting and enhancing indigenous biodiversity on their own land.

The BCG acknowledges the need to adequately recognise the traditional relationship of Māori with Aotearoa New Zealand's indigenous biodiversity, including the need to acknowledge the role of tangata whenua as kaitiaki. These principles have been embraced by the NPSIB, both through the overarching Hutia Te Rito approach, and through **Policies 1 and 2**.

The first step in protecting SNAs is to ensure landowners with SNAs on their property are appropriately communicated with, kept informed, provided with guidance, and remain involved throughout the identification process whenever possible. Considerations to guide councils' approach to SNA identification processes are included in **Policy 4**.

Policy 7 establishes the need to provide for social, cultural and economic wellbeing within and outside of SNAs, with provision for existing activities being a cornerstone to this. This provision includes acceptance that the planting of vegetation within SNAs that is for a specific purpose, should be able to continue if consistent with that purpose. Similarly, **Policy 8** provides for replacement consents, with gains for biodiversity where feasible.

In reality, provision for people and partnerships goes beyond the NPSIB itself, and it is a key aspect of the CSM Report. For biodiversity to thrive, and to ensure gains are made through restoration and enhancement, more than regulation is required. The CSM Report recognises that many of the opportunities for maintaining and enhancing biodiversity will occur on private land. Maintaining and improving biodiversity requires both significant effort and investment and this cannot come from landowners alone. Organisations like Landcare Trust will be key in providing advice and technical support in rural communities. The QEII Trust also plays a critical role but needs additional funds to meet demand. Moreover, landowners need access to more engagement, education and assistance with active management, provided in a coordinated and integrated way. This must come through a package of 'support' tools and actions to accompany the NPSIB, and to ensure its objectives can be met.

6. Wetlands

Wetlands are hotspots for indigenous biodiversity. They are also critically important because of the ecosystem services they provide for the wider environment and for people, which include flood protection, improving water quality, and resilience to drought. The preservation of their natural character is a matter of national importance under the RMA and protecting the significant values of wetlands is an obligation under the NPSFM. Inclusion of both goals in the NPSIB recognises the significance of wetlands and ensures alignment with the RMA and NPSFM. New Zealand is also a signatory to the Ramsar Convention on Wetlands, under which it must promote the wise use and conservation of all wetlands, and designate wetlands for inclusion on the List of Wetlands of International Importance.

However, despite preservation and protection of wetlands being a goal under the RMA and NPSFM, wetlands continue to be lost as land-use intensifies in rural areas and urban land expands. Loss and damage has been so pervasive that today only 10 per cent of the historical extent of wetlands remain. In many areas that percentage is even less; in Hawke's Bay for instance only 2 per cent of wetlands remain.

A key reason for the loss of wetlands is that their location often overlaps with where people live and work and because, until recent decades, there has been a lack of understanding and appreciation of their importance. Another key reason is the lack of specific direction in the RMA and NPSFM in terms of how to achieve the objectives of protection and preservation. Defining the physical characteristics of wetlands, or a nationally consistent process and criteria for spatially defining the extent of wetlands, for example, is lacking (as recently noted by the Land and Water Forum in its 2018 report).[16] This has resulted in regional inconsistency and disagreement in approaches to wetland identification and management.

The NPSIB is intended to address these issues. It focuses protection and preservation on wetlands that have retained ecological integrity, i.e., they have retained the indigenous vegetation, soil, and hydrological function that characterises wetlands. This is achieved through the use of the step-by-step wetland identification and delineation tool in **Appendix 3** which has been carefully developed with the help of experts to achieve that outcome.

View from Travis Wetland visitors' centre (Jon Sullivan).

[16] Land and Water Forum advice on improving water quality: preventing degradation and addressing sediment and nitrogen, received May 2018.

The NPSIB recognises that in wetlands with ecological integrity (i.e., those identified using **Appendix 3**) will require protection. The NPSIB also provides direction on what those significant values are in terms of indigenous biodiversity, including that a wetland may also be identified as a section 6(c) RMA area of significant indigenous vegetation or habitat of indigenous fauna (in respect of which the NPSIB also provides direction). The BCG's intention is to avoid any further loss and degradation of wetlands with ecological integrity, an objective also expressed by the Land and Water Forum in its 2018 Report.[17] Critically, this is not intended to disincentivise people from using wetlands as a natural method for achieving specific outcomes, such as sediment control or flood protection, or stop people from undertaking activities necessary for protection, such as fencing to keep stock out or crossings designed to get stock over without damage. For this reason, exceptions are included to make it clear that activities necessary for achieving the purpose for which a wetland was established, and those necessary for its protection, can occur.

Protecting the wetlands that are left is only one piece of the puzzle. Enhancing those that are degraded and reconstructing those that no longer retain ecological integrity are extremely important goals to promote if New Zealand is to increase the resilience and health of its natural environment. The group recognises that freshwater quality and quantity are managed under the National Policy Statement for Freshwater Management: accordingly Policy 12 (4) is intended to encourage non-regulatory responses to enhancement and reconstruction of wetlands.

17 Land and Water Forum advice on improving water quality: preventing degradation and addressing sediment and nitrogen, received May 2018.

Part 2: The Biodiversity Collaborative Group's Draft National Policy Statement for Indigenous Biodiversity

In this draft national policy statement [grey text] denotes that the provision is not agreed by all members of the Biodiversity Collaborative Group. The Background Report provides detail about the Group's various views on these grey texts. Text in *italics* denotes provisions that the BCG did not have time to fully develop. The Group anticipates that further work will be required to determine the nature of these provisions.

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Preamble

This national policy statement sets out objectives and policies to manage natural and physical resources so as to maintain indigenous **biological diversity** ('**biodiversity**') under the Resource Management Act 1991.

Aotearoa New Zealand's **biodiversity** is in decline. An urgent nationally coordinated response is required to halt that decline and ensure native species, **habitats** and ecosystems can thrive. Addressing this decline is an issue for all New Zealanders.

Aotearoa New Zealand has a unique natural heritage. That heritage defines what it means to be a New Zealander. Our land is young and geologically unstable. It has been separated from other major land masses for some 80 million years. In this isolation and geological instability, a unique ecology evolved. We have high endemism (species found nowhere else) and, in the absence of land mammals, highly distinct and internationally significant ecosystems.

Yet in just 700 to 800 years, humans have wrought huge change through our use of land and other natural resources, and through our introduction (deliberate or otherwise) of exotic species that have become pests outside their natural environments.

As a consequence, many indigenous species and ecosystems have been lost and many that remain are now highly vulnerable. More will be lost unless we intervene to protect them from the many threats they face.

This national policy statement uses Hutia Te Rito as the framework to achieve the integrated and holistic well-being of the natural environment. This framework recognises that the health and well-being of our natural environment, its ecosystems and unique indigenous flora and fauna, are vital for the health and well-being of our land, fresh water, coast and marine environment, and communities.

Some of the most important ecosystems and **habitats** are found within Aotearoa New Zealand's large conservation estate. However, much of Aotearoa New Zealand's remaining **biodiversity** is on privately owned and managed land. Indeed, private land hosts many ecosystems that are poorly, if at all, represented within the public conservation estate. Hence private landowners have a vital role in meeting our national **biodiversity** objectives, and partnerships between those landowners, their communities and public agencies will be critical to success.

Achieving the purpose of this national policy statement will involve retaining as many of our remaining species, populations, **habitats** and ecosystems as we possibly can, placing value not only on the pristine, but also on the more modified and degraded ecosystems that make an important contribution to maintaining **biodiversity**. We must recognise the importance of species and ecosystems that are locally rare but nationally abundant, as well as those that are locally abundant but nationally rare. Similarly, maintaining indigenous **biodiversity** will require retention of species across their natural range.

Yet stopping loss and arresting degradation will not in itself be sufficient. Maintaining **biodiversity** long-term will also involve taking positive steps to more effectively manage the ongoing and pervasive threats from plant and animal pests, as well as the emerging threat of climate change. It will also often necessitate enhancement of remaining ecosystems and even **reconstruction** of indigenous cover in the most modified environments.

While it is important to identify and protect **significant natural areas**, it is also important to understand that informed and sympathetic management is required of all New Zealanders across the landscape - not just in defined **significant natural areas**. This includes a concern for highly mobile fauna that do not necessarily limit themselves to areas easily defined on maps.

As a signatory to the Convention on Biological Diversity, New Zealand has committed to the conservation of **biodiversity**, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding. Aotearoa New Zealand is also a signatory to the Ramsar Convention on Wetlands. This national policy statement is an important part of New Zealand's response to meeting those international obligations.

Regional and district councils have a statutory function under the Resource Management Act 1991 to maintain **biodiversity** and that is complemented by Part 2 principles including the need to:

- Safeguard the life-supporting capacity of ecosystems
- Protect significant **indigenous vegetation** and significant **habitat** of indigenous fauna
- Provide for the relationship of Māori and their culture and traditions with their taonga
- Have particular regard to kaitiakitanga, and the ethic of stewardship
- Take into account the principles of Te Tiriti o Waitangi

This national policy statement states objectives and policies for those matters of national significance. It does so while recognising the traditional relationship of Māori with Aotearoa New Zealand's indigenous **biodiversity**. It acknowledges the role that Māori have as kaitiaki in all aspects of **biodiversity** management. Recognising those relationships will assist in developing stronger working relationships between Māori and the Crown.

While this national policy statement supports the existing good work of local authorities and looks to secure the gains already made in terms of regional and local planning responses, it seeks a step change in management recognising the opportunity before us to secure the distinct identity of Aotearoa New Zealand for generations to come.

Review

This will include a statement on the date this national policy statement is to be reviewed by central government.

Scope of National Policy Statement for Indigenous Biodiversity

Biodiversity is relevant to the terrestrial, freshwater and marine domains. The application of this national policy statement to each of those domains is as follows:

Terrestrial domain

This national policy statement applies to all land regardless of tenure.

Freshwater domain

This national policy statement does not apply to fresh water other than provisions relating to wetlands. In relation to wetlands this national policy statement does not deal with water quantity or quality. It applies to the banks or beds of rivers to the extent that they support terrestrial ecology.

The application of this national policy statement to freshwater is to be reviewed by the Ministry for the Environment prior to notification.

Marine domain

Provisions of this national policy statement relating to identification of **significant natural areas** apply to the coastal marine area. This national policy statement does not otherwise apply to the coastal marine area.

Hutia Te Rito

Hutia te rito o te harakeke	When the centre of the flax bush is picked
Kei hea te Kōmako, e kō?	Where will the bellbird sing?
Kī mai ki ahau	You ask me
He aha te mea nui o te ao?	What is the greatest thing in the world?
Māku e kī atu	My reply is
he tangata, he tangata, he tangata	It is people, it is people, it is people

This whakataukī recognises the impact people have on our natural environment and its survival; our actions can determine whether it is destroyed or degraded or whether it thrives. This requires recognition of the interconnected and whakapapa (familial) relationship between the natural environment and communities; people are part of and dependent upon the natural environment and its ecosystems.

In this national policy statement, Hutia Te Rito provides a framework to achieve the integrated and holistic well-being of the natural environment. It recognises that the health and well-being of our natural environment, its ecosystems and unique indigenous flora and fauna, is vital for the health and well-being of our land, our fresh water, our coast, our marine environment, and our communities.

Upholding Hutia Te Rito acknowledges and protects the mauri (life force) of our indigenous **biodiversity**. This requires that in using the natural environment and its resources and providing for te hauora o te tangata (the health of the people), we have a responsibility to provide for the te hauora o te koiora (the health of indigenous **biodiversity**), te hauora o ngā taonga (the health of taonga species and ecosystems) and te hauora o te Taiao (the health of the wider environment). Resource use and development which degrades the mauri and hauora of our indigenous **biodiversity** will also degrade the hauora of our people.

Hutia Te Rito incorporates the values of tangata whenua and the wider community in relation to indigenous **biodiversity** and the natural environment. The engagement promoted by Hutia Te Rito will help regional and district councils to develop meaningful, tailored responses to maintaining and enhancing indigenous **biodiversity** that work within their region.

By recognising and providing for Hutia Te Rito as the framework for managing indigenous biodiversity, it is intended that the health and well-being of indigenous **biodiversity** is front of mind in decision-making about the natural environment, including the identification and protection of **significant natural areas** and of taonga, restoring and enhancing depleted ecosystems as part of achieving landscape-scale ecosystem **restoration**, and halting the decline of our indigenous **biodiversity** to ensure it is maintained for the health, enjoyment and use of and by all New Zealanders now and for future generations.

Interpretation

Terms defined in the Resource Management Act 1991 and used in this national policy statement have the meaning given in the Act.

Where the following terms defined in this interpretation section are used in this national policy statement they are denoted in bold.

In this national policy statement:

"At risk or threatened species" means those species accorded the status of "At Risk" or "Threatened" using the New Zealand Threat Classification System and which are listed as having that status by the Department of Conservation.

"Biodiversity" has the same meaning as "biological diversity" as defined in the Resource Management Act 1991.

"Biodiversity compensation" means positive measurable outcomes for indigenous biodiversity resulting from actions designed to counter any [significant] residual adverse effects of a subdivision, use or development on indigenous biodiversity values after application of appropriate avoidance, remediation and mitigation measures, [where the overall result is no net loss of impacted ecological values], including measures to continue or extend existing biodiversity-related actions.

"Biodiversity offset" means an action to achieve a positive measurable outcome for biodiversity that adheres to the principles in Appendix 4.

"Bonus development rights" are rights to, or to seek resource consent to, subdivide land, or use or develop a natural or physical resource on a landholding, conditional upon a specific biodiversity enhancement or **restoration** action being undertaken, where that right is expressly provided for in the relevant regional or district plan and provided it is exercised on the same landholding as that where the biodiversity enhancement or **restoration** action occurs.

"Ecological district" means the ecological districts as shown in McEwen, W. M. (ed.), 1987. *Ecological regions and districts of New Zealand.* Wellington: Department of Conservation.

"Ecological integrity" means the ability of an ecosystem to support and maintain its composition, structure and function, where:

- composition means the natural diversity of indigenous species, **habitats** and communities
- structure means the physical features (biotic and abiotic)
- function means the ecological and physical processes.

"Ecological reconstruction" means re-introducing and maintaining appropriate biota to re-create an ecosystem that would not regenerate or recolonise even with best practice **restoration** interventions. **Reconstruction** has the corresponding meaning.

"Ecological restoration" is the process of assisting the recovery of an ecosystem that has been degraded, damaged or otherwise lost as a result of human activity. **Restoration** has the corresponding meaning.

"Ecosystem function" is the property of an ecosystem that occurs where that ecosystem retains ecological integrity allowing it to undertake its natural processes. **Ecosystem functioning** has a corresponding meaning.

"**Ecosystem services**" are the benefits obtained from ecosystems. These include:

- Supporting services (e.g., nutrient cycling, soil formation, **habitat** creation)
- Provisioning services (e.g., food, fresh water, wood, fibre, fuel)
- Regulating services (e.g., water purification, climate regulation, flood regulation, disease regulation)
- Cultural services (e.g., aesthetic, spiritual, educational, recreational).

"Functional need" means the need for a proposal or activity to traverse, locate or operate in a particular environment because the activity can only occur in that environment.

"Habitat" means the area or environment where an organism or ecological community lives or occurs naturally for some or all of its life cycle or as part of its seasonal feeding or breeding pattern.

"Indigenous biodiversity depleted environment" means any urban, peri-urban, or other heavily modified area where remaining indigenous cover is below 10 per cent.

"Indigenous vegetation" means vascular and non-vascular plants that are native to the ecological district or marine biogeographic region.

"Land Environment" is a land environment as identified by the Land Environment New Zealand terrestrial environment classification system, (Leathwick et al., 2003, as maintained by Landcare Research).

"Maintenance and upgrading of activities and structures" means works required for the continued safe and efficient operation of an activity or structure, or upgrades to those activities or structures where the activity or structure was lawfully existing as at the date of gazettal of the national policy statement or is an activity or structure approved (or otherwise lawfully established) in accordance with a plan after gazettal of the national policy statement.

"Māori land" means Māori customary land and Māori freehold land as defined in Te Ture Whenua Māori Act 1993.

"Marine biogeographic area" means an area that is defined according to patterns of ecological and physical characteristics in the seascape.

"Natural range", in relation to species, refers to the geographical area within which that species can be expected to be found naturally (without human intervention).

"**Operational need**" means the need to traverse, locate or operate in a particular environment because of technical, logistical or operational characteristics.

"Peri-urban area" in relation to identification of **indigenous biodiversity depleted environments**, means an area immediately adjoining any urban area which has a mixed rural and urban character.

"Significant natural area" means:

- an area identified in accordance with Policy 4; or
- prior to complete implementation of Policy 4 includes an area identified in an operative regional or district plan or regional policy statement as a **significant natural area** or an area that has been identified as a **significant natural area** in accordance with Appendix One through an assessment undertaken as part of a resource consent application.

"Subdivision, use and development" means any activity that is controlled by sections 9, 11, 12, 13, 14 or 15 of the Resource Management Act 1991 and includes maintenance and upgrading of activities and structures.

"Transferable development rights" are rights to, or to seek resource consent to, subdivide land, or use or develop a natural or physical resource within a recipient area, conditional upon a specific biodiversity enhancement or **restoration** action being undertaken within a donor area where the recipient area, donor area and specific action are all specified in the relevant regional or district plan.

"Urban area" in relation to identification of **indigenous biodiversity depleted environments**, means an area of land containing or intending to contain a concentrated settlement of 10,000 people or more and any associated business land, irrespective of local authority or statistical boundaries.

Objectives

Objective 1: Hutia Te Rito

1. To recognise and provide for Hutia Te Rito in managing te Taiao.

Objective 2: Te Tiriti o Waitangi

1. To take into account the principles of Te Tiriti o Waitangi by:
   a) Recognising the role of tangata whenua as kaitiaki;
   b) Providing for tangata whenua involvement in the management of indigenous **biodiversity** by:
      i. supporting the ongoing and enduring relationship of tangata whenua over their lands, waters, rohe, and resources;
      ii. building meaningful relationships and partnerships between tangata whenua and persons exercising functions and powers under the RMA;
      iii. incorporating mātauranga Māori and tikanga Māori into indigenous **biodiversity** decision-making and management;
      iv. identifying and protecting the values of indigenous species and ecosystems that are taonga to tangata whenua; and
      v. recognising that only tangata whenua can identify and demonstrate their relationships and that of their culture and traditions with their ancestral lands, water, sites, waahi tapu and taonga.

Objective 3: Maintaining indigenous biodiversity and enhancing ecosystems

1. To maintain the indigenous **biodiversity** of New Zealand such that there is no reduction in the following ecological attributes from their state at the gazettal of this national policy statement:
   a) Species occupancy across their **natural range**;
   b) Indigenous character – to maintain the attributes of ecosystems and **habitats;**
   c) Ecosystem representation – to maintain a full range of ecosystems and **habitats**;
   d) Ecosystem connectivity, buffering, resilience, and adaptability – to mitigate vulnerabilities across the landscape;

   By:
      i. identifying and protecting areas of significant **indigenous vegetation** and significant **habitats** of indigenous fauna;
      ii. safeguarding the life supporting capacity of ecosystems and their **biodiversity**, functioning and adaptability;
2. To enhance the sustainability of **indigenous biodiversity depleted environments** through the **restoration** and **reconstruction** of a representative range of **indigenous vegetation** and **habitats**.

3. To restore and enhance the **ecosystem function** and **ecological integrity** of degraded **significant natural areas**, and areas that provide important connectivity or buffering functions.
4. To reduce the vulnerability of indigenous **biodiversity** of New Zealand to the effects from climate change.

Objective 4: Integrated and evidence-based management

1. To improve the integrated management of New Zealand's land, fresh water and coastal environments to promote the objectives of this national policy statement, including the coordination and alignment within and across local authority boundaries, between central government, regional councils and territorial authorities, and between methods (including non-regulatory methods and methods under other legislation).
2. To improve the scope and detail of information collected on the state of indigenous **biodiversity** and on the pressures on **ecological integrity** and **ecosystem functioning**.
3. To achieve decision-making by those exercising functions under the Resource Management Act 1991 that is based on suitable information on the actual and potential effects of existing and proposed activities on **biodiversity** and on the actual and potential effect of existing and proposed activities on the promotion of the objectives of this national policy statement.

Objective 5: People and partnerships

1. To enable people and communities to provide for their social, economic, and cultural wellbeing and their health and safety, through subdivision, use, and development, while recognising:
    a) The need for resource use and development to occur within appropriate constraints to promote the objectives of this national policy statement;
    b) That people are critical to the maintenance and **restoration** of indigenous **biodiversity** and the importance of respecting and fostering the contribution of landowners as stewards/kaitiaki of their land;
    c) That active management is often necessary to protect **indigenous vegetation** and fauna from non-anthropogenic threats and the importance of forming partnerships with people and communities to support and encourage such management;
    d) The value of supporting people and communities in their understanding of, connection to, and enjoyment of nature; and
    e) That the protection of indigenous **biodiversity** and taonga contributes to the social, economic and cultural wellbeing of people and communities.

Objective 6: Wetlands

1. To protect wetlands and their significant values, and encourage wetland **restoration** and **reconstruction**.

Policies

Policy 1: Hutia Te Rito

1. When preparing regional policy statements and plans, every regional council and territorial authority shall recognise and provide for Hutia Te Rito noting that:
   a) Hutia Te Rito recognises the broader connections between:
      i. te hauora o te koiora (the health of indigenous **biodiversity**);
      ii. te hauora o te Taiao (the health of the wider environment);
      iii. te hauora o te tangata (the health of the people).
   b) Maintenance and enhancement of mauri is achieved through kaitiakitanga and stewardship.

Policy 2: Tangata whenua as kaitiaki

1. By every regional council and territorial authority:
   a) Involving tangata whenua in the preparation of regional policy statements, regional and district plans, and regional biodiversity strategies by:
      i. undertaking early, effective consultation, that is in accordance with tikanga Māori as far as practicable;
      ii. working with tangata whenua to:
         - identify indigenous species and ecosystems that are taonga in accordance with Policy 13, and develop objectives, policies, and methods to protect values of identified taonga, recognising that tangata whenua have the right to choose not to identify taonga;
         - develop objectives, policies, and methods to recognise and provide for Hutia Te Rito;
         - incorporate mātauranga Māori and tikanga Māori into indigenous **biodiversity** decision-making and management in policy statement, plans, effects assessments of resource consents and notices of requirement where appropriate, and environmental monitoring.
   b) Taking all reasonable steps to:
      i. provide for tangata whenua to exercise kaitiakitanga over indigenous **biodiversity** and ecosystems, in particular taonga, identified in accordance with Policy 13;
      ii. provide opportunities for tangata whenua involvement in decision-making on regional policy statements, plans, notices of requirement, and resource consents;
      iii. provide opportunities for sustainable customary use and take.

Policy 3: Consideration of climate change

1. By every regional council and territorial authority adopting a precautionary approach to the management of indigenous **biodiversity** that is potentially vulnerable to effects from climate change so that:

    a) Natural adjustments to maintain **ecological integrity** of ecosystems, **habitats**, and species are allowed to occur;

    b) **Restoration** and **reconstruction** activities will persist;

    c) Pressure from mammalian and plant pests and pathogens is reduced;

    d) Connectivity between ecosystems and **habitats** remains to enable migrations and allow ecosystem adjustment in order to provide for species to find viable niches as the climate changes.

Policy 4: Identification of significant natural areas

1. By every territorial authority applying the criteria set out in Appendix 1 to assess all areas of **indigenous vegetation** and **habitat** of indigenous fauna within its district to determine its ecological significance.

2. By every regional council applying the criteria set out in Appendix 1 to assess the ecological significance of the whole of the coastal marine area within its region.

3. By territorial authorities and regional councils considering the following matters at all relevant points in the assessment process:

    a) Partnership – councils should seek to engage with landowners and share information about **biodiversity** values, potential management options, and support and incentives that may be available.

    b) Transparency – councils should clearly inform landowners about how information gathered will be used, making existing information, draft assessments and other relevant information available to the relevant landowners for review.

    c) Quality – wherever practicable, the values and extent of **significant natural areas** assessed as potentially meeting the Appendix 1 criteria should be verified by physical inspection unless the council and landowner are satisfied with a desktop approach.

    d) Access – where permission to access a property on a voluntary basis is not provided, councils should first rely on a desktop assessment. Powers of entry under section 333 of the RMA should be used as a last resort.

    e) Equity – **significant natural area** identification should be based on the presence of **biodiversity** attributes, identified through the consistent and tenure-neutral application of the criteria set out in Appendix 1.

4. By territorial authorities and regional councils:

    a) Preparing a schedule itemising each **significant natural area** and the attributes associated with each area with reference to the criteria of Appendix 1;

    b) Mapping each area scheduled in accordance with Policy 4 a); and

    c) Making or changing district plans and regional plans to identify **significant natural areas**.

[Policy 5: Precautionary approach

1. By every regional council and territorial authority adopting a precautionary approach towards proposed activities with effects on indigenous biodiversity and ecosystems that are uncertain, unknown, or little understood, but potentially significantly adverse.]

Policy 6: Managing effects within a significant natural area

1. By every regional council and territorial authority ensuring that any **subdivision**, **use and development** within a **significant natural area**:
   a) Avoids:
      i. fragmentation;
      ii. loss of extent;
      iii. disruption to sequences, mosaics, or processes;
      iv. loss of buffering or connectivity within and between ecosystems;
      v. a reduction in population size of any **at risk or threatened species**.
   b) Protects **ecological integrity** of **significant natural areas**, including by also managing the following adverse effects:
      i. degradation of mauri;
      ii. degradation of the quality of an ecosystem, or a reduction in the natural diversity of vegetation communities or species' **habitats**, or a reduction in a **habitat's** species richness or viability;
      iii. pest plant or animal incursions, and changes that result in increased risk of such incursions;
      iv. disruption to indigenous fauna by people, their pets or livestock, and changes that increase the risk of that disruption;
      v. a reduction in people's ability to connect with and benefit from nature, including:
         - historical, cultural or spiritual relationships of mana whenua with their taonga;
         - scientific, educational, amenity, historical, cultural, landscape or natural character values of **indigenous vegetation** or **habitat** of indigenous fauna;
         - **ecosystem services**.
      vi. cumulative adverse effects on ecosystems.

Policy 7: Providing for social, cultural and economic wellbeing

1. Despite Policy 6, every regional council and territorial authority must provide for:
   a) Existing activities in accordance with Policy 9;
   b) Use and development for the purpose of protecting or enhancing a **significant natural area**;

c) Use and development that addresses an immediate risk to public health or safety;

d) Replacement consents in accordance with Policy 8;

e) Where the **indigenous vegetation** or **habitat** was established for a purpose other than the maintenance or enhancement of indigenous **biodiversity**, activities that are necessary for that purpose to be met must be provided for when managing effects;

f) Plantation forestry activities within a plantation forest that are not provided for by the Resource Management (National Environmental Standard on Plantation Forestry) Regulations 2018;

g) The adverse effects of the **subdivision, use and development** within a **significant natural area** on attributes assessed as medium value in accordance with Appendix 2 to be avoided, remedied, mitigated, offset or compensated where:

   i. the **subdivision**, **use and development** is associated with either:

      - nationally important infrastructure;
      - mineral and aggregate extraction that is essential to provide a domestic supply for New Zealand's mineral or aggregate needs;
      - the provision of papakāinga, marae and ancillary community facilities and associated customary activities on **Māori land**; and

      the activity is locationally constrained because it has a **functional or operational need** to operate in a particular location and there are no practicable alternative locations for the activity that would provide for its **functional or operational needs** to be met; or

   ii. the use and development is a single dwelling on an allotment created before the date of gazettal of this national policy statement and there is no location within the existing allotment where a single residential dwelling and essential associated on-site infrastructure can be constructed in a manner that avoids the adverse effects specified in Policy 6;

h) the adverse effects of the subdivision, use and development within a **significant natural area** that supports attributes assessed as having high value to be avoided where practicable, or otherwise remedied, mitigated, offset, or compensated where:

   i. The subdivision, use and development comprises, or relates to an activity that is locationally constrained because it has a functional or operational need to operate in a particular location and there are no practicable alternative locations for the activity that would provide for its functional or operational needs to be met, and,

   ii. It is an activity that would promote recognition of a matter of national significance as specified in any national policy statement set out in another national policy statement:

      - The National Policy Statement for Renewable Electricity Generation);
      - The National Policy Statement on Electricity Transmission)],

i) despite Policy 6, where activities referred to in a (ii) are undertaken in an identified geothermal system and have an adverse effect on an significant natural area comprising indigenous species and habitats that have a geothermal association, such activities shall be managed so as to:

i. remedy, mitigate, offset or compensate for significant adverse effects on such species and habitats in geothermal systems classified as 'Development' in a regional policy statement or plan.

ii. avoid where practicable, or otherwise remedy, mitigate, offset or compensate for significant adverse effects on such species and habitats in geothermal systems classified as 'Conditional Development' in a regional policy statement or plan.

iii. avoid significant adverse effects on such species and habitats in geothermal systems classified as 'Limited Development' in a regional policy statement or plan, and remedy, mitigate, offset or compensate any other adverse effects.

2. Despite Policy 6, where an area of production forest is identified as a **significant natural area** the effects of plantation forest activities (other than afforestation) on the **significant natural area** are to be managed in accordance with the Resource Management (National Environmental Standard on Plantation Forestry) Regulations 2018.

Policy 8: Replacement consents

1. When an application is made for resource consent for subdivision, use and development associated with:

   a) An activity affected by section 124 of the Resource Management Act 1991; and

   b) It is not feasible that the activity and its effects will cease to continue at the expiry of the existing consent,

   that application shall be assessed, and conditions imposed, to give effect to Policy 6 or Policy 7 (as is relevant) except that adverse effects on **biodiversity** resulting from that activity, which have occurred in a more or less continuous manner since that activity was first lawfully established, need not be avoided, provided reasonable steps are taken to mitigate those effects as far as practicable in the circumstances.

Policy 9: Existing activities

1. In respect of **subdivision, use, and development** that was lawfully established as at the date of gazettal of this national policy statement:

   a) Section 10 and section 20A of the Resource Management Act 1991 apply according to their terms;

   b) Regional councils must provide direction in regional policy statements on the management of adverse effects of those activities which ensures that the activities do not compromise the achievement of the objectives of this national policy statement, while recognising the social, cultural and economic wellbeing that the activities provide;

   c) Except as required by b) above, regional policy statements and plans should provide for those activities to continue, provided that:

      i. the adverse effects of the activity are no greater in character, intensity, and scale; and

ii. if the activity takes place within a **significant natural area**, it will not lead to loss of **ecological integrity** or degradation of the attributes for which the **significant natural area** was identified.

d) Regional councils and territorial authorities must provide for use and development for the purpose of **maintenance and upgrading of activities and structures** where the adverse effects of the activity or structure on **ecological integrity** are no greater in terms of character, intensity or scale;

e) Policy 8 applies to replacement resource consents rather than this policy.

f) Where indigenous vegetation or habitat has naturally re-established within improved pasture, activities necessary for that improved pasture to be maintained for animal grazing purposes must be provided for when managing effects, except that, where improved pasture is within a **significant natural area** the clearance of indigenous vegetation shall avoid the loss of **ecological integrity** of the **significant natural area**.

Policy 10: Providing for Māori cultural activities and Māori land

1. In addition to the circumstances specified in Policy 7, regional councils and territorial authorities must, when preparing regional policy statements and plans, have regard to:

   a) Opportunities for the development of **Māori land** and the associated potential to enhance the social, cultural and economic wellbeing of Māori; and

   b) The benefits of providing for papakāinga, marae and ancillary community facilities and associated customary activities on **Māori land**; and

   c) Opportunities to provide planning incentives, including **transferable development rights**, that recognise the opportunity costs associated with protecting **biodiversity** on **Māori land**.

Policy 11: Managing effects outside significant natural areas

1. Without limiting Policies 7, 8, and 9, by regional councils and territorial authorities recognising that maintaining **biodiversity** requires more than protecting **significant natural areas** and providing across regions and districts for:

   a) Control of cumulative adverse effects to ensure there is no reduction in:

      i. Species occupancy across their **natural range**.

      ii. Indigenous character – to maintain the attributes of ecosystems and **habitats**.

      iii. Ecosystem representation – to maintain a full range of ecosystems and **habitats**.

      iv. Ecosystem connectivity linking, buffering, resilience, and adaptability – to mitigate vulnerabilities across the landscape;

   b) Control of pest plants or animals;

   c) Opportunities to incentivise **restoration** or enhancement of areas that provide important connectivity or buffering functions and of **indigenous biodiversity depleted environments**;

   d) *The BCG considers that a provision relating to subdivision may be appropriate within this policy.*

Policy 12: Protecting and enhancing wetlands

1. When preparing relevant regional plans regional councils must:

   a) Identify wetlands within their region which retain **ecological integrity** in accordance with Appendix 3.

   b) Recognise that all wetlands identified in accordance with Appendix 3 exhibit significant values, which may include but are not limited to:

      i. presence of indigenous wetland vegetation;

      ii. providing **habitat** for indigenous wetland fauna;

      iii. provision of wetland **ecosystem services;**

      iv. connectivity between terrestrial and aquatic (marine and freshwater) ecosystems;

      v. cultural value as taonga in accordance with Policy 13;

      vi. significant value in accordance with Policy 4.

2. Avoid loss or degradation of any wetland or part of any wetland identified in accordance with Policy 12 1a) above and Appendix 3, or any wetland identified in accordance with Appendix 3 through an assessment undertaken as part of a resource consent application.

3. Provide for activities that are necessary for:

   a) The intended purpose of the wetland to be met where that wetland was established for a purpose other than the maintenance or enhancement of indigenous **biodiversity**.

   b) The protection of the wetland.

4. Regional councils must include in regional plans provisions (including, in particular, non-regulatory methods) that promote, and where possible, incentivise:

   a) The enhancement of wetlands in which **ecological integrity**, presence of indigenous wetland vegetation, or indigenous wetland fauna **habitat** viability are degraded; and

   b) The **reconstruction** of areas of historical wetlands which no longer retain **ecological integrity**, **indigenous vegetation**, or provide **habitat** for indigenous fauna, where **reconstruction** is likely to result in those values being regained.

Policy x: Freshwater and biodiversity

Explanatory comment only

The need for, and content of, a policy in relation to the biodiversity of freshwater bodies should be revisited by the Ministry for the Environment in accordance with the BCG's recommendations as set out in the Covering Report.

Policy 13: Managing Taonga

1. Regional council and territorial authorities together shall work with tangata whenua to identify species, populations and ecosystems that are taonga by:

   a) Describing and mapping the taonga and its values; or

   b) Describing the taonga and its values.

2. Effects on identified taonga are to be addressed by:

   a) Avoiding adverse effects as specified under Policy 6 where an identified taonga is also a **significant natural area** or within a **significant natural area**;

   b) Otherwise managing adverse effects as necessary to protect identified taonga and their values; and

   c) Considering opportunities for sustainable customary take and use in a manner that is consistent with taonga protection.

Policy 14: Protecting highly mobile indigenous fauna

1. In order to protect indigenous fauna species that:

   a) Are highly mobile;

   b) Are likely to depend on **habitat** beyond identified **significant natural areas**;

   c) Are at risk or threatened species; and

   d) Whose presence in the environment may be difficult to detect;

   every regional council and territorial authority shall collaborate to:

   e) Where practicable, undertake region-wide surveys or use existing information to indicate the likely presence or absence of the highly mobile indigenous fauna, and include maps in regional and district plans of areas of likely presence where this will assist their protection;

   f) Provide information about these species and their **habitat** requirements to people and communities, and encourage actions to protect them, including working to develop best practice; and

   g) Ensure that any activities within areas of likely presence that may adversely affect these species are managed by incorporating policies and methods in regional and district plans to avoid, remedy, or mitigate adverse effects on these species and their **habitat** as necessary to protect viable populations of these species across their **natural range**.

2. An area identified in accordance with this policy is not a **significant natural area**, unless the area also meets the criteria in Appendix 1.

Policy 15: Assessing environmental effects on indigenous biodiversity

1. Regional councils and territorial authorities must ensure an assessment of environmental effects provided in association with any resource consent:

   a) In accordance with Schedule 4 clause 1, is specified in sufficient detail to satisfy the purpose for which it is required.

   b) In accordance with Schedule 4 clause 3 includes such detail as corresponds with the scale and significance of the effects that the activity may have on the environment.

2. In providing a description of the site at which the activity is to occur in accordance with Schedule 4 clause 2(b), consideration must be given to identification, where relevant, of:
   a) **Significant natural areas** and other **indigenous vegetation** or **habitat** of indigenous fauna.
   b) Where the site is within an area of likely presence of highly mobile fauna identified in accordance with Policy 14, the use of the site by relevant fauna species.
   c) The site's role in maintaining connections between the indigenous **biodiversity** of the site and the wider ecosystem.

3. In assessing any effects in accordance with Schedule 4 clause 7(c), address where relevant:
   a) Any effects on:
      i. **significant natural areas** and other **indigenous vegetation** or **habitat** of indigenous fauna.
      ii. highly mobile fauna within identified areas of likely presence.
   b) Measures to avoid, remedy, mitigate, offset or compensate for adverse effects, including:
      i. if remediation is proposed, sufficient information to enable an assessment of the likelihood of success of remediation measures;
      ii. if a **biodiversity offset** is proposed, sufficient information to demonstrate compliance with Appendix 3;
      iii. if **biodiversity compensation** is proposed, sufficient information to demonstrate its intended outcomes;
      iv. how those outcomes are intended to be secured; and
      v. an assessment of residual adverse effects that takes into account the likelihood of success of remediation or **biodiversity offset** or **biodiversity compensation** measures.

4. In assessing any effects in accordance with Schedule 4 clause 7(d), address, where relevant, effects on identified taonga, **ecosystem services**, and the site's role in maintaining the mauri of the site and the wider ecosystem.

5. Use methodology consistent with best practice for the ecosystem type or types present. Consider including a mātauranga Māori and tikanga Māori assessment methodology where relevant, in particular in respect of identified taonga.

Policy 16: Integrating decision-making

Explanatory comment only

The issue this policy seeks to address is compartmentalised decision-making by territorial and regional authorities in relation to indigenous biodiversity. The issue arises because both local *authorities have functions relating to indigenous biodiversity. The undesirable outcomes of compartmentalised decision-making include:*

- *impacts of activities on biodiversity not being fully recognised, or not being addressed effectively.*
- *additional costs and unexpected outcomes for applicants who believe they have all necessary approvals.*

The intent of this policy is to ensure that decision-making on aspects of activities that relate to district and regional functions occurs holistically, by:

- *Requiring that where activities will require consent from another local authority, this is identified when an application for consent is lodged*
- *Encouraging contemporaneous applications to both authorities*
- *Ensuring that when consent authorities are considering whether to hold a joint hearing in accordance with section 102, they have particular regard to combined effect of the required resource consents on indigenous species, habitats and ecosystems.*

Policy 17: Enhancing and restoring through regional biodiversity strategies

1. By every regional council preparing, in conjunction with territorial authorities, tangata whenua and the community, a regional biodiversity strategy that:
   a) Has as its purpose the promotion of a landscape-scale enhancement and **restoration** vision for the region's indigenous **biodiversity**.
   b) Addresses the principles set out in Appendix 4.

Policy 18: Maintenance, enhancement and restoration of significant natural areas, connectivity, and buffering

1. By regional councils and territorial authorities promoting the maintenance, enhancement and **restoration** of **significant natural areas**, and other areas that provide important connectivity or buffering functions, including in the following ways:
   a) Including objectives for the enhancement of **ecosystem function** and **ecological integrity** of degraded **significant natural areas**, and other areas that provide important connectivity or buffering functions in regional and district plans.
   b) Specifying in a regional biodiversity strategy actions to achieve those objectives.
   c) Ensuring policies and methods in regional and district plans promote voluntary **restoration** or **reconstruction** actions.

Policy 19: Restoring indigenous biodiversity depleted environments

1. By every regional council in a relevant regional plan, identifying as **indigenous biodiversity depleted environments** any **urban**, **peri-urban**, and other heavily modified areas within a region where remaining indigenous cover is below 10 per cent.

2. For all **indigenous biodiversity depleted environments**, identified in accordance with Policy 19(1), establish in regional plans:

   a) A target for indigenous cover, which in **urban areas** and **peri-urban areas** must be at least 10 per cent.

   b) **Restoration** and **reconstruction** objectives for indigenous cover that prioritise:

      i. representation of ecosystems naturally and formerly present, in particular nationally threatened ecosystem types and **indigenous vegetation** in threatened land environments;

      ii. species richness;

      iii. connectivity between, and buffering of, existing **habitats;** and

      iv. **ecological restoration** at a landscape scale across the region.

   c) Timeframes for achieving the indigenous cover target and **restoration** and **reconstruction** objectives.

3. Specify in each regional biodiversity strategy, actions to achieve the objectives of the relevant regional plan established in accordance with Policy 19(2)(b).

Policy 20: Restoring and enhancing through transferable development rights

1. By regional councils and territorial authorities considering the use of **transferable development rights**, in preference to **bonus development rights**, where necessary and appropriate to:

   a) Promote the **restoration** and enhancement of:

      i. **significant natural areas** identified in accordance with Policy 4; and

      ii. **ecological integrity** in the areas identified in a regional biodiversity strategy prepared in accordance with Policy 17; and/or

2. To ensure that **transferable development rights** contribute effectively to the objectives of this national policy statement, regional councils and territorial authorities will:

   a) Require that the enhancement and **restoration** required to qualify for the creation of a **transferable development right**:

      i. is designed by an suitably qualified ecologist;

      ii. uses eco-sourced plant material where practicable; and

      iii. is of a scale that makes a meaningful and enduring contribution to objectives for the area identified in the regional biodiversity strategy.

b) Require that the interest registered on any certificate of title, covenants the owner to take all reasonable steps to preserve and protect the area of enhanced or restored **indigenous vegetation** and **habitat** on a continuing basis.

c) Ensure that the recipient area for the **transferred development right** excludes any location that is:

   i. a **significant natural area**;

   ii. an area identified for enhancement or **restoration** in a regional biodiversity strategy;

   iii. in such proximity to any area identified in i) or ii) above, as may result in adverse effects to the **ecological integrity** of such areas;

   iv. likely to result in significant adverse effects on ecological processes including connections and corridors between areas identified in i) and ii) above.

d) Maintain a register of **transferable development rights** in use of sufficient detail to demonstrate compliance with this national policy statement.

Policy 21: Monitoring and reporting

Explanatory comment only

The issue this policy seeks to address is the need to strengthen the depth and consistency with which biodiversity (state of the environment) and biodiversity interventions (the effectiveness of the NPS, plans and regional biodiversity strategies) are monitored and the results of that monitoring reported around the country.

The recommendations made in the CSM report assist in conveying the BCG's thinking on the monitoring requirements but there has been insufficient time to develop the NPS policy to a standard that the BCG can confidently promote as appropriate and practicable.

In broad terms, the policy should:

- *Require regional councils, in cooperation with territorial councils, to monitor the condition and state of indigenous biodiversity and significant natural areas in their regions*
- *Require monitoring to be undertaken according to nationally agreed standards*
- *Require the reporting of information at appropriate intervals.*

Policy 22: Implementing this national policy statement

1. This policy applies to the implementation by a regional council or territorial authority of a policy of this national policy statement.

2. In accordance with section 55 (2D) of the Resource Management Act 1991, except as provided for in Policy 22(3)–(6), every regional council and territorial authority is to implement this national policy statement as promptly as is reasonably practicable.

3. Unless Policy 22(4) applies, every regional council or territorial authority must:
   a) Implement Policy 4(1) and 4(4)(a) and (b) of this national policy statement within [five] years of the gazettal of this national policy statement; and
   b) Notify a plan change to implement Policy 4(4)(c) within [six] years.
4. Regional councils and territorial authorities need not comply with Policy 22(3) if their relevant plan contains mapped **significant natural areas** that are demonstrated, following an evaluation of the plan, to have been identified in substantial conformance with the criteria of Appendix 1 of this national policy statement.
5. Where Policy 22(4) applies, each regional council and territorial authority must implement:
   a) Policy 4 at the next scheduled review of the district plan or by [2028], whichever is sooner; and
   b) Policies 6 and 7 as if reference to **significant natural areas** in those policies was reference to **significant natural areas** identified in the district plan or proposed district plan as at the date of gazettal of this national policy statement.
6. Every regional council must implement Policy 17 within [three years] of gazettal of this national policy statement.

Appendix 1: Criteria for identifying significant natural areas in accordance with Policy 4

Terms defined in the Interpretation section of this national policy statement also apply to Appendices 1 to 4.

Direction on approach

In accordance with Policy 4 of this national policy statement, regional councils in the coastal marine area and territorial authorities in the terrestrial domain must, through a suitably qualified ecologist, use the following four criteria for assessment of significant **indigenous vegetation** and significant **habitats** of indigenous fauna:

- Representativeness
- Diversity and Pattern
- Rarity and Distinctiveness
- Ecological Context.

The frameworks for assessment of significance are ecological districts or land environment, [except for geothermal vegetation assessments for the Taupo Volcanic Zone in which case the ecological district is the Taupo Volcanic Zone], and marine biogeographic areas.

A site should be regarded as significant if it meets any one of the four criteria.

Physical identification of each **significant natural area** must be accompanied by a description of its significant attributes. For each criterion that description must include the attribute statement from the 'site attribute' that applies to that site. Under that attribute statement the **significant natural area** description must identify the specific **indigenous vegetation**, fauna, **habitat**, and ecosystems present. Additional description may be included.

Representativeness

The extent to which the vegetation or habitat of indigenous fauna is typical or characteristic of the indigenous biodiversity of the ecological district or marine biogeographic area.

Guidance

Indigenous vegetation or habitat of indigenous fauna that would be expected to occur at undeveloped[18] sites in the ecological district or marine biogeographic area in the present-day environment (e.g., landform, soils, substrate, climate), including seral (regenerating) **indigenous vegetation**. Representativeness includes commonplace vegetation/**habitats**, which is where most indigenous **biodiversity** is present. It is not restricted to the best or most representative examples. And, it is not a measure of how well that vegetation or habitat is protected elsewhere in the ecological district.

[18] 'Undeveloped' sites mean those sites at which the soil/substrate has not been cultivated/dredged

Assessment

Significant vegetation has structure and composition (**biodiversity**) typical of the **indigenous vegetation** of the ecological district or marine biogeographic area in the present-day environment. This includes secondary or regenerating vegetation that is recovering following natural or induced disturbance, provided species composition is typical of that type of vegetation. Significant fauna habitat is that which supports the typical suite of indigenous animals that would occur in the present-day environment.

Site attributes

Sites that qualify under this criterion will have any of the following attributes:

- Vegetation which has structure and composition (**biodiversity**) that is highly typical of the **indigenous vegetation** of the ecological district or marine biogeographic area.
- Intact habitat that supports a highly typical suite of indigenous animals.
- Vegetation which has modified structure and/or composition (**biodiversity**) though is still typical of the **indigenous vegetation** of the ecological district or marine biogeographic area.
- Modified habitat that supports a typical suite of indigenous animals.

For the avoidance of doubt, **indigenous vegetation** or habitat that is not typical of the **indigenous vegetation** or habitat of the ecological district or marine biogeographic area will not qualify as a **significant natural area** under this criterion.

Diversity and Pattern

The diversity and pattern of biological and physical components at the site.

Guidance

Diversity has biological components, such as species/taxa, communities, and ecological variation. It also has physical components, such as geology, soils/substrate, aspect/exposure, altitude/depth, temperature, salinity, turbidity, and waves/currents. Pattern includes changes along environmental gradients, such as ecotones and sequences. Some communities or **habitats** are uniform, with naturally low species diversity; that attribute is assessed under the representativeness criterion.

Assessment

Significance is the extent to which the biological range and environmental variation at a site reflects that present in the ecological district. Sites that have a wider range of species, **habitats**, or communities, or wider environmental variation due to ecotones, gradients and sequences, rate more highly.

Site attributes

Sites that qualify under this criterion will have any of the following attributes:

- A high diversity of indigenous species, **habitats** or communities, and/or presence of important ecotones, or complete gradients or sequences.

- A moderate diversity of indigenous species, **habitats** or communities, and/or presence of ecotones, or partial gradients or sequences.

For the avoidance of doubt, a site with low diversity of indigenous species, **habitats** or communities, and lack of ecotones, gradients or sequences will not qualify as a **significant natural area** under this criterion.

Rarity and Distinctiveness

The presence of rare or distinctive species, habitats, vegetation or ecosystems.

Guidance

Rarity is the scarcity (natural or induced) of indigenous species, habitats, vegetation, or ecosystems. Rarity includes things that are uncommon, and things that are threatened. 'Threatened' and 'at risk' (including 'naturally uncommon') species at a national scale are listed in publications (for plants, mammals, birds, and reptiles) prepared and regularly updated by the Department of Conservation. Rarity at a regional or local scale is defined by local lists or determined by expert ecological advice. Further effort is needed to prepare regional and local lists, especially for fauna. The significance of nationally-listed species should not be downgraded if they are locally common.

Historically rare (or naturally uncommon) terrestrial ecosystems are defined and listed by Williams et al (2007). These ecosystems, along with wetlands and sand dunes, are proposed as a priority for protection on private land by the Ministry for the Environment (2007).

Two national frameworks that are available for the assessment of depletion of terrestrial **indigenous vegetation** or ecosystems are in common use: Ecological Districts, as defined by McEwen (1987); and Land Environments, as defined by Leathwick et al. (2003). Rarity of **indigenous vegetation** in each Land Environment has been assessed by Walker et al. (2006) and Cieraad et al. (2015). Land Environment data should be interpreted with caution. These are based on physical attributes which may not accurately reflect vegetation (or habitat) patterns at a local scale.

Distinctiveness includes distribution limits, type localities, local endemism, relict distributions, and special ecological or scientific features.

Assessment

Vegetation/habitat is significant if it supports any of the following:

- 'threatened', 'at risk' or 'data deficient' indigenous species (as defined by national lists)
- regionally or locally uncommon indigenous species, **habitats**, vegetation or ecosystems
- terrestrial **indigenous vegetation** depleted to less than 20 per cent of its former extent in the ecological district or land environment
- **indigenous vegetation**/habitat on sand dunes, wetlands, or estuaries
- biogenic **habitats**[19] in the marine environment

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[19] "biogenic habitats" are **habitats** created by the physical structure of living or dead organisms or by their interaction with the substrate

- **indigenous vegetation** in historically rare/naturally uncommon ecosystems
- an indigenous species at its distributional limit
- the type locality of an indigenous species
- a distinctive assemblage or community of indigenous species (such as on unusual substrates)
- a special ecological or scientific feature.

Application of the recently published list of the threat status of indigenous plants (de Lange et. al., 2018) should be guided by expert ecological advice. Species within the Myrtaceae family that are relatively common in many areas (kānuka, mānuka, and rata species) are listed as 'threatened' or 'at risk', due to the threat posed by myrtle rust. These species are listed with the qualifiers DP (data poor) and De (taxa) that do not fit the criteria so are designated to the most appropriate listing).

With respect to fauna habitat, professional ecological judgement should be used when assessing significance, such as a golf course that has the occasional presence of a mobile 'threatened' species (e.g., black stilt), compared with a shrubland that has the presence of a relatively sedentary 'at risk' species (e.g., southern grass skink). The golf course should not be rated as significant habitat; whereas the shrubland should.

Site attributes

Sites that qualify under this criterion will have any of the following attributes:

- Provides habitat for a nationally 'threatened', or several 'at risk', indigenous plant or animal species
- An indigenous species or plant community at its distributional limit
- **Indigenous vegetation** or habitat of indigenous fauna, or ecosystem, that has been reduced to less than 10 per cent of its former extent in the ecological district or land environment
- **Indigenous vegetation**/habitat occurring on sand dunes, wetlands, or estuaries
- Biogenic **habitats** in the marine environment
- **Indigenous vegetation/habitat** occurring on 'originally rare' ecosystem types.
- Provides habitat for an 'at risk', 'data deficient', regionally uncommon, or locally uncommon indigenous plant or animal species.
- An indigenous species or plant community near its distributional limit
- **Indigenous vegetation** or **habitat** of indigenous fauna, or ecosystem, that has been reduced to between 10 and 20 per cent of its former extent in the ecological district or land environment
- The presence of a distinctive assemblage or community of indigenous species, or special ecological or scientific feature.

For the avoidance of doubt, sites with the following attributes do not qualify as **significant natural areas** under this criterion:

- Supports no 'threatened', 'at risk', 'data deficient', regionally or locally uncommon indigenous species, and no indigenous species near distribution limits

- Is not **indigenous vegetation/habitat** on sand dunes, wetlands, estuaries or 'originally rare' ecosystems.
- Is not **indigenous vegetation** or **habitat** of indigenous fauna that has been reduced to less than 30 per cent of its former extent in the ecological district or land environment
- Has no distinctive assemblage or community of indigenous species, or special ecological or scientific features.

Ecological context

The extent to which the size, shape, and position of an area within the wider environment (land, fresh water or marine) contributes to the maintenance of indigenous biodiversity.

Guidance

Ecological context has two main attributes: the characteristics that help maintain indigenous **biodiversity** at the site (such as size, shape and configuration); and the contribution the site makes to protection of indigenous **biodiversity** in the wider landscape (such as by linking or buffering other sites, providing 'stepping stones' of **habitat**, or maintaining ecological and hydrological processes).

Assessment

Higher value is placed on sites that: have features (such as size, shape, configuration or buffering) that help maintain indigenous **biodiversity** at the site; support large numbers of, or provide important **habitat** for, indigenous fauna; provide a buffer to, or link between, other significant areas; or play an important role in the biological/natural functioning of a freshwater or coastal/marine system.

Attributes

Sites that qualify under this criterion will have any of the following attributes:

- A site that is large, has a good shape, and is well-buffered
- A site that provides a substantial buffer to, or link between, other significant sites and/or is very important for the natural functioning of a freshwater or coastal/marine system
- A site that supports large numbers of and/or provides critical **habitat** for indigenous fauna
- A site that is of moderate size, and has a good shape and/or is well buffered
- A site that provides a partial buffer to, or link between, other significant sites and/or is moderately important for the natural functioning of a freshwater or coastal/marine system.

For the avoidance of doubt, sites with the following attributes do not qualify as **significant natural areas** under this criterion:

- A small and/or poorly-buffered site
- A site that does not buffer or link other sites, and is unimportant for the natural functioning of a freshwater or coastal/marine system.

Appendix 2: Tool for managing effects on significant natural areas

Direction on approach

General

This appendix supports application of this national policy statement's policies relating to effects management in **significant natural areas** (Policies 6 and 7).

Pursuant to Appendix 1 and Policy 4, local authorities are required to map **significant natural areas** and to include a description of the specific attributes that contribute to the areas qualifying as **significant natural areas**. That description must include the relevant attribute from the 'site attribute list' under each criterion. This management tool includes the same 'site attributes' as those used in Appendix 1. It then allocates a 'high' or 'medium' rating to each attribute. The rating applying to a particular **significant natural area** will determine the effects management policies that apply to it. Some of the policies are worded in generic terms (i.e., they apply to all **significant natural areas**). Where that is the case, the policy applies irrespective of the **significant natural area**'s rating. Some of the policies are worded to specifically apply to **significant natural areas** with a 'high' rating or with a 'medium' rating. Where that is the case then that policy only applies to **significant natural areas** with that rating.

A **significant natural area** qualifies as having a 'high' rating if it has one or more attributes that rate as 'high' in respect of any one of the four criteria.

Mānuka and Kānuka

Species within the Myrtaceae family that are relatively common in many areas (e.g. kānuka, mānuka, and rata species) are listed as 'threatened' or 'at risk', due to the threat posed by Myrtle Rust.

If a **significant natural area** is identified **only** because of the presence of mānuka and kānuka that is considered threatened on the **sole** basis of the threat posed by Myrtle Rust, that area should not be identified in planning maps as a **significant natural area** and Policy 6 does not apply. For the avoidance of doubt, this does not apply to species of mānuka and kānuka that are considered threatened for reasons other than Myrtle Rust, or which are present within a **significant natural area** that is identified as significant due to other attributes.

This exception must be reviewed within five years of gazettal.

Management framework

Representativeness

Site attributes	Rating
Vegetation which has structure and composition (biodiversity) that is highly typical of the indigenous vegetation of the ecological district or marine biogeographic area.	H
Intact habitat that supports a highly typical suite of indigenous animals.	H

Site attributes	Rating
Vegetation which has modified structure and/or composition (biodiversity) though is still typical of the indigenous vegetation of the ecological district or marine biogeographic area.	**M**
Modified habitat that supports a typical suite of indigenous animals.	**M**

Diversity and Pattern

Site attributes	Rating
A high diversity of indigenous species, habitats or communities, and/or presence of important ecotones, or complete gradients or sequences.	**H**
A moderate diversity of indigenous species, habitats or communities, and/or presence of ecotones, or partial gradients or sequences.	**M**

Rarity and Distinctiveness

Site attributes	Rating
Provides habitat for a nationally 'threatened', or several 'at risk', indigenous plant or animal species.	**H**
An indigenous species or plant community at its distributional limit.	**H**
Indigenous vegetation or habitat of indigenous fauna, or ecosystem, that has been reduced to less than 20% of its former extent in the ecological district or land environment.	**H**
Indigenous vegetation/habitat occurring on sand dunes, wetlands, or estuaries.	**H**
Biogenic habitats in the marine environment.	**H**
Indigenous vegetation/habitat occurring on 'originally rare' ecosystem types.	**H**
Provides habitat for an 'at risk', 'data deficient', regionally uncommon, or locally uncommon indigenous plant or animal species.	**M**
An indigenous species or plant community near its distributional limit.	**M**
Indigenous vegetation or habitat of indigenous fauna, or ecosystem, that has been reduced to between 20% and 30% of its former extent in the ecological district or land environment.	**M**
The presence of a distinctive assemblage or community of indigenous species, or special ecological or scientific feature.	**M**

Ecological context

Site attributes	Rating
A site that is large, has a good shape, and is well-buffered.	**H**
A site that provides a substantial buffer to, or link between, other significant sites and/or is very important for the natural functioning of a freshwater or coastal/marine system.	**H**
A site that supports large numbers of and/or provides critical habitat for indigenous fauna.	**H**
A site that is of moderate size, and has a good shape and/or is well buffered.	**M**
A site that provides a partial buffer to, or link between, other significant sites and/or is moderately important for the natural functioning of a freshwater or coastal/marine system.	**M**

Appendix 3: Wetland identification and delineation

In accordance with Policy 9 of this national policy statement, regional councils must, through a suitably qualified ecologist, use the following procedure for identification and delineation of wetlands. Defined terms relevant to this Appendix are set out below the procedure steps.

1. Determine general project area i.e., putative wetland.

2. Confirm that 'regular' circumstances are present (i.e., typical climatic and hydrologic conditions for the time of year, no recent disturbances such as flooding).

3. Determine whether **off-site methods** or **on-site methods** are to be used.

4. Undertake Hydrophytic vegetation determination by **Rapid Test** to determine if all dominant species are **OBL** or **FACW**.

   a) If the **Rapid Test** finds all **dominant species** are **OBL** or **FACW** the assessed area is a wetland/part of a wetland. Further analysis is not required.

5. If the **Rapid Test** finds not all dominant species are **OBL** or **FACW** then undertake a **Dominance Test**:

   a) If **Dominance Test** finds **OBL**, **FACW**, or **FAC** species are >50% the assessed area is a wetland/part of a wetland. Further analysis is not required.

6. If the **Dominance Test** finds:

   a) All or most **dominant species** are **FAC**; or

   b) **OBL**, **FACW**, or **FAC** species are <50%,

   then assess soil type and hydrology.

7. If an assessment of soil type and hydrology confirms:

   a) That **hydric soils** are present; and

   b) That wetland hydrology is present,

   then undertake a **Prevalence Index Test**. If an assessment confirms that **hydric soils** and wetland hydrology are not present the assessed area is not a wetland/part of a wetland.

8. If the **Prevalence Index Test** finds that **hydrophytic** vegetation is ≤3.0 the assessed area is a wetland/part of a wetland. Further analysis is not required

9. If the **Prevalence Index Test** finds that **Hydrophytic** vegetation is >3.0 the assessed area is not a wetland/part of a wetland.

Supporting definitions for Appendix 3

Dominant Species: The most abundant plant species (when ranked in descending order of abundance, e.g., in a plot, and cumulatively totalled) that immediately exceed 50% of the total cover for the stratum, plus any additional species comprising 20% or more of the total cover for the stratum. Known as the 50/20 rule. Calculated for three stratum: tree, sapling/shrub, herb.

Dominance Test: More than 50% of dominant species across all strata are rated OBL, FACW, or FAC using the 50/20 rule.

Hydric Soils are soils that have been formed under conditions of saturation, flooding, or ponding and that have caused anaerobic (low oxygen) conditions in at least the upper 30cm of the soil.

Hydrophytes (hydrophytic vegetation)*:* plant species capable of growing in soils that are often or constantly saturated with water during the growing season. The hydrophyte categories are:

- ***Obligate (OBL)****:* Occurs almost always in wetlands (estimated probability >99% in wetlands*)*
- ***Facultative Wetland (FACW)****:* Occurs usually in wetlands (67–99%)
- ***Facultative (FAC)****:* Equally likely to occur in wetlands or non-wetlands (34–66%)
- ***Facultative Upland (FACU)****:* Occurs occasionally in wetlands (1–33%)
- ***Upland (UPL)****:* Rarely occurs in wetlands (<1%), almost always in 'uplands' (non-wetlands)

Off-site methods*:* Methods by which wetland identification and delineation can occur away from the project area. Ability to use off-site methods will depend on:

- Amount and quality of data including aerial photographs, maps, previous reports
- Wetland ecological expertise to interpret data.

On-site methods: Methods by which wetland identification and delineation can occur at the project area:

- For small areas (≤ 2ha), establish a representative plot in each major vegetation type. Record plot vegetation in 3 strata: tree, sapling/shrub, herb
- For large areas (> 2ha) establish representative plots along transects as per Clarkson et al., 2014. Record vegetation in 3 strata: tree, sapling/shrub, herb

Prevalence Index Test: A plot-based algorithm derived from the unique combination of OBL–UPL plants and their cover. The vegetation is considered to be hydrophytic if PI ≤3.0, but values around 3.0 should be used alongside other wetland indicators.

Rapid Test: All dominant species across all strata are rated OBL and/or FACW.

Appendix 4: Principles for offsetting effects on indigenous biodiversity

The following framework for the use of **biodiversity offsets** should be read in conjunction with the New Zealand Government Guidance on Good Practice Biodiversity Offsetting in New Zealand, New Zealand Government et al., August 2014 (or any successor document):

1. **Restoration**, enhancement and protection actions will only be considered a **biodiversity offset** where it is used to offset the [significant] residual effects of activities after the adverse effects have been avoided, remedied or mitigated.
2. **Restoration**, enhancement and protection actions undertaken as a **biodiversity offset** are demonstrably additional to what otherwise would occur, including that they are additional to any avoidance, remediation or mitigation undertaken in relation to the adverse effects of the activity.
3. **Biodiversity offset** actions should be undertaken close to the location of development, where this will result in the best ecological outcome.
4. The values to be lost through the activity to which the offset applies are counterbalanced by the proposed offsetting activity, which is at least commensurate with the adverse effects on indigenous **biodiversity**. The overall result should be no net loss, and preferably a net gain in ecological values.
5. The offset is applied so that the ecological values being achieved through the offset are the same or similar to those being lost.
6. There are situations where residual impacts cannot be fully compensated for by a **biodiversity offset** because of the irreplaceability or vulnerability of the **biodiversity** affected.

Appendix 5: Principles for Regional Biodiversity Strategies

1. The purpose of the regional biodiversity strategy is to promote a landscape-scale enhancement and **restoration** vision for the region's indigenous **biodiversity** that:
   a) Recognises and provides for Hutia Te Rito;
   b) Restores and enhances **significant natural areas**, connectivity and buffering;
   c) Enhances the sustainability of **indigenous biodiversity depleted environments**;
   d) Increases or strengthens biological or physical connections with identified taonga and between terrestrial, freshwater, and coastal marine ecosystems;
   e) Supports achievement of any national priorities for **biodiversity** protection;
   f) Is resilient to biological and environmental changes associated with climate change.

2. To achieve its purpose the regional biodiversity strategy shall:
   a) Spatially identify the components of the region's landscape-scale enhancement and **restoration** vision including:
      i. existing **significant natural areas** and identified taonga to be protected;
      ii. areas within **indigenous biodiversity depleted environments** that are intended to be reconstructed or restored; and
      iii. any other components to be enhanced or restored.
   b) Specify:
      i. actions that will be undertaken by local or central government;
      ii. actions that the community including tangata whenua will be supported or encouraged to undertake; and
      iii. how those actions will be resourced

   to assist the achievement of indigenous cover targets, and **restoration**, **reconstruction** and enhancement objectives set in accordance with Policies 16–18.

   c) Specify milestones for achieving the Strategy's purpose and the objectives of this national policy statement.
   d) Specify how progress on achieving the Strategy's purpose is to be monitored and reported on and measures to be taken if milestones are not being met.

3. In developing the regional biodiversity strategy, take into account:
   a) Opportunities to engage the community including tangata whenua in conservation, and in particular to connect urban people and communities to the natural environment.
   b) Opportunities for partnerships with the QEII Trust, Ngā Whenua Rāhui and other
   c) Considering incentive opportunities specific to Māori Land.

d) Co-benefits, including for water quality and freshwater **habitats**, carbon sequestration, and hazard mitigation.

e) Alignment with strategies under other legislation.

4. The regional biodiversity strategy may include measures that are intended to implement other objectives such as biosecurity, climate mitigation, amenity, or improved freshwater outcomes as well as **biodiversity** outcomes.

Part 3: The Biodiversity Collaborative Group's Complementary and Supporting Measures for Indigenous Biodiversity

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Introduction and summary

Protecting nature is a values-based concept. While law and regulation set important boundaries for human actions, as proposed with the draft National Policy Statement for Indigenous Biodiversity (NPSIB), other initiatives are equally important. Complementary and supporting measures are required. This report sets out the actions and resources that the Biodiversity Collaborative Group (BCG) consider are needed both to make sure the NPSIB is implemented well, and perhaps more importantly, to encourage the step change in how people care for and protect indigenous biodiversity.

This report recommends leadership initiatives that are essential to ensure focus, coordination, drive and continuity at a national, regional and local level to improve the condition of indigenous biodiversity.

If we want to see our indigenous flora and fauna flourish throughout our country, not only in protected areas, it is essential that current efforts are supported and expanded. Engaging hearts and minds involves encouraging the considerable voluntary effort that takes place now and expanding those efforts. The report recommends allocating significant resources to support and expand the voluntary-based efforts of Māori, other landowners and managers, and communities and environmental groups. This will also require improving and disseminating knowledge, assisting with good practice and techniques, monitoring of results of initiatives and measures, and experts working to assist and promote improved management.

Success in arresting biodiversity decline also requires integrating and aligning wider government policy, institutional arrangements and regulations. Otherwise we run the risk of one initiative negating or impeding the other. The report identifies key areas where alignment is important.

A final important part of these supporting measures is a comprehensive approach to understanding where indigenous biodiversity is improving or declining. It is not sufficient to simply encourage actions without knowing what the results are. It requires nationally consistent monitoring and reporting in a way that is accessible to everyone. It also means being prepared to act when things are clearly declining and when there are actions that are in breach of the provisions of the law or consents.

The BCG cannot emphasise more strongly how important the supporting measures are. Regulation alone will not solve such a complex issue as biodiversity decline. It will require leadership, increased knowledge, encouragement, resourcing and alignment of initiatives. An integrated approach will deliver the step change needed to halt the decline in indigenous biodiversity and encourage it to flourish in Aotearoa New Zealand.

NOTE: Terms defined in the Interpretation section of the National Policy Statement for Indigenous Biodiversity also apply to this Report.

1. Leadership in protecting and maintaining Aotearoa New Zealand's indigenous biodiversity

Objective: Coordinated, strategic leadership of the biodiversity management system is provided to ensure protection and enhancement actions are focused on where they are needed most, and that the different agencies, businesses, and communities involved are working together.

Empower the Department of Conservation to provide national leadership of the biodiversity management system

Every cause needs strong leadership. Halting the decline in Aotearoa New Zealand's biodiversity and ensuring it thrives is no exception. Fortunately, many entities have responsibilities for or have in interest in protecting our indigenous biodiversity. Those involved in biodiversity management include:

- Department of Conservation (DOC)
- Ministry for the Environment (MfE)
- Ministry for Primary Industries, including Biosecurity New Zealand and Te Uru Rākau
- New Zealand Conservation Authority
- Tangata whenua
- Predator Free New Zealand
- Local authorities
- QEII National Trust, Ngā Whenua Rāhui and other covenanting entities
- Private landowners
- Community groups
- Landcare Trust
- Private entities with a conservation focus
- Collaborative entities formed for a specific outcome.

What is missing, however, is coordination. Symptoms of lack of coordination are that:

- There are multiple players but none has a clear and specific mandate for overseeing the maintenance of indigenous biodiversity at a national level
- The roles and responsibilities of different agencies for biodiversity management are not clear in relevant legislation

- The overall system for biodiversity management has not dealt with the recent emergence of new entities and responsibilities well
- There are a plethora of documents which do not consider biodiversity in a holistic manner, and there is no clear mechanism to ensure alignment and compatibility between these documents
- Although the high-level goals of the Biodiversity Strategy (2000) and Biodiversity Action Plan (2016) are generally sound, they have failed to fulfil their respective objectives owing to slow and ineffective implementation and monitoring of achievement of actions and goals
- There is a conflation of DOC's and MfE's respective roles, and, to a lesser extent, those of the Ministry of Primary Industries.

The BCG has come to the view that strong, overarching, national leadership of the biodiversity management system is urgently required to provide coordination in order to maximise the impact of the collective efforts across the country.

The BCG considers that, with the plethora of actors already involved in biodiversity management, it is preferable for an existing entity to take on the leadership role. The BCG recommends that this entity be DOC because:

- DOC's primary function is to protect and manage indigenous biodiversity. It has greater focus than other agencies with competing non-biodiversity priorities.
- DOC has a statutory duty to manage public conservation land for conservation purposes, i.e., the protection and preservation of natural and historic resources which includes inter alia plants and animals of all kinds; air, water, and soil; and systems of interacting living organisms and their environment.[20]
- DOC has broader statutory duties to advocate for conservation of natural resources, promote the benefits of conservation, and to educate New Zealanders about conservation.
- DOC administers the QEII National Trust Act 1977 and much of the nation's other nature conservation legislation.
- DOC has a duty in legislation to advocate for conservation on land of all tenures (e.g., public, private, lease-hold), irrespective of ownership.
- DOC has nationwide connections with people and groups outside government, and a national and regional presence. This existing network of connections would allow it to provide national-level strategic oversight, as well as to play a practical role on the ground to assist with the alignment of regional and district efforts and actions with national strategic direction and priorities.
- DOC is a repository for information, resources and expertise. It combines policy, regulatory and operational expertise.
- DOC has other functions relevant to biodiversity outside of those relating specifically to public conservation land such as wildlife protection and biosecurity, and functions that cross land, freshwater and marine environmental domains.
- The Department has clear, directive Treaty of Waitangi obligations.

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[20] Conservation Act 1987 s6.

A national-level, strategic oversight role will require action and change for DOC: change in the way all central government agencies cooperate with each other, as well as with local government and other organisations and sectors – all with the objective of halting biodiversity decline. For DOC, being a leader at a national level will require it to work collaboratively with others, and take a wide view to ensure everyone's environmental, economic, social and cultural perspectives are incorporated.

As the leader of the biodiversity management system, DOC will need to:

- Work with other national agencies with interests in halting the decline in indigenous biodiversity to set the agenda for action by identifying priorities for protection and management alongside specific and measurable national level objectives and targets taking a tenure-neutral approach.
- Ensure there is clear direction on the roles and responsibilities of different players, including on how those players are to communicate in decision-making in their respective spheres – for example where different consents or permissions are required (i.e. under a district and regional plan or under a Resource Management Act plan and the Wildlife Act).
- Act as a conduit between the different players by ensuring the information and means for easy communication is available.
- Engage in and facilitate partnerships with and between the different players in order to progress protection and enhancement efforts.
- Monitor and assess progress in achieving national objectives and targets and take responsibility for developing and implementing changes or for filling gaps if necessary.
- Oversee the national biodiversity database (see Section 4).
- Support uptake of nationally applicable monitoring (currently Tier 1 and 2 of the biodiversity monitoring frameworks) to achieve standardisation (see Section 4).
- Support establishment and operation of regional community conservation hubs (see Section 2 below).
- Assist in the development of regional biodiversity strategies (Policy 17 in the proposed NPSIB).

The BCG sees the pending review of the Biodiversity Strategy as an opportunity for repositioning DOC as the leader of the biodiversity management system.

The recommendations in this section are intended to sit alongside and support the recommendation to develop community conservation hubs and to develop non-regulatory regional biodiversity strategies. Community conservation hubs are intended to be the on-the-ground method for connecting community and private sector action with the action of agencies (government departments and councils). Regional biodiversity strategies, developed through the collaboration of regional and district authorities, DOC and the community, are intended to provide the same strategic vision at the regional scale that DOC will provide at a national scale. The NPSIB also provides some direction on roles and responsibilities between regional and district councils.

Recommendations

1.1 DOC assumes the leadership role of Aotearoa New Zealand's biodiversity management system and undertakes the necessary steps to:

- Ensure there is a clear agenda for action identifying priorities for protection and management, and specific and measurable national-level objectives and targets taking a tenure-neutral approach
- Ensure there is agreement and clarity in roles and responsibilities of government agencies
- Monitor and assess progress in achieving national objectives and targets and where they are not, take responsibility to lead change any necessary change in strategy, policy and actions
- Oversee the national biodiversity database
- Support establishment and operation of regional community conservation hubs
- Assist in the development of regional biodiversity strategies
- Support the application of standardised nationally-applicable monitoring.
- That work is collaborative in nature and considers a full range of environmental, economic, cultural and social perspectives

1.2 The review of the National Biodiversity Strategy be used as a mechanism to implement the above requirements.

Increase the profile of indigenous biodiversity within local and central government

Halting the decline in indigenous biodiversity is a critically important national issue. It involves cross-cutting considerations similar to addressing human-induced climate change.

The previous section addressed the need for leadership at a national level for indigenous biodiversity. This section looks at how to coordinate and integrate biodiversity action at a governmental level, nationally, regionally and locally.

The BCG understands there is currently a cross-Ministry working group which is intended to ensure indigenous biodiversity is considered across government decision-making. However, in the BCG's experience halting biodiversity decline has tended to become a lower priority when measured against other government actions. This undermines public confidence in the government's commitment to ensuring a healthy, natural environment for future generations, and compromises public understanding of the severity of biodiversity loss and the importance of addressing it.

The BCG considers that a more targeted and strategic approach is required at a national level to ensure cross-Ministry decision-making. In particular, policy, investment, and development decisions should be required to consider impacts to determine consistency with objectives to maintain indigenous biodiversity.

There are also many current programmes which are either directly related to indigenous biodiversity in some way, or which could contribute to indigenous biodiversity gains if strategically applied. However, it does not appear that these programmes are aligned to ensure that indigenous biodiversity is considered, and to target complementary indigenous biodiversity outcomes. Some of these programmes are specifically addressed under Section 5 below, however the BCG considers that a government-wide analysis of relevant opportunities followed by changes to ensure alignment and consideration of indigenous biodiversity under each programme is required.

Coordination and integration is similarly required at regional and local government levels. The Local Government Act 2002 (LGA) has very little scope for consideration of indigenous biodiversity despite the regional and district council obligation under the Resource Management Act 1991 (RMA) to maintain indigenous biodiversity and other local authority biodiversity-related responsibilities. In performing their roles under the LGA, local authorities must act in accordance with a set of principles that include a 'sustainable development' approach which incorporates consideration of the need to maintain and enhance the quality of the environment. However, this principle is too general to provide clear direction for decision-making that has indigenous biodiversity front of mind. Reorientation of local authorities' operating principles to raise the profile of indigenous biodiversity maintenance is necessary to ensure decision-making appropriately considers this objective. A related issue and recommendation regarding bylaw powers is set out in Section 5.

Recommendations

1.3 The cross-Ministry indigenous biodiversity working group should ensure there is a regular forum, preferably at CEO level, and:

- In addition to its current membership of DOC, MPI, MFE, LINZ, MFAT, TPK and Treasury, also include the Ministry of Business, Innovation and Employment, Ministry of Foreign Affairs and Trade, Ministry of Housing and Urban Development, and Ministry of Transport.
- Be tasked with developing a protocol to be used by all ministries to analyse decisions to ensure impacts on indigenous biodiversity are appropriately considered, and consistency of decisions with the objective of maintaining indigenous biodiversity.
- Develop a working group feedback procedure, reporting to DOC on analysis of decisions against that protocol in order for DOC to be able to assess the efficacy of that approach and recommend changes required.
- If not at a CEO level, to ensure that the members of the forum are of appropriate seniority to ensure the protocol in Recommendation 1.3 is applied.

1.4 Subsequent to development of a national protocol, regional and territorial authorities to develop a similar protocol for local government decision-making. The local government protocol should align with the national protocol.

1.5 Parliament to amend section 14 of the Local Government Act 2002 to provide for maintenance of indigenous biodiversity as a principle relating to local authorities' performance of their role

1.6 The Ministry for the Environment, overseen and supported by the cross-Ministry indigenous biodiversity working group should undertake a comprehensive analysis of existing government programmes to:

- Determine which are currently directly related to indigenous biodiversity
- Which are not directly related to indigenous biodiversity but through which indigenous biodiversity outcomes could be achieved
- Recommend changes to each programme to ensure alignment in how indigenous biodiversity is considered, and the specific indigenous biodiversity outcomes being contributed to by each.

Supporting implementation of the National Policy Statement for Indigenous Biodiversity

Financial support and guidance

Some elements of the BCG's proposed NPSIB provisions will require action over and above what is currently being undertaken by many councils. In particular, compliance with the proposal that significant indigenous vegetation and significant habitat of indigenous fauna (the protection of which is required under section 6(c) of the RMA) be identified and mapped instead of identified on a case-by-case basis in response to a consent application, will be resource intensive. Many councils have already undertaken this process and the NPSIB includes transitional provisions to ensure that the cost to those councils and to councils that are yet to undertake this work can be managed. Nonetheless, the BCG recognises that this process will present some challenges, particularly for those with smaller populations and large jurisdictions. For some, the process will be challenging for financial reasons, and for others because councils do not have ready access to the necessary expertise. As a result, the BCG recommends that MfE and DOC should provide support for those councils that need it to ensure the identification and mapping of these significant natural areas is thorough, robust, and done as quickly as possible.

For other elements of the proposed NPSIB, guidance will be needed to assist correct and consistent implementation, particularly in respect of identification and management of section 6(c) significant areas of indigenous vegetation and habitat of indigenous fauna. The BCG considers that guidance on the implementation of terms used in the policies relating to identification of significant natural areas and management of effects is essential, and that this guidance should be developed with input from ecologists. As has been noted, many of the BCG's recommendations are intended to tie together. Here, community conservation hubs will be the critical mechanism for ensuring guidance is disseminated.

Recommendations

1.7 The Ministry for the Environment and DOC establish and maintain a contestable fund for local authorities to access for assistance with identification and mapping of s6(c) areas of significant indigenous vegetation and habitats of indigenous fauna. The fund should be subject to criteria prioritising local authorities with a large land area and a low rating base.

1.8 DOC make its ecological experts available to local authorities to assist with identification and mapping of section 6(c) areas of significant indigenous vegetation and habitats of indigenous fauna.

1.9 The Ministry for the Environment and DOC ecological experts develop guidance with local authorities to support appropriate implementation of policies, in particular, in respect of:

- Fragmentation
- Loss of extent
- Disruption of ecological sequences, mosaics, or processes
- Loss of buffering or connectivity
- Reduction in population size
- Reduction in species occupancy across natural range
- Reduction in indigenous character
- Reduction in ecosystem representation
- Ecosystem resilience
- Ecosystem adaptability.

Identifying section 6(c) areas of significant indigenous vegetation and habitat of indigenous fauna on public land

Protection of s6(c) areas of significant indigenous vegetation and habitat of indigenous fauna on public land is a critical part of the management framework. An understanding of biodiversity values across all land tenures is needed, and mapping significant natural areas on public and private land will assist in this understanding. Surveys of the presence of highly mobile fauna will also need to be across tenures.

The NPSIB requirement for identification and mapping of these areas is directed at regional, unitary and district councils as the entities with responsibility for developing plans under the RMA. However, the network of Aotearoa New Zealand's significant natural areas needs to be complete so that informed and effective decisions on protection and enhancement can be made (for example, in identifying a landscape-scale restoration project focused on 'building on what we've got' by connecting existing significant areas). It is also critical for monitoring overall state and trends. In short, a "tenure neutral" approach across public and private land is crucial for effective biodiversity management.

Central government should be responsible for providing the resources and expertise required for SNA identification on all central government-administered land to avoid placing an undue burden on ratepayers (who are already responsible for the costs of mapping SNAs on private land). The same ecological criteria should be used to determine significance, regardless of tenure.

Recommendations

1.10 Public land managers, including the DOC, Land Information New Zealand (LINZ), and Ministry of Defence, to undertake and cover the costs of identification and mapping of s6(c) areas of significant indigenous vegetation and habitat of indigenous fauna on government administered land applying the criteria in Appendix 1 of the proposed NPSIB.

1.11 DOC to assist local government by providing information regarding highly mobile fauna.

Continue the Department of Conservation's existing work programmes and support increased efforts

DOC has the responsibility of managing large areas of New Zealand's remaining forests, wetlands, braided river habitats, and other threatened ecosystems that are home to numerous indigenous plants and animals that are in serious trouble. Despite small local gains, the overall situation for indigenous biodiversity is getting worse.

Where there is regular pest control, native species are doing well, but most forests are not receiving regular pest control and in these areas time is running out. A third of Aotearoa New Zealand's land area is public conservation land managed by DOC but only one eighth of that is subject to predator control. Only about five percent of public conservation land is treated with 1080 in a normal year.

The Parliamentary Commissioner for the Environment found in a report evaluating the use of 1080 (a poison comprised of a synthetic form of sodium fluoroacetate used to control pest animals), that Aotearoa New Zealand should be using more 1080 to save our forests and the wildlife that lives in them.[21] At this stage, 1080 is the most effective method available to eradicate predators at landscape scale necessary to control pests.

The community has an essential role to play in ensuring that our indigenous biodiversity thrives, but DOC's role is, and will continue to be, fundamental to achieving that goal. If we are to halt the ongoing decline of our indigenous species and their habitats DOC must have a central role in managing pest species and advocating for the protection of our natural resources generally. Maintaining indigenous biodiversity is going to require an increased proportion of Aotearoa New Zealand's environment to be protected and actively managed to remove pests. Because of the distribution of threatened environments, much of this work will need to occur on private land. In order for promotion by government of increased protection on private land to have resonance it needs to show that it is prepared to increase its financial commitment to protecting land under its control.

Recommendations

1.12 DOC's core funding be increased to enable it to effectively carry out its role as the lead agency for biodiversity management (as per Recommendation 1.1), and to:

- ensure continued active management of the conservation estate currently being actively managed, and
- increase the area being actively managed.

1.13 Expand landscape-scale pest control using the most appropriate and effective methods at that scale.

21 Parliamentary Commissioner for the Environment (2011). *Evaluation the use of 1080: predators, poisons and silent forests*. Wellington: Parliamentary Commissioner for the Environment.

2. Support and better coordinate efforts

Objective: Local communities and tangata whenua are empowered to protect and enhance indigenous biodiversity at home and within their rohe.

Community coordination through regional community hubs

Funding restraints, personnel demands, and the scale and changing nature of conservation mean government departments cannot do it alone. It is fortunate therefore that community-based conservation initiatives are growing. Community conservation activities are those primarily planned, led, and executed by volunteers, people or entities other than publicly-funded government bodies, and include landowner-led projects, projects administered by community groups, and conservation projects led by tangata whenua.

These community projects contribute significantly to halting the decline of indigenous biodiversity.

Community-led tree-planting projects, for example, increase habitat to support indigenous species and indigenous vegetation cover to help bring depleted ecosystems to a point where they are self-sustaining. The community also plays an essential role in eradicating pest plants and animals through initiatives such as large-scale trapping projects in rural areas, through to home-owners in urban communities putting traps in their backyard. A lot of these projects are supported by DOC and local government but community-based conservation needs more support and clear direction to maximise benefits and to ensure those benefits endure.

Issues faced by community-based conservation groups and initiatives have been investigated by the Parliamentary Commissioner for the Environment (PCE) in a 2017 report, and in a 2018 report commissioned by Predator Free New Zealand (PFNZ).[22] These include:

- Lack of clear national direction on the role of community conservation
- Lack of alignment with national conservation priorities and ecological outcomes
- Difficulties in accessing funding, complexity of applications, timing and the amount of funding
- Need for practical support (e.g., what to plant and how to trap), and access to tools and physical resources, education, advice and support
- Need for administrative support
- Need for information and technical support to ensure ecological outcomes are met and to prevent poor monitoring of ecological outcomes
- Lack of connectivity between multiple, small-scale projects.

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[22] PCE (2017). *Taonga of an island nation: Saving New Zealand's birds*. Wellington: PCE; Brown, Marie (2018). 'Transforming community conservation funding in NZ', a report prepared for PFNZ.

Both reports suggest that the establishment of community conservation hubs would resolve many of these issues. The success of existing conservation hubs, such as Wellington City Council's Our Natural Capital, Taranaki's Wild for Taranaki, and the Bay of Plenty's Bay Conservation Alliance show how effective these entities can be.

Exactly where these hubs should sit and which entity should oversee them is a difficult question. Both the PCE and PPNZ Reports suggest a new, independent agency. However, because responsibility for conservation sits with multiple public agencies, to maximise efficient use of resources, and ensure easy access for community groups and individuals, the BCG recommends that community conservation hubs should:

- Be based at regional council offices, ideally with a staff member dedicated to enabling community conservation
- Have oversight from regional councils but be a partnership between DOC, district councils, tangata whenua, one or more private conservation covenant entities (e.g., QEII, Ngā Whenua Rāhui), any privately operated entities overseeing large scale conservation projects in the region with a person or persons from each specifically allocated to a community conservation role
- Have a national oversight team at DOC to assist with and ensure national consistency in necessary areas such as monitoring and funding applications.

Funding for community conservation is critical for success. In addition to helping with the direct costs of a project, regional council support and alignment with national and regional conservation priorities helps to give other funders confidence to support a project. The BCG is acutely aware of the cost of conservation and the need to ensure ecological gains from investment are maximised. The PFNZ report includes a comprehensive analysis of the issues with funding of community conservation, some of which have simple answers:

- Reviewing application templates to make them simpler and making them available online
- Including a requirement for applications to identify ecological outcomes and provide detail about the activity (e.g., what trees, how many and where they will go) so funders feel confident to pay upfront
- Clearly identifying priority restoration areas and prioritising community initiatives which align with national or regional restoration objectives, but not excluding consideration of other areas that the community are passionate about.

Any restriction on funding allocation priorities needs to be carefully considered to prevent perverse outcomes. Community conservation initiatives are typically driven by a personal and emotional connection to a specific area and cannot simply be uplifted and transferred somewhere else, even if the new area better aligns with broader conservation priorities. Funding of priority areas should be preferred but ability to secure funding and other support (e.g., information, seedlings, traps etc.) for other areas community groups care about should still be available where there is positive contribution to biodiversity outcomes (e.g., connectivity with a priority site, co-benefits for freshwater quality).

Some of the issues identified above can also be addressed by being more specific about where community conservation sits in the overall conservation effort at a national and regional level; others by standardising monitoring measures and making those simple and accessible; and others by providing incentives to focus on priority areas, such as regional funds being preferentially allocated to projects which align with priority areas (similar to the funding approach applied to transport).

Recommendations

2.1 Regional councils, in partnership with the DOC, district councils, private conservation covenant entities (e.g. QEII, Ngā Whenua Rāhui), and privately operated entities overseeing large scale conservation projects (e.g., Cape to City, Reconnecting Northland) to establish community conservation hubs to:

- Provide support and direction to community conservation to support existing effort, and expand capacity to maximise environmental benefits and ensure those benefits endure
- Recognise and support the role of community-based conservation efforts in achieving regional biodiversity strategy conservation priorities
- Support alignment of community conservation effort with national and regional conservation priorities.

2.2 Each community conservation hub should:

- Ideally, have at least one staff member primarily dedicated to supporting and expanding community conservation efforts
- Facilitate partnerships between different entities looking to undertake protection and enhancement actions, including between existing and new actions, proposed actions and Regional Biodiversity Strategy goals, and between entities (e.g., community groups and QEII National Trust or corporate entities)
- Ensure coordination with DOC, district councils, Ngā Whenua Rāhui, QEII National Trust, Landcare Trust, NGOs, tangata whenua, funding entities
- Provide administrative support to assist with funding applications and accountability
- Provide practical support (e.g., helping to get the message out about planting days, provision of traps)
- Providing technical support (e.g., which trees to plant where and how to monitor)
- Improve the value of citizen science through the provision of tools and direction on how to ensure alignment of citizen monitoring with agency monitoring.

2.3 DOC, regional council biodiversity managers, and private funders (where willing) to work together to review funding application forms and processes in order to:

- Standardise their structure, as far as appropriate
- Simplify them
- Move to an online format
- Ensure that anticipated ecological outcomes, details of methods to achieve those outcomes, and how success will be assessed (monitoring and evaluation) are specified.

2.4 When making funding decisions on community conservation proposals national funding agencies should:

- Preferentially align funding with national conservation priorities and conservation priorities identified in a regional biodiversity strategy
- Consider supporting non-aligned projects that are important to the community, including tangata whenua, and which, while not priority matters, will contribute to national priorities and the objectives of the relevant Regional Biodiversity Strategy.

3. Support landowners and land managers

Objective: Private landowners and land managers are supported to protect and enhance indigenous biodiversity on their properties.

Funding for biodiversity actions on private land

Much of New Zealand's remaining biodiversity is on privately owned and managed land, meaning that landowners have a vital role in ensuring that Aotearoa New Zealand's indigenous biodiversity thrives. Strong partnerships with landowners and meaningful support and incentives to help them manage indigenous vegetation and habitats on their properties will be critical to go beyond maintaining biodiversity and to achieve restoration and enhancement.

In rural landscapes, indigenous biodiversity is present at a farm or other enterprise scale and not only in identified significant natural areas; they are often part of a complex and dynamic mosaic which may include mixed indigenous and exotic vegetation and successional communities at different stages. Exotic flora can also provide habitat for indigenous plants, animals and insects, even in highly modified landscapes. The co-existence of indigenous biodiversity in these landscapes represents an exciting opportunity to continue to develop land management techniques that maximise both economic and biodiversity benefits.

Managing activities on private land to achieve biodiversity gains requires significant investment, often beyond the means of private landowners. There is currently very limited funding available to assist landowners for projects that have biodiversity benefits including the necessary ongoing maintenance. The Community Conservation Fund is one funding source but it appears to be weighted towards community group or charitable trust applicants and should be made more readily available to private individuals.

The benefits of the QEII National Trust and Ngā Whenua Rāhui Fund in supporting the protection of indigenous biodiversity on public and Māori-owned land respectively cannot be overstated. QEII covenants alone protect more than 180,000 ha of private land and play a critical role as a refuge for some of New Zealand's rarest and most endangered biodiversity and ecosystems. Yet demand for these covenants outstrips the resources of these organisations to facilitate them and there is a shortfall in funding to provide ongoing support such as for maintenance. Furthermore, when landowners do establish these covenants on their properties, they are often still required to pay rates on the covenanted land (some councils provide rates remission but others do not). This does little to encourage or incentivise participation in these programmes and sends a negative signal about the public benefit of covenanting land in perpetuity. While there is some legal ambiguity surrounding the rateability of covenanted land under the Local Government (Rating) Act 2002, the BCG's interpretation of the intention of this legislation is that QEII and Ngā Whenua Rāhui covenanted land is non-rateable.

A range of funding mechanisms exist to assist with the costs of indigenous biodiversity protection on private land. The tax system could be used to provide powerful incentives to retain indigenous cover on land holdings with a mixed production/protection model. The BCG has not had the opportunity to explore such tax arrangements in detail, but is aware that tax rebates, depreciation schemes and similar methods are regularly used internationally.

Payments for ecosystem services (simply defined as the benefits people and societies derive from the natural environment) is another opportunity. As biodiversity declines, the functioning of ecosystems destabilises which, in turn, puts at risk the flow of related benefits, such as the provision of food and clean water, mitigation of natural disasters, and physical, mental and spiritual wellbeing. This in turn affects the long-term viability of economic activities and human wellbeing. The ecosystem services approach seeks to assign a value to the benefits provided by ecosystem services, so that they can be better incorporated into decision-making. Placing a value on ecosystem services can provide greater recognition of the range and amount of benefits that nature provides and can lead to an improved understanding that society and the economy depend on nature and the socio-economic benefits of ecosystem services. Conversely, a requirement to pay for loss of ecosystem services can dis-incentivise activities, designs, or operational methods which result in biodiversity degradation or loss. This recognition incentivises protection of ecosystems (and thus biodiversity) and the services provided by them. Taking an ecosystem services approach to biodiversity protection could:

- Promote and incentivise the ongoing conservation, restoration and sustainable use of biodiversity due to the critical role played in the provision of ecosystem services
- Make trade-offs in decision-making more explicit
- Create an innovative source of funding for biodiversity protection.

Biobanking is a systematised market measure for delivering conservation gains required to address the ecological impact of a development through the ‘trading’ of biodiversity values. One side of the market is the ‘biobank’ in which conservation projects are held for sale to development interests, and maintained and enhanced in perpetuity at the developers cost. On the other side of the market are development interests which can buy a conservation project from the biobank to offset or compensate for the impacts of that development. Such a system can work to incentivise landowners to actively enhance or restore indigenous biodiversity, through providing a return for that work. This has particular resonance in respect of Māori land, much of which retains some indigenous cover or is difficult to develop. A biobank system can also work to ensure that promised gains are delivered and delivered ahead of the loss that occurs.

Crucial to remember is that biobanking comes with significant risks. Despite there being some good international examples, overall it has a history of failure or poor biodiversity outcomes. This is ultimately because biodiversity is non-fungible (meaning one attribute cannot readily be traded or exchanged). Another reason is that biobanking can have the effect of ‘locking in’ loss through the setting of an expectation that any development can go ahead provided a ‘biobank’ transaction is used to offset the loss. Analyses of international examples shows the efficacy of a biobanking regime is intrinsically linked to the robustness of the underlying biobanking system and the accuracy with which it ensures losses and gains are equivalent, and clarity of the overall policy framework in providing direction around appropriateness of offsets or compensation.

To date biobanking has not made a formal entrance into New Zealand but there is interest in its potential to effect better outcomes. An initial feasibility study was undertaken in 2017.[23] The BCG considers that any proposal to implement it as a widely-used tool should be carefully researched and evaluated. A successfully run pilot is a critical precondition to wider use.

Recommendations

3.1 Treasury, the Tax Working Group, and IRD to investigate opportunities within the tax system, such as tax rebates or tailored depreciation schemes, to incentivise retention of indigenous cover on private land where this would support the maintenance and enhancement of indigenous biodiversity.

3.2 The Ministry for the Environment and DOC, with the assistance of Treasury, to continue investigating new funding mechanisms to assist with the cost of indigenous biodiversity protection on private land, including:

- Valuation of and payments for ecosystem services
- Valuation of and accreditation for ecosystem services/presence of indigenous biodiversity as part of a product/operation certification scheme
- Biobanking
- Funds targeted at specific areas and/or specific outcomes.

3.3 Funding should be available to private landowners for enhancement works. It would be prudent to review the Community Conservation Fund application criteria and methodology for assessing applications and to amend these if necessary to direct the fund towards applications with the best indigenous biodiversity gains with a neutral/equal approach to whether the application is made by a private individual, community group, or other eligible entity.

3.4 Central government to review the resourcing of covenanting bodies, including QEII National Trust and Ngā Whenua Rāhui to ensure they have sufficient resources to:

- Meet demand, including for necessary maintenance, and
- Undertake effective monitoring, reporting, and where necessary, enforcement.

3.5 Land that is subject to a QEII covenant or Ngā Whenua Rāhui kawenata (covenant) be exempt from rates and legislation be amended accordingly.

Supporting primary sector environmental management initiatives

In response to changing expectations of markets (demanding proof of responsible performance), and growing concern amongst communities (who ultimately provide the social license to operate), various primary sector organisations have implemented, or are establishing environmental management initiatives. These initiatives generally involve producers committing to certain standards and/or undertaking certain actions. The nature of commitments to these programmes is varied, with some being purely voluntary, while others are overseen by international accreditation bodies and forming part of contractual obligations or market access requirements.

[23] Environmental Defence Society (2017). 'Banking on Biodiversity – The feasibility of biodiversity banking in New Zealand'.

These schemes have varying degrees of sophistication and the biodiversity-related obligations are similarly varied. Several rely on the concept of property-specific management plans where environmental objectives and risks are identified, and management practices to respond to those risks set out in the plan. Examples include:

- Horticultural producers who must comply with NZGAP requirements (a quality assurance programme with an environmental module).
- Independent third party certification such as the Forest Stewardship Council (FSC), which has a certification/product labelling scheme that allows wood and wood-based products to be FSC labelled, providing assurance that certain environmental management/sustainability requirements have been met in forest management.
- Beef and Lamb NZ recently instituted a system of supporting dry-stock farmers to develop environment plans to identify and plan responses to particular on-farm environmental risks.
- Fonterra is currently assisting farmers to produce (across its supplier base) around 1000 Farm Environment Plans per year – with farmers opting in on a voluntary basis and gaining expert support through Fonterra's sustainable dairy advisers. The primary aim is to support farmers to identify and manage environmental risks on farm as opposed to biodiversity gains.

As farm environment plans (of various forms) are increasingly required by regional councils for water and nutrient management purposes, many farmers will need to develop them to comply with regional rules. There is a real opportunity for the development of these plans to include biodiversity objectives and associated monitoring and reporting obligations.

Recommendations

3.6 The Ministry for the Environment and Ministry for Primary Industries to investigate:

- Use of industry-led tools to enhance the profile of biodiversity in primary sector management
- Implementation of property-specific management plans that are personalised to be meaningful to the farm business and provide for (amongst other things) biodiversity outcomes at the property level, in a way which complements regulation.

Support for biodiversity actions on Māori land

Improved protection and enhancement of indigenous biodiversity on Māori-owned land will provide biodiversity benefits as well as opportunities for restoring the relationships of whānau, hapū and iwi with their whenua, in accordance with their kaitiaki role.

Around 80 per cent of the 1.3 million ha of land administered under Te Ture Whenua Māori Act 1993 is steep with moderate to severe limitations for conventional agricultural use, making it attractive for the management of indigenous biodiversity. These areas are in the 'less threatened, better protected' land environments[24] which, despite not falling in the most threatened category, is nonetheless important to protect nationally. However, Māori land retains a disproportionate percentage of indigenous vegetation compared to other land. Up to 50 per cent of the land cover on Māori-owned land comprised of indigenous vegetation, meaning that limitations on the use and development of land this is likely to disproportionately impact Māori compared to other private landowners.

There is a lack of statutory coherence relating to biodiversity management incentives for Māori land owners. Historically, the focus of government interventions is limited to 'increasing productivity' rather than the provision of mechanisms to enable co-benefits associated with biodiversity management. Māori land is subject to restrictions and protections that do not apply to other privately-owned land. Barriers to land use change and biodiversity maintenance include: fragmentation of ownership, restrictions on sale, lack of access to bank lending, inefficiencies of legal processes in comparison to privately owned non-Māori land, and lack of coordinated access to land information and support for owners across agencies and service providers.

On some Māori land parcels, part of the parcel is in productive use (often forestry) while other parts are retained in indigenous cover. This mixed-use model provides opportunities for incentivising retention of indigenous vegetation cover in order to maintain biodiversity. Incentivising active protection (e.g., predator control) on Māori land not only protects vulnerable species but also supports the involvement of tangata whenua in the care of their taonga, and may provide employment opportunities.

Recommendations

3.7 In investigating incentive opportunities within the tax system under Recommendation 3.1, Treasury, the Tax Working Group and IRD should examine incentives for retaining Māori land in indigenous cover.

3.8 In undertaking its review to ensure alignment of current programmes in supporting indigenous biodiversity gains under Recommendation 1.6 MfE should examine how those programmes do and can be amended to support indigenous biodiversity protection on Māori land.

3.9 Central government to enhance support services for indigenous biodiversity protection on Māori land by:

- Redesigning Māori land services (currently administered by the Māori Land Court) to improve access to biodiversity knowledge and networks
- As per Recommendation 3.4 review funding available to Ngā Whenua Rāhui to expand the national network of kawenata.

[24] This refers to the Threatened Environments Classification: Manaaki Whenua - Landcare Research, Threatened Environments Classification <https://www.landcareresearch.co.nz/resources/maps-satellites/threatened-environment-classification>

4. Improve monitoring, information and knowledge

Objective: Nationally consistent approaches to monitoring, reporting, data management and prioritisation to improve biodiversity management decision-making.

Consistent and comprehensive monitoring and reporting

To maintain indigenous biodiversity in Aotearoa New Zealand, it is important to understand current state, trends, and pressures on indigenous biodiversity. Environmental monitoring is a key component to enable us to better understand the environment and involves the collection of long-term data that informs us about the condition of our natural resources. The information collected allows us to assess whether environmental quality and our indigenous biodiversity is improving, remaining the same, or becoming degraded.

State of the environment monitoring:

- Builds on and provides information on the environment which helps inform the public, stakeholders and our international partners about the condition of the environment, key pressures, and supports decision-making on resource allocation
- Measures the efficiency and effectiveness of policies, rules and methods, which helps to inform decision-makers on how well policies are working in practice.

It is difficult to collate and interpret the information we have available to form a comprehensive national-level assessment of state of indigenous biodiversity because of:

- Data gaps
- Inconsistent monitoring methods across councils and between councils and other actors (e.g., citizen science generated by individuals or community groups)
- Lack of a standardised recording and reporting framework across councils and between councils and other actors
- Inconsistent methods for ecological classification and selection of management approaches that are important in assessing the effectiveness of policy intervention and informing regional and national prioritisation or where to best invest management effort
- Data acquisition difficulties.

There is also a poor understanding of what the public wants to know about indigenous biodiversity and how they want to receive the information. This is an important component of an effective reporting system and should complement the information needed to meet agencies' statutory reporting requirements.

These issues are due in part to a lack of standardised, mandatory monitoring and reporting requirements, and in part to a lack of resources (particularly in the case of smaller councils).

The BCG considers there is an essential need for the environment to be monitored and data to be collected and reported in a consistent form. There has been significant effort by regional councils and DOC, with the help of Landcare Research, to achieve that outcome, most notably through the development of the Tier 1 and Tier 2 biodiversity monitoring frameworks which involve the measurement of specified biodiversity indicators:[25]

- Tier 1 comprises broad scale monitoring for national context. It is underpinned by a systematic sampling programme involving regular assessment of a selection of indigenous species and pests at locations 8 km apart and spaced evenly across a landscape
- Tier 2 comprises detailed monitoring of managed places and species on land, fresh water, and in the ocean to report on management effectiveness. It involves consistent, rigorous monitoring of the outputs (management results) and outcomes (management achievements) of specific activities on land, in fresh water, or in the marine environment.

These are currently being applied by DOC in its indigenous biodiversity monitoring system on public conservation land, as well as Tier 3 monitoring which comprises intensive monitoring of key sites for research purposes. Uptake by local authorities in monitoring biodiversity on private land is inconsistent.

The BCG considers that consistent national monitoring of biodiversity, in particular in significant natural areas, on both public and private land is essential and that Tier 1 and Tier 2 are the best available tool. It understands that regional councils and DOC are supportive of this proposal, but there are some issues that need to be addressed before consistent national monitoring of biodiversity can be implemented:

- Tier 1 implementation is currently limited by complexity and cost. Questions are also raised over whether the costs and benefits fall fairly, given the reporting outputs are designed for multiple reporting levels (e.g., international, national and local)
- Tier 2 monitoring data is not shared well or reported anywhere. Use of a standardised monitoring methodology and reporting is also an issue
- The Tier 1 and Tier 2 framework is not as consistently applied in the freshwater or coastal environments as in the terrestrial environment.

Recommendations

4.1 The Tier 1 and Tier 2 monitoring frameworks are adopted and applied by local authorities in monitoring and reporting on indigenous biodiversity on private land. To enable this to occur:

- DOC in partnership with Landcare Research must review the Tier 1 and Tier 2 frameworks to:
    - Ensure application to the freshwater and marine environments
    - Develop guidance for application to the freshwater and marine environments
    - Develop a standardised monitoring information recording and reporting template to be used across all land tenures

[25] See: https://www.doc.govt.nz/our-work/monitoring-and-reporting-system/

- Ensure Tier 1 and Tier 2 frameworks are fit for application on private land, in particular in terms of alignment with the location of significant natural areas

– The Department of Conservation, in its role as the lead agency for indigenous biodiversity management (as per Rec 1.1), to establish a Tier 1 and Tier 2 Establishment Team, tasked with assisting local authorities with deployment

– Regional and district councils must work together to establish a monitoring and reporting plan which identifies Tier 1 and Tier 2 monitoring site locations and specifies which entity is responsible for which sites, and which entity is to oversee collation and synthesis of recorded data

– Regional councils work in collaboration with landowners and land managers to implement monitoring and to share information

– Central government to consider funding a proportion of Tier 1 monitoring by regional councils on private land.

Development of a national biodiversity database

Policy makers and researchers need better access to a national picture of indigenous biodiversity to improve decision-making, make operational processes more efficient, increase opportunities for collaboration between organisations, and to incentivise new research opportunities to further inform policy development.

Aotearoa New Zealand's current data on indigenous biodiversity suffers from two key deficiencies:

a) It is incomplete. This is discussed above and recommendations relating to increased monitoring are recorded.

b) Available data is not always comparable because different schemas and standards are used between local authorities, and between local authorities and other indigenous biodiversity management entities. This undermines, for example, the use of data for purposes other than that for which it was specifically collated or outside the area in which it was collated, such as for national reporting.

While there has been attempts to develop data standards and schemas that are interoperable, an ongoing coordinated and well-resourced national commitment has not been sustained. The Terrestrial and Freshwater Biodiversity Information System Programme (TFBIS) outputs have recently been incorporated into the New Zealand Organism Register (nzor.org.nz) which has a core objective to maintain a compilation of all organisms relevant to Aotearoa New Zealand. However inadequate resourcing has hindered the next phase of establishing an interoperable biodiversity data platform specifically able to federate biodiversity data.

These deficiencies are inhibiting the development of a clear and comprehensive picture of the state of Aotearoa New Zealand's indigenous biodiversity. This in turn compromises the quality of policy and undermines the ability of policy makers to counter criticism of the need for controls in order to protect and maintain indigenous biodiversity. The result is the current continued trajectory of decline, despite an increased active management effort.

Change is urgently required to move to a system where data collected by one entity is comparable to data collected by another entity, and which is then able to be exchanged and collated to provide a national picture.

The first part in making this happen is ensuring that everyone is monitoring and measuring the same thing. The second part is developing appropriate schemas and standards for those who collect, file, and analyse data on indigenous biodiversity, and requiring those to be consistently used. Development of nationally applicable schema and standards will require an ongoing input from central government, local government, and other organisations that are undertaking indigenous biodiversity monitoring, in order to ensure they are fit for purpose across multiple environments and uses.

A shift to consistently collected, filed, and analysed data across Aotearoa New Zealand will provide the springboard for the development of a decentralised, distributed, and publicly accessible data system that provides a comprehensive picture of indigenous biodiversity and ecosystems across Aotearoa New Zealand, or incorporation of such a database as a layer or layers into a national platform in a way to similar to LAWA (Land, Air, Water Aotearoa).

Recommendations

4.2 The Ministry for the Environment and Statistics New Zealand, in collaboration with DOC and regional councils (in the first instance the Regional Bio-Managers Group), should lead a staged work programme with the ultimate output being a decentralised, distributed, and publicly accessible data platform that provides a comprehensive national picture of indigenous biodiversity and ecosystems. This work programme should:

a) Begin with the development of:

- Standardised data formats that will be used by those who collect, maintain, and analyse data on indigenous biodiversity and ecosystems
- An agreed schema for indigenous biodiversity data and ecosystems
- Build on existing processes as detailed in the New Zealand Organism Register so to achieve an appropriately detailed data dictionary for indigenous biodiversity and ecosystems.

This process must:

- Be undertaken working with the decision-makers, managers with data custodian responsibilities, and data collation and management staff from the organisations with statutory responsibility for biodiversity functions as well as covenanting entities, and key indigenous biodiversity research institutes such as Landcare Research and NIWA
- Cover and capture all data sources including mātauranga Māori and citizen science.

b) Investigate how to ensure use of schema and standards developed under (a) can be made mandatory, for example through a National Environmental Monitoring Standard, and take the necessary steps for that to occur.

c) Develop a decentralised and distributed data platform into which data collected used the schema and standards developed under (a) can be collated, or incorporate that data into an existing appropriate data platform.

d) Ensure that the data platform is publicly available.

Identification of wetlands

Wetlands are hotspots for indigenous biodiversity. They are also critically important because of the ecosystem services they provide for the wider environment and for people, including flood protection, improving water quality, and resilience to drought. The preservation of their natural character is a matter of national importance under the RMA and protecting the significant values of wetlands is a requirement under the National Policy Statement Freshwater Management (NPSFM).

Yet wetlands continue to be lost as land-use intensifies in rural areas and urban land expands. Loss and damage has been so pervasive that today only 10 per cent of the historical extent of wetlands remain. In many areas that percentage is even less; in Hawke's Bay for instance only 2 per cent of wetlands remain.

A key reason for the loss of wetlands is that their location often overlaps with where people live and work and because, until recent decades, there has been a lack of understanding and appreciation of their importance. Another key reason is the lack of specific direction in the RMA and NPSFM in terms of how to achieve the objectives of protection and preservation. Defining the physical characteristics of wetlands, or a nationally consistent process and criteria for spatially defining the extent of wetlands, for example, is lacking (as recently noted by the Land and Water Forum in its 2018 Report). This has resulted in regional inconsistency and disagreement in approaches to wetland identification and management.

The NPSIB includes a policy relating to wetlands. This requires wetlands to be identified using the specific process set out in the NPSIB's appendices, recognises the significant values of wetlands that relate to indigenous biodiversity, and requires that loss of and degradation to those wetlands is avoided.

Identification has proven to be particularly controversial around the country and the BCG considers it is important for any wetland identification criteria and methodology to focus on wetlands that retain ecological integrity (i.e. they function like a wetland) as opposed to an area of paddock that is wet from persistent rain. The criteria and methodology for identification of wetlands has been carefully developed with the help of experts to achieve that outcome. The proposed approach is underpinned by analysis of the indigenous vegetation present, but sometimes, typically in determining the margins of a wetland, reference to analysis of soil and hydrology is required. Vegetation analysis and soil analysis tools specific to Aotearoa New Zealand have been developed and are used widely. A hydrology tool specific to New Zealand conditions has not yet been developed, and instead a tool developed in the United States is used. While the tools available are adequate for wetland identification, it is important that a full suite of tools specific to New Zealand conditions is developed to ensure the identification process is as robust and accurate as possible.

As wetlands are identified across the country it is important that their extent, location, state, structure, and significant values are recorded in a systematic and standardised way, and that a wetland inventory is established and maintained. This is necessary to monitor change over time, and to make comparisons with historic extent. Development of a wetland inventory will also assist Aotearoa New Zealand in fulfilling its obligations as a signatory to the Ramsar Convention on wetlands, through providing a database against which decisions on how to achieve the 'wise use' anticipated by the Convention, and to maintain the ecological character of wetlands, can be made.

Recommendations

4.3 Ministry of Business, Innovating and Employment to fund Landcare Research to complete development of the wetland hydrology assessment tool in order to complete the suite of tools required to effectively identify and assess wetlands.[26]

4.4 The Ministry for the Environment and DOC to:

a) Establish and oversee an online wetland inventory to record all wetlands identified in accordance with Policy 13 and Appendix 3 of the NPSIB, including: map of location, extent, state, structure, significant values, and other information identified as necessary.

b) Through the Biodiversity Strategy review require that all regional councils record all wetlands identified in their region in the inventory.

[26] The other two tools being the vegetation assessment tool (Clarkson et al, 2014) and the soil assessment tool (Fraser et al, 2018). All tools are based on the USA Army equivalent models.

5. Align institutional frameworks, policies and regulatory tools

Objective: Alignment of central government decisions and direction to maximise benefits and to minimise risks to indigenous biodiversity.

As discussed in Section 1, there is an urgent need for an overarching leader of Aotearoa New Zealand's indigenous biodiversity management system, and the BCG recommends that DOC assumes this role. It is also essential that government policies are aligned across agencies to achieve (or at least not undermine) biodiversity benefits or co-benefits, and to ensure decisions on non-biodiversity specific activities do not inadvertently result in biodiversity loss or degradation. This should include alignment with the imminent refresh of the National Biodiversity Strategy. This is a critical part of central government showing leadership in maintaining indigenous biodiversity and supporting it to thrive. In Section 1, the BCG recommended that the existing cross-Ministry indigenous biodiversity working group be reinvigorated and tasked with reviewing existing programmes across government to ensure alignment in achieving positive outcomes for indigenous biodiversity, and to develop protocols to ensure the natural environment is factored into all future decision-making. This section of the report focuses on specific areas where the BCG has considered how each can be better organised and orientated to achieve benefits for indigenous biodiversity.

Many non-biodiversity specific government programmes can be modified without difficulty to secure biodiversity co-benefits, and existing functions and powers can be reoriented to ensure there is a full toolbox for controlling impacts on indigenous biodiversity. Key opportunities exist in the following areas:

- Bylaw powers
- 1 Billion Trees Programme
- Carbon sequestration schemes
- National Environmental Standards for Plantation Forestry 2018
- Biosecurity Act
- Wild Animals Control Act
- New riparian planting
- Implementation of the Waitangi Tribunal's Wai 262 Report recommendations.

Bylaw powers

Bylaws can act as an effective tool for local authorities to control effects of people and animals on indigenous species and their habitat. Some activities that are theoretically able to be managed under the RMA but are not readily suited to its plan and consent-based controls. Particular examples are the public's use of vehicles or horses on beaches, and control of dogs and (non-feral) cats. Vehicles and horses both have the potential to cause damage to beach habitats, such as the nesting areas of shorebirds and seabirds, and coastal vegetation. Dogs and cats pose a threat to kiwi, lizards and other fauna if not properly controlled or kept away from their habitats. It is clear that powers under the Dog Control Act 1996 can be used where dogs are a danger to indigenous wildlife. However, non-feral cats, and the use of horses or vehicles on beaches are normally dealt through bylaws under the Local Government Act 2002 (the Reserves Act also contains bylaw-making powers specific to reserves). As discussed in Section 1, the protection of indigenous biodiversity is not an objective of the Local Government Act and, in general, bylaws must be for the purpose of controlling a nuisance rather than addressing an environmental issue.

The change to the RMA in 2003 to make maintenance of indigenous biodiversity an explicit function of regional and territorial authorities significantly raised the profile of biodiversity and resulted in improved measures to maintain it. A similar amendment to ensure that bylaws can be used to control impacts on species, habitats and ecosystems and to raise the profile of biodiversity in decision-making under the Local Government Act could bring about a similar step-change.

Where bylaws are used, enforcement remains an issue. Bylaws may be enforced through prosecution in the District Court but this is a complex, lengthy and expensive process that may not be justified by the nature of the breach. Breaches of bylaws may be specified by regulation made through Order in Council to be infringement offences, in which case infringement fines may be imposed. Access to a full range of enforcement tools is likely to make enforcement of bylaws for biodiversity objectives more effective.

Recommendations

5.1 The Department of Internal Affairs to amend sections 145 and 146 of the Local Government Act 2002 to ensure that bylaws may be made for the purpose of protecting indigenous species and ecosystems in public places and consider whether constraints should be placed on this power.

5.2 The Minister of Local Government to recommend regulations to ensure that biodiversity-related bylaws may be enforced by infringement notice.

5.3 Consider whether additional specific enforcement provisions would be required for the purpose of protecting biodiversity in public places.

1 Billion Trees programme

The 1 Billion Trees programme has the potential to achieve significant biodiversity gains, as well as gains for climate mitigation, freshwater quality, and employment. However, it also carries risks for biodiversity. In order to ensure the BCG's recommendations were provided to Ministry of Primary Industries/Forestry New Zealand Te Uru Rākau in time to be considered in developing the overarching criteria for decision-making on the 'right tree in the right place', they were provided to the Ministry on 14 August 2018. Those recommendations and explanatory text are set out below.

> The Group has identified the 1 Billion Trees programme as a key opportunity for achieving biodiversity gains. It also presents risks for biodiversity.
>
> You have advised that the criteria for guiding selection of what is planted, where, and when, as part of the 1 Billion Trees programme is to be finalised in September, and that the recommendations from the Group on what those criteria should be, should be provided

now to ensure there is opportunity for them to be incorporated (as opposed to October when its final report is due). In response, this letter sets out the Group's recommendations with supporting reasons.

Recommendations & reasons

The 1 Billion Trees Programme has the potential to achieve significant biodiversity gains, as well as gains for climate mitigation, freshwater quality, and employment. It also carries risks for biodiversity if planting decisions are not carefully managed.

Gains will be achieved through planting indigenous species, targeting restoration of Aotearoa New Zealand's most biodiversity depleted environments (those where there is less than 10% cover remaining) and of areas of high biodiversity value that also secure wider environmental outcomes like riparian networks and wetlands, increased ecosystem services, and contributing to connectivity and landscape-scale restoration. Some indigenous planting may be temporary for commercial harvest. But permanent planting can secure economic return too, through conservation jobs and through increasing the type, location, quality, and extent of environments available for people to visit and experience. These co-benefits were recently recognised by Prime Minister Ardern and Minister Whaitiri in the 13 August announcement of increased funding for the 1 Billion Trees programme.

Risks arise if decision-makers fail to consider what is being planted, where, and the impacts of climate change. Pest species must be avoided. Planting of exotic forestry species should not occur in areas where wilding spread is a problem or in areas with existing indigenous vegetation or habitat that contributes to maintenance of indigenous biodiversity. Failure to consider how climate change will impact rainfall, temperature, and soil risks planting species that will not be able to survive long term. Even planting indigenous species can have bad outcomes if the wrong species is planted.

The Group considers there is a real opportunity to secure biodiversity co-benefits (maximising biodiversity gains and minimising biodiversity risks) and associated ecosystem services from new planting under the 1 Billion Trees programme and recommends that the criteria for guiding selection of what is planted, where, and when, should include the following:

- New plantings should:
  - not be restricted to trees but include other indigenous vegetation;
  - include a significant indigenous component;
  - focus on restoration of Aotearoa New Zealand's most biodiversity depleted environments and riparian networks;
  - support achievement of ecological connectivity and landscape-scale restoration;
  - support achievement of regional landscape-scale indigenous restoration strategies or plans where they exist.
  - ensure no pest species are planted, and ensure any exotic species are appropriately located. In particular, that new exotic plantation forestry is not established where it will increase the risk of wilding incursions into areas with existing indigenous biodiversity value, or in areas with existing indigenous vegetation or habitat that contributes to maintenance of indigenous biodiversity.
  - carefully consider whether only indigenous species that are native to the environment in which the planting is occurring should be used.
  - ensure that the foreseeable impacts of climate change on the environment in which the planting is occurring is considered as part of species selection.

Carbon sequestration schemes

There are a number of mechanisms in Aotearoa New Zealand that landowners can use to obtain finance and New Zealand Units (carbon credits) for afforestation efforts: the Emissions Trading Scheme (ETS), the Afforestation Grant Scheme (AGS) and the Permanent Forest Sink Initiative (PFSI).

To date forestry planting under the ETS has favoured commercial planting for harvest of predominantly exotic forest, with 300,000 ha of forest land registered in the ETS, of which only 25,000 ha is indigenous (8 per cent).[27] Estimates are that 10,000 ha of post-1989 native forest land would sequester 65,000 tonnes of carbon dioxide equivalent (CO_2e) annually over an average of 50 years, and would be eligible to earn 65,000 NZUs per year under the ETS.

Extending the scope of sequestration interventions that can generate eligible carbon credits under the ETS has the potential to achieve significant biodiversity co-benefits. The current ETS rules make it difficult to receive carbon credits for any planting other than large-scale forestry that has been 'actively' planted (both temporary and permanent, and indigenous or exotic). This means that forest and other vegetation regeneration initiatives that achieve both carbon sequestration and biodiversity benefits do not earn carbon credits under the ETS or other schemes. Such initiatives include:

- Native forest regeneration on marginal land. Difficulties include costs of assessment, proving eligibility for carbon credits (i.e. proving that the forest has regenerated since 1989), and with measurement of regenerated areas.[28]
- Riparian planting. Most riparian planting is not eligible to earn carbon credits because the planting area is does not meet the 30 metre width requirement for the ETS.[29] Many of these areas are now required to be fenced for water quality purposes which significantly reduces the opportunity costs of also planting the fenced off area, and, with the right incentives, increases the likelihood of this planting occurring.
- Reconstruction of drained wetlands. As above, the width restrictions or restrictions on density and height of planting prevent credits from being obtained.[30]

Extension of the ETS would also provide significant opportunity for economic and biodiversity gains on Māori land through planting and ecosystem reconstruction. For example, current statistics indicate that the carbon that would have been stored on Māori land could have potentially earned between 298,400 to 1 million carbon credits, worth between $5.9 million and $19.8 million.

The AGS and PFSI provide alternative mechanisms through which landowners can achieve carbon credits for planting trees. Under the PFSI land that has been forested since 1990 and complies with the area size and tree density and height thresholds is eligible for carbon credits. Forests registered under the PFSI are subject to a protective covenant theoretically in perpetuity but which is actually subject to a review after 50 years.[31] Under the AGS

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27 Carver T., Kerr S., (2017). *Facilitating Carbon Offsets from Native forests.* Wellington: Motu.

28 Ibid.

29 Ibid; Land & Water Forum (2018). 'Land and Water Forum advice on improving water quality: preventing degradation and addressing sediment and nitrogen'.

30 IAG Science Advisory Panel (2018). 'Hutia te Rito' (Paper for Biodiversity Collaborative Group).

31 Ministry for Primary Industries (2015). 'Guide to the Permanent Forest Sink initiative'.

landowners can apply for a funding grant of $1,3000 per hectare for new small to medium-sized forests (5 ha-300 ha) for the purpose of reducing soil erosion, improving land productivity, storing carbon, and improving water quality.[32] Currently both schemes allow for the planting of exotic forest and place height and size restrictions on the type of vegetation that can be planted. The draft NPSIB would require regional councils to set indigenous cover targets in indigenous biodiversity depleted environments (those with less than 10 percent indigenous cover). Amendments to the AGS and PFSI to favour indigenous planting, in particular in environments that currently retain the least indigenous cover, and to increase the types of eligible indigenous species could result in significant co-benefits for biodiversity that contribute to achievement of those indigenous cover targets.

The government's commitment to scaling up Aotearoa New Zealand's climate policy framework is an opportunity to review these mechanisms to maximise opportunities for carbon sequestration, and achieve co-benefits for biodiversity at the same time.

Recommendations

5.4 In order secure indigenous biodiversity co-benefits from planting for carbon sequestration MfE and Te Uru Rākau (or and Te Uru Rākau and the Climate Commission if established) should:

- Investigate additional carbon sequestration opportunities from indigenous planting (including riparian planting and wetland planting) which result in co-benefits for biodiversity, and make the necessary changes to the ETS for their incorporation.
- Make changes to the PFSI eligibility criteria to favour indigenous planting, favour planting in Aotearoa New Zealand's most biodiversity-depleted environments (<10%) and create additional sequestration opportunities.
- Make changes to the AGS eligibility criteria to favour planting of indigenous species.

Criteria will also need to be developed to ensure that the indigenous vegetation planted at any given location is appropriate for the specific environment.

Resource Management (National Environmental Standards for Plantation Forestry) Regulations 2017

Plantation forestry can provide buffering for and connectivity with areas of significant indigenous vegetation, and can assist in the natural development or reestablishment of additional indigenous vegetation areas along stream setbacks, non-productive and retired areas. The forests themselves provide habitat for many indigenous species, including Threatened and At Risk species, such as bats, lizards, invertebrates, and forest birds like kiwi and falcon. The forestry industry has protocols for managing these fauna, and there are over 1 million hectares of plantation forest certified by the Forest Stewardship Council (independent third party certification) which has many criteria, indicators and verifiers around fauna. Many plantation forests also benefit from predator control carried out by forestry companies, which greatly enhances their value as habitat. Plantation forestry is typically a 25 – 30 year cycle, and there are differing views as to its value as habitat as a result.

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[32] Ministry for Primary Industries (2018). 'Guide to the Afforestation Grant Scheme'.

The National Environmental Standard on Plantation Forestry 2017 (NESPF) provides a suite of rules for plantation forestry activities. It provides for indigenous vegetation clearance associated with plantation forestry, other than within significant natural areas (with two exceptions relating to incidental damage and clearance of vegetation overhanging forestry tracks). These rules recognise SNAs and wetlands. A further general indigenous vegetation rule constrains the circumstances and area of any indigenous vegetation clearance within the planted forest estate and identifies the circumstances and scale of indigenous vegetation damage that may occur. The NESPF also has rules to protect the nesting sites of At Risk and Threatened bird species, and rules to protect the spawning conditions for a number of indigenous fish species.

A review of the NESPF, focussing on wilding pines and fauna, is being undertaken at one-year post gazettal.

The NESPF states that rules in regional or district plans may be more stringent than the NESPF if the rule recognises and provides the protection of significant natural areas.

The NESPF states that new production forestry (afforestation) cannot occur in a significant natural area as a permitted activity (Reg 12). If new production forestry planting is proposed to occur within a significant natural area it is to be considered as a restricted discretionary activity, with the matters of discretion focusing on the effects on the areas significant values (Regs 16, 17). Any vegetation clearance required prior to afforestation is out of scope of the NESPF and covered by applicable regional or district plan rules. The predominant focus of the NESPF is on established production forestry. It specifies rules for activities undertake as part of the operation of established production forestry (including activities as part of the ongoing operation of the production forest, harvesting, and replanting) seeking to ensure that activities are managed in a way that:

- ensures measures to control forestry's effects on indigenous biodiversity are targeted to appropriately minimise adverse effects, and are cost-effective; but
- does not result in perverse outcomes, such as discouraging predator control or discouraging plantation afforestation or reforestation in appropriate locations.

A key issue is that the NESPF does not provide for circumstances where plantation forestry itself is designated a significant natural area. While in most situations indigenous vegetation (including understorey, areas of failed planting/windthrow) is unlikely to be significant indigenous vegetation, the plantation forest does commonly provide habitat for threatened and at risk species. If this were to result in the forest being designated as an SNA some activities currently permitted under the NESPF would require consent due to permitted activity rules specifying that the activity must not take place within an SNA without regulatory oversight (for example river crossings (Reg 43), and others may not occur as a permitted activity depending on how the requirements of the NESPF are interpreted (for example harvest (Reg 66, Sch 3). This could have the perverse incentive of discouraging predator control, discouraging the planting of longer rotation or native species, encouraging browsing of the understorey, to reduce the value of the forest as potential habitat.

A related issue is that the NESPF deals with the effects of forestry on spawning fish and nesting birds but does not address effects on other biodiversity such as non-nesting birds, bats, and lizards.

FOA's suggested approach to these issues is to exclude application of the NPSIB's Appendix 1 significant natural area identification criteria to production forests, and for Appendix 1 to state that a production forestry cannot be a significant natural area. The majority of the Group does not agree to this because areas where threatened species live are significant regardless of human use of the area and for the reasons set out in the Covering Report (in summary that identification of section 6 (c) significant areas and their management are two separate steps, where identification is a technical, expert exercise based on ecological attributes, and management and human use (new and existing) is a separate issue addressed via policy. The rest of the Group has endeavoured to address these issues through the NPSIB (see Covering Report) and considers that the review of the NESPF, beginning in early 2019, provides an appropriate opportunity to address these issues. The Group has made recommendations on key issues that the NESPF review should investigate.

Recommendations

5.5 As part of the one-year review of the NESPF:

a) Definition of indigenous vegetation: As part of the NESPF review, consider aligning the NESPF definition with the NPSIB definition. Consider interaction with the approach to plantation forest understorey from NESPF reg 93(2).

b) Regulation 93 (Indigenous vegetation clearance rule) – as applied to fauna significant natural areas: Consider amending Regulation 93 so that in areas of plantation forestry that meet significance criteria due to the presence of mobile fauna, indigenous vegetation clearance associated with harvesting is provided for, subject to controls that ensure that adverse effects on Threatened or At Risk fauna are avoided, remedied or mitigated.

c) Consider amending Regulation 102 of the NESPF so that mobile Threatened or At Risk fauna in plantation forests is protected through controls to avoid or mitigate adverse effects on such Threatened or At Risk fauna. Controls should be effective but practical means to manage effects while recognising the purpose for which the plantation was established. Any proposed new controls should ensure that adverse effects on Threatened or At Risk fauna are avoided, remedied or mitigated:

- Determine the details of these controls as part of the NESPF review, seeking input from relevant experts (e.g. forest managers, ecologists, Kiwis for Kiwis).
- Controls should be effective but practical means to manage effects while recognising the purpose for which the plantation was established.
- Note that controls will likely differentiate between static species and mobile fauna (e.g. some highly threatened species may require protection in situ, where-as mobile species may be protected through measures such as ensuring forestry workers are able to identify the presence of these species and avoid harvesting where they would be hurt or killed, and/or providing alternative refugia where necessary.

d) Provide for additional ancillary rules and/or Harvest Plan requirements to implement those measures.

The BCG would like to emphasise that this is not a comprehensive review of the suitability of the NESPF to address the positive and adverse effects of plantation forestry on indigenous biodiversity and is not expressing a view that the scope of the NES review should be limited to these matters.

Biosecurity Act

The Biosecurity Act 1993 was recently reviewed (in 2012) and provides for biosecurity interventions that advance biodiversity outcomes. This includes options for harmful organism or pest interventions at the regional level, including strategic programmes. Strategic programmes are: eradication, exclusion, progressive containment, sustained control and site-led management as may be included in a regional pest plan.

However, for a harmful plant or animal to be able to be included in a pest plan it must first meet the tests set out in the Act (focusing on cost-benefit analysis).

That means that not all harmful organisms will be subject to a pest plan with the associated access to interventions and rules (an example would be Old Man's Beard – an organism that is harmful to biodiversity but which is likely to be spread widely across a region making it highly unlikely to ever meet a cost-benefit test for region-wide control).

A core issue is that many harmful organisms can affect biodiversity values and the only legal/regulatory means to manage these species under the biosecurity Act is via 'site led' programmes which require specificity in location and the organism type. Owing to the targeted nature of these site led programmes, regional councils lose the flexibility to take measures to manage a range of harmful organisms posing a risk to biodiversity. This may not be an issue if voluntary intervention is justified and forthcoming, but if rules or public funding are required to secure long-term sustainable outcomes then statutory arrangements currently act more like a barrier than an enabler.

Recommendation

5.6 The Ministry for Primary Industries to investigate options to ensure that the Biosecurity Act can be used by regional councils with maximum flexibility so as to address threats to biodiversity with particular focus on removing barriers to the use of regulatory and funding tools for all strategic programme options. This includes, in particular, the cost-benefit test that applies to the identification of pests in regional pest plans, which should be revised to ensure that environmental costs and benefits are able to be fully considered even if they are not readily able to be monetised.

Wild Animals Control Act

The Biosecurity Act addresses risks associated with:

- Potential new incursions of species from overseas (i.e., managing biological risk control at the border and surveillance)
- Incursions (i.e., responses to eradicate unwanted organisms that are newly discovered to have breached border defences)
- Pest management (i.e., the control of unwanted organisms, declared as pests, that have established in Aotearoa New Zealand, including legacy pests).

As noted above, since 2012, the Biosecurity Act has a much clearer purpose in terms of pest management (one that more expressly recognises the role in biodiversity management).

However, the framework for managing biological risks to indigenous biodiversity is actually far more complex than just the Biosecurity Act and includes the Hazardous Substances Act 1996 (which amongst other things regulates the introduction of new organisms into Aotearoa New Zealand), the Wild Animals Control Act 1977 (WAC Act) and the RMA.

That creates some untidy interface issues between, in particular the Biosecurity Act and the WAC Act. Recently wallabies and possums were removed from control under the WAC Act in response to concerns from regional councils that control under the WAC Act made management under the Biosecurity Act difficult. While that resolved one area of uncertainty, similar issues remain in respect of feral goats (i.e. whether regional councils can control goats when that is the specific role of DOC under the WAC Act).

The WAC Act contains a schedule of 'wild animals' that includes deer, tahr, chamois, feral goats and feral pigs, and declares all wild animals to be the property of the Crown.

The WAC Act has a purpose of controlling wild animals generally, and of eradicating wild animals locally where necessary and practicable, as dictated by proper land use '…to ensure concerted action against the damaging effects of wild animals on vegetation, soils, waters, and wildlife and achieve co-ordination of hunting measures…'. However, other purposes include to 'achieve co-ordination of hunting measures and provide for the regulation of recreational hunting, commercial hunting, wild animal recovery operations, and the training and employment of staff'.

The WACA applies to all land (public and private) and gives the Minster of Conservation a range of powers including to:

- Control the capture and liberation of wild animals
- Control the farming and breeding of animals
- Enter private land to kill animals
- Control hunting.

In a practical sense the WAC Act is important tool to be able to maintain or create areas free of certain wild animals (or maintain certain populations, such as tahr, at agreed levels). Northland, for example, is a declared deer-free zone. WAC Act powers are used by DOC to eradicate (often in conjunction with regional councils) populations that have been illegally released (as has occurred multiple times in Northland for example). Other powers can be used to stop farming of certain animals (such as goats).

While the WAC Act has proved a necessary and effective tool, the relationship between the RMA (that controls land use), the Biosecurity Act (that empowers regional councils with pest management powers) and the WAC Act (that also controls some land use and some pest management) is not a clear as it might be.

There is no doubt that the risk of people illegally introducing certain pest species (including freshwater fish species) continues to be a major threat to indigenous biodiversity. While action under the WAC Act may be 'fighting fires' as they arise, knowledge of the Act and the controls and offenses under it, are not well known among the public generally.

More action is required to:

- Resolve legislative interface issues and inconsistencies (including, for example, ensuring alignment between land use rules of district plans and WAC Act controls over the farming of certain species)
- Raise awareness of the controls in place under the WAC Act (and the Freshwater Fisheries regulations prepared under the Conservation Act) and the need for/purpose of those controls
- Undertake surveillance activity to enable early detection of illegal releases
- Resolve issues in relation to whether wild animals are a (hunting) resource or a pest and thus the purpose of population control
- Improve compliance monitoring and enforcement.

Recommendation

5.7 That DOC, Ministry for Primary Industries and MfE review the interface between the Biosecurity Act , Wild Animals Control Act and the RMA to ensure that, without losing important powers, the regimes are better integrated to:

a) Provide a modern and seamless regime for the effective management of animals that pose a risk to biodiversity; and

b) Ensure that any uncertainty regarding regional councils' ability to use powers under the Biosecurity Act in respect of animals controlled under the Wild Animals Control Act is removed.

New riparian planting

Maintenance of a vegetated riparian strip of an adequate width is known to be beneficial in reducing some impacts of land use on freshwater quality. There are also opportunities for riparian strips to be the connection between the mountains and the sea, and potentially between isolated areas of significant indigenous vegetation. These plantings can provide new habitat for indigenous species, food sources and nesting sites.

As riparian vegetation can also be a corridor for pest species to move through the landscape, management of predators and weeds should also be actively encouraged and supported. It would be perverse if any requirement to control pest species led to a discouragement in such planting.

Inappropriate plantings can also be a risk to biodiversity, creating opportunities for introduced plants to interbreed with or outcompete local genetic variants. Consideration of appropriate eco-sourcing of plant material may therefore be required and advice in this regard should be made available.

The government is considering regulations relating to the exclusion of stock from waterways. An opportunity exists to use this to encourage maintenance of vegetated riparian margins, where feasible and appropriate, as part of good management practice.

To incentivise planting activity and its significant benefits, government should ensure funding assistance through contestable funds and council grant schemes is available.

Recommendations

5.8 The Ministry for the Environment to include consideration of co-benefits for biodiversity if progressing regulations for stock exclusion.

5.9 Government to ensure these co-benefits are realised, by providing and encouraging the establishment of funding assistance, through contestable funds and council grant schemes, that should be available to both individual landowners and catchment/community groups.

Biodiversity/conservation law reform and tangata whenua

The need for biodiversity and conservation law reform to address the recognition of rights around, and control of, traditional Māori knowledge, customs and relationships with the environment has been well documented in the Waitangi Tribunal's report on the WAI 262 claim.

In 2011, the Tribunal concluded that a 'Treaty-compliant environment management regime' is needed that balances kaitiaki interests alongside other legitimate interests to deliver the following outcomes:

- '**control** by Māori of environmental management in respect of taonga, where it is found that the kaitiaki interest should be accorded priority
- **partnership models** for environmental management in respect of taonga, where it is found that kaitiaki should have a say in decision-making but other voices should also be heard
- **effective influence and appropriate priority** to the kaitiaki interests in all areas of environmental management when the decisions are made by others'.[33]

The Tribunal found that the current system does not provide for these outcomes and recommended that these shortcomings be remedied urgently. While some of the recommendations made in WAI 262 are responded to in the BCG's draft National Policy Statement, other recommendations relate to broader institutional matters that are beyond the scope of the BCG's work but warrant further attention by way of a comprehensive review of the legislative framework.

Recommendation

5.10 That the recommendations made by the Waitangi Tribunal within the Wai 262 Report (2011) are taken into account as part of the review of the Aotearoa New Zealand's Biodiversity Strategy as well as during an iterative review and refresh of the biodiversity/conservation legislative framework.

33 Waitangi Tribunal (2011). *Ko Aotearoa Tēnei (WAI 262 report),* pp. 112, 118.

Reconsider limitations on tree protection

Amendments to the RMA that came into force in 2012 and 2013 prohibit 'blanket tree protection rules' in urban environments, except within a reserve or an area subject to a conservation management plan or conservation management strategy. The provisions require councils to specifically identify 'notable' trees for protection in a plan, either individually or as part of a definable group. Individual specimens or small groups of native trees (or exotic vegetation that provides important urban habitat for native fauna) are unlikely to be identified as a significant natural area, and rely on tree protection rules to prevent their loss.

Research demonstrates that in areas with weak tree protection provisions, removal of vegetation is more widespread and rapid than where tree protection is more stringent.[34] In areas facing urban development pressure, there are significant drivers to remove trees and other vegetation to maximise development potential (particularly infill housing). Implementation of the National Policy Statement on Urban Development Capacity 2017 is likely to increase prioritisation of space for urban development over space for vegetation. The RMA's limitations on tree protection mean councils are faced with the onerous task of identifying individual trees or groups of trees in order to retain vegetation in urban areas, particularly where trees on private property make an important contribution to an area's overall vegetation.

Protection of indigenous biodiversity should not be a responsibility that is left to rural areas. The urban forest has significant ecological, social, cultural and economic values. Valuable vegetation tends to be spread over both public and private land. In Auckland, a significant proportion of the remaining mature trees are located on private land. Yet evidence from the Auckland Unitary Plan hearings showed that Auckland's Schedule of Notable Trees protects just 15 per cent of the large trees in the urban centre, and is biased toward older and wealthier suburbs (where the majority of Auckland's older and larger trees are located), with new and low socio-economic areas having limited or less established tree cover and very little of that protected. Few threatened species are represented. Alternative approaches have been proposed (by a University of Auckland study) such as using species and tree targets for each suburb. This approach is considered likely to improve biodiversity outcomes and ensure the benefits of trees are enjoyed by more than just residents of more established and affluent suburbs.[35]

In order to promote maintenance of indigenous biodiversity in urban areas, increase opportunities for people to experience nature across all socio-economic urban areas and reduce the administrative burden on councils, the tree protection limits in the RMA should be reconsidered.

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[34] Brown M., Simcock R, Greenhalgh S. (2015). 'Protecting the urban forest'. *Landcare Research Policy Brief* No. 13. July 2015.

[35] Wyse, Sarah V., Beggs, Jacqueline R., Burns, Bruce R. and Stanley, Margaret C. (2015). 'Protecting trees at an individual level provides insufficient safeguard for urban forests', *Landscape and Urban Planning*, 141, pp. 112–122.

Recommendations

5.11 The Ministry for the Environment to review evidence of the impact of RMA tree protection limits on:

- Maintenance of indigenous biodiversity in urban areas
- Opportunities for people to experience nature across all socio-economic urban areas
- Administrative burden on local authorities
- Taking into account community and landowner perspectives.

On completion of the review in Recommendation 5.6 make amendments to section 76 of the RMA to ensure maintenance of indigenous biodiversity.

6. Improved compliance, monitoring and enforcement

Objective: Resourcing and implementation of compliance, monitoring and enforcement functions by local authorities to ensure activities are managed to avoid biodiversity loss.

Commitment to and resourcing of compliance, monitoring and enforcement

Compliance, monitoring, and enforcement (CME) refers to measures taken to ensure adherence with rules or other requirements in order to achieve the purpose of legislation or policy.[36] Poor CME by local authorities is a cross-cutting RMA issue. Research shows Aotearoa New Zealand's institutions are not fulfilling this function well, which is resulting in significant environmental harm.[37] The way in which biodiversity is typically managed by plans means that biodiversity is particularly vulnerable to degradation and loss from poor CME, for example:

- There is a heavy reliance on permitted activity standards to maintain indigenous biodiversity, in particular for indigenous vegetation clearance. Permitted activity standards are set at the point at which a local authority is no longer confident clearance can occur at a rate that will maintain biodiversity or protect significant natural areas. This means that unless monitored and enforced, loss of indigenous vegetation and associated habitat will occur beyond what was contemplated and beyond the level at which biodiversity is maintained.
- Resource consent conditions requiring mitigation, remediation, offsetting, or compensation are often subject to long timeframes. If those conditions are not complied with then biodiversity outcomes anticipated when consents were granted will not be realised.
- Biodiversity is not easy to visually define or monitor because it is made of up of multiple components of a diverse range of ecosystems. As a result, it is particularly susceptible to cumulative effects and gradual loss: 'death by 1000 cuts'. Every failure to monitor and enforce non-compliance with plan rules and consent conditions is another 'cut'.

Significant shortcomings in the way the CME is carried out in Aotearoa New Zealand were identified in a 2017 report.[38] Key factors identified both in this report and by the BCG include:

- Lack of financial and physical resources being available or allocated to this function
- Inadequate training opportunities for enforcement officers, resulting in a lack of professionalism and skill to deal with the technical, social, and political difficulties of enforcement

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36 Brown M., *Last line of Defence: Compliance, monitoring, and enforcement,* (NZ Law Foundation, EDS) 2017.

37 Ibid.

38 Ibid.

- Unclear career pathways for environmental enforcement officers when compared with comparable professions
- Reluctance to undertake CME due to fear of public perception and political pressure from elected officials
- Non-independent decision-making on whether enforcement action should be taken.

The BCG has identified two measures it considers are critical to improving CME under the RMA in order to improve biodiversity outcomes. The first is to develop an environmental enforcement accreditation programme to improve the status of CME as a profession, and ensure officers are properly skilled and maintain their aptitude for the job. The second is to develop a central hub of professionals to provide expert CME assistance to small local authorities or local authorities where political pressure has been revealed to be severely compromising CME.

The BCG considers these recommendations are achievable in the short term because the administrative structures and mechanisms for their implementation already exists: the G-REG Level 3 Core Knowledge Certificate for regulatory compliance could be implemented through the government's recently established Enforcement Unit or the Environmental Protection Authority.

Recommendations

6.1 Local authorities must have human and financial resources specifically allocated to CME. This must be detailed as a method in relevant planning instruments and in the Regional Biodiversity Strategy.

6.2 The G-REG Level 3 Core Knowledge Certificate for regulatory compliance be analysed to determine whether it covers all appropriate matters for compliance under the RMA or whether additional biodiversity-specific modules need to be incorporated for RMA enforcement officers undertaking the programme. If required additional biodiversity-specific modules be developed and be included in the G-REG programme.

6.3 A mandatory requirement for professional accreditation for RMA enforcement officers be introduced requiring successful completion of the G-REG Level 3 Core Knowledge Certificate, including any additional modules incorporated under recommendation 1.

6.4 A central hub be developed with capacity to provide advice on biodiversity compliance monitoring and enforcement, and to coordinate and support mutual assistance amongst councils.

6.5 The central hub or a separate entity also has the role and capacity to assist directly with enforcement actions.

6.6 There is a centralised audit function to assess how well enforcement functions are undertaken and to take action where they are not adequate.

The BCG notes that some or all of the above functions are likely to fall within the remit of the new RMA 'Oversight Unit'.

Part 4: Annexes

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Appendix 1: Summary of evidence received by the Biodiversity Collaborative Group on biodiversity pressure, state and trends

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Introduction

This report summarises the information received on biodiversity pressure, state and trends by the Biodiversity Collaborative Group (**BCG**) to inform its decisions and recommendations for a National Policy Statement on Biodiversity (**NPS**) and complementary supporting measures (**CSM**).

The scope of the report is limited to biodiversity pressure, state and trends, as well as comments on information gaps identified and potential solutions to addressing biodiversity issues. It does not include other information received by the BCG such as that relating to the regulatory system, roles of agencies responsible for biodiversity management, or Mātauranga Māori.

The report draws on the following information received by the BCG:

- Presentations and supporting documents
- Circulated reading documents
- BCG commissioned research

The report is structured by topic, with material received summarised in a table under the following headings:

- Name of report/presentation, presenter, date received by the BCG
- State & Trend
- Pressures
- Current Actions
- Gaps and Issues Raised
- Solutions Suggested by author/presenter

The first section, "Overall Biodiversity" covers information received on biodiversity generally.

This is followed by sections on specific topics, e.g., "Freshwater Biodiversity".

Where a report or presentation covered more than one topic, that information is presented in each topic area (e.g., "Overall Biodiversity" and "Birds").

While other topics may warrant a separate section (e.g., "Terrestrial Biodiversity" or "Dune Systems"), because specific information was not received on these topics, information pertaining to them is covered in the "Overall Biodiversity" section.

Summary

State and trend

The experts on Aotearoa New Zealand's biodiversity referenced in this document, concur that assessing biodiversity state and trends is complicated by significant gaps in data coverage and scale as well as the inconsistent use of monitoring methodologies and reporting systems.

Despite these information deficiencies, the evidence is consistent and can be summarised at a very high level as follows:

- Remaining indigenous vegetation cover is mostly in hilly and mountainous areas, with only small fragments in lowland and coastal environments
- Between 1996-2012 there was a net loss of 71,000 hectares of indigenous land cover (~1%), mostly in least represented areas of lowland and coastal environments
- Between 2001-2016, 214 wetlands were lost (~ 1,250 hectares), primarily converted to pasture
- 2/3 of rare and naturally uncommon ecosystems are threatened
- 83% (285 of 344 taxa) of land vertebrates classified in the threatened species system are threatened or at risk of extinction
- Between 2005 and 2011, extinction risk worsened for 8 freshwater fish species
- Between 2010 and 2016, extinction risk worsened for 7 (of 77 threatened) bird species, 3 gecko species, and 1 species of wētā
- Between 2012 and 2016, extinction risk reduced for 20 bird species, largely due to intensive conservation management (1/4 of these are still classified as threatened with extinction)

Pressures

The range of pressures on New Zealand's biodiversity are well understood and include introduced pest plants and animals, disease, nutrient and sediment losses from land, habitat loss and modification and fragmentation (e.g., for urban and agricultural development), and climate change. Many of the experts referenced in this document add that the poor alignment of existing effort and national policy direction is a further pressure – and one that should be most reconcilable.

Where uncertainty arises is in the degree of impact of the range of pressures. It is incontrovertible, for example, that possums are one of the major threats to indigenous forests; it is less certain the extent (and proportion) of the threat of trout to indigenous fish. The loss of indigenous vegetation is a specific and direct loss of indigenous biodiversity and therefore quantifiable, whereas the loss of biodiversity through clearance of exotic vegetation providing habitat for native species is extremely difficult to quantify.

Gaps in land use information,[39] the rate of change, and how emergent land use practices impact biodiversity exacerbate the uncertainty around the extent and impact of contemporary activities, such as indigenous vegetation clearance. Public conservation land, for example, increased by more than 1 million hectares between 1990 and 2016 and there was an overall reduction in agricultural land over the same period. Cautionary interpretations of land use change statistics, however, are recommended by the experts. They note that regional rather than national scale assessments, recognising exactly 'where' and 'what type' of change is occurring, is necessary for informing assessments of biodiversity change. Between 1996 and 2012, for example, although the greatest change in land use was from exotic grasslands to exotic forestry, 31,000 hectares of tussock grassland, 24,000 hectares of indigenous shrubland, and 16,000 hectares of indigenous forest was also lost.

These losses were predominantly in lowland and coastal environments where indigenous vegetation is most limited in extent and where naturally uncommon ecosystems are most at risk. Small changes can also misrepresent the impacts of fragmentation which can increase the proportion of vulnerable 'edge habitats', cause species isolation, and make populations more vulnerable to chance events. A further example of caution is necessary in interpreting wetland extent and protection statistics. Although over two-thirds of remaining 'large' wetlands (>100ha) are protected, these large wetlands are predominantly in DOC high-country, and are quite different systems and support different species to smaller wetland types on lowlands of which 214 were lost between 2001 and 2016.

[39] Gaps still exist despite the large range of information sources including Land Environments of New Zealand LENZ, Land Cover Database, Agricultural Production Censuses and Surveys aerial photographs, multispectral satellite analysis and imagery, resource consent records, property boundary extents (ie land ownership and title data), Waters of National Significance and Sentinel -2 satellite imagery, Fundamental Soil Layers database.

Biodiversity overview

Introductory reading: *State, trends, pressures and values.* Report. MfE. March 2017.

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
• >40 species extinct since human arrival and many more threatened (see Table 1). • Risk of extinction of threatened indigenous species 2005-2011: – 7% (59 of 799) worsened – 1.5% improved • Most threatened indigenous environments in coastal and lowland areas, esp. east of South Island and most of the North Island. • Rate of loss of indigenous forests has slowed, but not stopped. • 1996-2012 – 10,000 ha of indigenous forest lost. Worst in lowlands where 57% of threatened plant species grow – 3% decrease in scrub cover (including exotic species such as gorse) • 1990 2008: – 70,000 hectares indigenous grassland in SI converted to pasture • Many specialised invertebrates rely on grasslands, e.g., 130-140 species of beetle at two Otago sites.	• Dunes: coastal development and rising sea levels • Growth, development and land conversion – Urbanisation – Rural land use change (area of pastoral farming remained relatively stable 1996-2012 but intensification has occurred) – Infrastructure projects – Nutrients & sediment • Pest plants and animals • Direct human impacts - recreation, tourism, off-road vehicles and tramping threaten 12 of 18 critically endangered terrestrial ecosystems; tourism increases the chances of pests and disease • Climate change likely to be biggest impact - degradation of the alpine zone; flooding may increase egg/chick mortality for braided-river birds; warming increases tuatara ratio of males to females; estuarine habitats will be affected by changing rainfall or sediment discharges, as well as temperature, acidification, sea level and connectivity to the ocean	• Formal protection of high altitude grasslands has increased since 2000 as a result of the tenure review of high country leases. • Low to mid altitude systems are poorly protected and are undergoing rapid land transformation	Nothing noted.	Nothing noted.

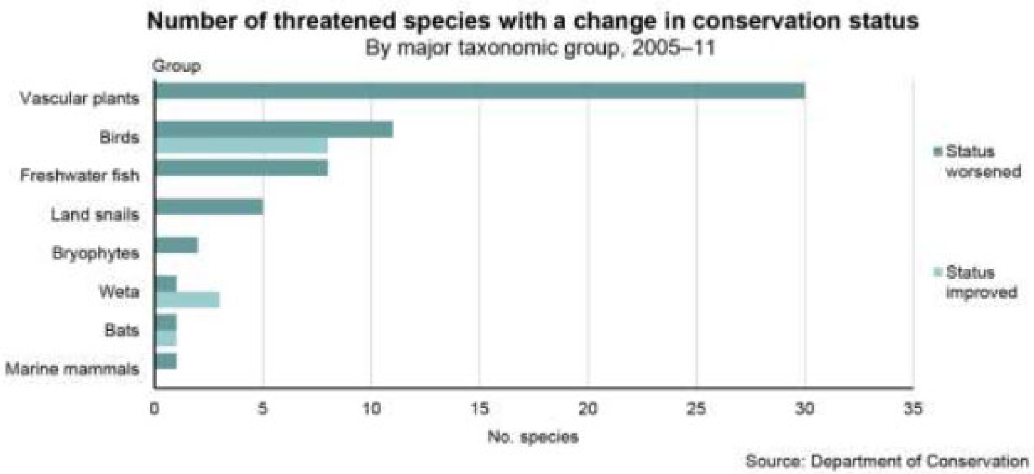
State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
• 2008-2012: Manuka/kanuka (10, 865 ha) and tall tussock grassland (8, 400 ha) greatest net losses. • Dunes < 20% of 1950s area • 71 naturally uncommon ecosystems. Generally small (< 1 ha to 1,000 ha) non-forested, but conditions support unique communities of plants and animals, many of which are threatened. Loss of many of these ecosystems is continuing. Almost two-thirds (45) of the rare ecosystems are also classified as threatened under the IUCN red-list criteria. Of these, 18 (40 %) are critically endangered • 1/4 of the world's seabird species breed in NZ, and almost 10 % breed only in our marine environment. • 90% of indigenous seabird species and subspecies that breed in New Zealand are threatened or at risk of extinction; risk has increased for eight of the 92 seabird species since 2005	• Risk that long lag times means negative impacts of human activities not apparent until too late			

Table 1. Indigenous species that are threatened or at risk of extinction, by taxonomic group (Source: Department of Conservation 2017)

Taxonomic group	Still living (number)	Threatened or at risk (number)	Threatened or at risk (%)
Bats	4	3	75
Birds	203	164	81
Earthworms	171	32	19
Freshwater fish	39	28	72
Freshwater invertebrates	580	148	26
Frogs	4	4	100
Reptiles	57	50	88
Vascular plants	2378	918	39

Source: Department of Conservation; Threat Classification System 2012–14; Hitchmough et al. (2013); de Lange et al. (2013); Robertson et al. (2013); Newman et al. (2013); O'Donnell et al. (2013); Goodman et al. (2014); Grainger et al. (2014); Freeman et al. (2014); Buckley et al. (2015).

Table 2. Number of threatened species with changed conservation status between 2005 and 2008-2011 (Source: Department of Conservation 2017)



Threat classification and prioritisation. Presentation and PowerPoint. Fiona Carswell (Landcare Research). 25 May 2017.

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
• 70% birds, 100% reptiles/frogs/bats, 80% vascular plants, 38% marine species, 84% freshwater fish, 80% invertebrates are only found in NZ. Threatened: • 71/218 birds • 289/2542 flowering plants/ferns • 47/2547 mosses etc (11065 data deficient) • 37/106 reptiles • 3/5 bats • 304/3859 invertebrates (1297 data deficient) • 21/53 freshwater fish • 8/31 marine mammals • 11/440 marine invertebrates 1996-2012 land cover decline: indigenous forest, broadleaved indigenous hardwoods, tussock grassland, exotic grassland, scrub. Biggest increases in exotic forest, urban, cropping/hort.	6 key pressures: • introduced predators • herbivores • weeds • land use • illegal activities • industrialisation Also, pressure to provide opportunity to offset/ compensate for loss but some effects cannot be offset or compensated e.g. very rare places.	• Number of classification systems can be used to generate pictorial images of current, past, future state. E.g LENZ map – PAN-NZ map = TEC map.	• Data from multiple sources (e.g. citizen science) is not standardised so compilation and use is difficult.	• Need standardised methods for monitoring that can be used across professional and citizen science actions. • Achieving healthy bird populations requires large and connected habitat, rapid population growth (supported by food, predator control, and quality habitat), and strong genetics. • Need a robust process and guidance around offsetting/compensation

Environmental Reporting on land, coastal and marine biodiversity. Presentation and PowerPoint. Fiona Hodge & Pierre Tellier (MfE). 28 June 2017

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
Environment Aotearoa 2015: • Many indigenous plants and animals at risk of extinction, and risk increasing for many • Most land environments < than 10% of indigenous cover • 46% land environments < 20% of indigenous cover • Most threatened indigenous environments are coastal, wetland and lowland areas • Still losing habitat, 1996 -2012: – ~ 10,000 (0.08%) hectares indigenous forest lost – 97,110ha increase in agriculture, forestry, and urban • ~ 40% of vascular plants threatened or at risk of extinction • 2005-2011: – extinction risk worsened for 30 plants, 11 birds and 1 bat – risk improved for 8 birds, 3 weta and 1 bat • > 80% birds threatened or at risk of extinction • Many of our (known) marine species are at risk of extinction • 28% of marine mammals are threatened • 90% of seabirds threatened or at risk of extinction • 86% of shorebirds threatened or at risk of extinction • 2008-14, risk of extinction worsened for 8 seabirds; risk improved for 1 seabird and 1 marine mammal	• Terrestrial: Land use conversion is the key threat to indigenous cover. • Freshwater: land use impacts, sedimentation, barriers to fish passage, riparian habitat loss, introduced species. • Possums, rats and stoats in 94% of NZ; feral goats 30% and red deer 57% • Marine: habitat loss, pests & weeds, climate change (also overfishing). • More exotic plant species than indigenous plant species	• Protection focused on areas where humans haven't developed; now some ecosystems have minimal or no protection.	• Marine data gaps: 1/3 marine mammal species assessed for conservation status are data deficient	• Should prioritise by analysis of which ecosystems have been most heavily lost & which have the least representation on public conservation land. • Outcomes that should be sought: resilience, integrity, connections. • Should avoid fragmentation, loss of extent, loss of condition of threatened areas in particular.

Biodiversity issues and solutions. Presentation and PowerPoint. Bruce Clarkson (University of Waikato). 28 June 2017

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
• Rare ecosystems: total extent < 0.5% (<134,000ha) of NZ's total area. Rare ecosystems contain 50% of NZ's threatened plant species • QE2 covenants >180,000ha, average size 40ha, but median is 5.8ha. • low native cover in urban area; increases out to 20km	• Clearance rates decreased but pressure and severity of impact increased. • Legacy effects especially where habitat type is <10% of area. • Habitat isolation and fragmentation • Novel species assemblages • Lack of ecological knowledge and acceptance • Varied values, human-wildlife conflicts	Nothing noted.	Monitoring issues: • Tier 1 monitoring: misses significant and nationally iconic ecosystems and has uncertain link to management action. Tier 2 is better but significant gaps/variations between regions. • Only 150/3000 threatened species monitored • Resource consent/RMA monitoring and enforcement is poor. • Incentives for private protection insufficient/under resourced. • Lack of connectivity with QE2 covenants. • Variable monitoring and controls in place	• Community monitoring and citizen science need co-ordination and standardisation and to be used more • Region scale action best. Different regions and cities will have different solutions. • Need regional restoration plans to coordinate action. • Urban restoration is key due to population density (+engagement & resourcing) – e.g., 28000 plants planted in 3 hours • Aspiration target of at least 10% with structural requirements/criteria to where e.g. not fragmented. • Priority for action: ecosystems less than 10% with following outcomes / tools: buffering, linking, corridors, stepping stones – "reassemble". • Monitoring: standardised and universal approach. • Connectivity is a key outcome: starting opportunity is connecting QE2 areas. • Aligned oceans management and governance. • Consistent SOE monitoring and reporting

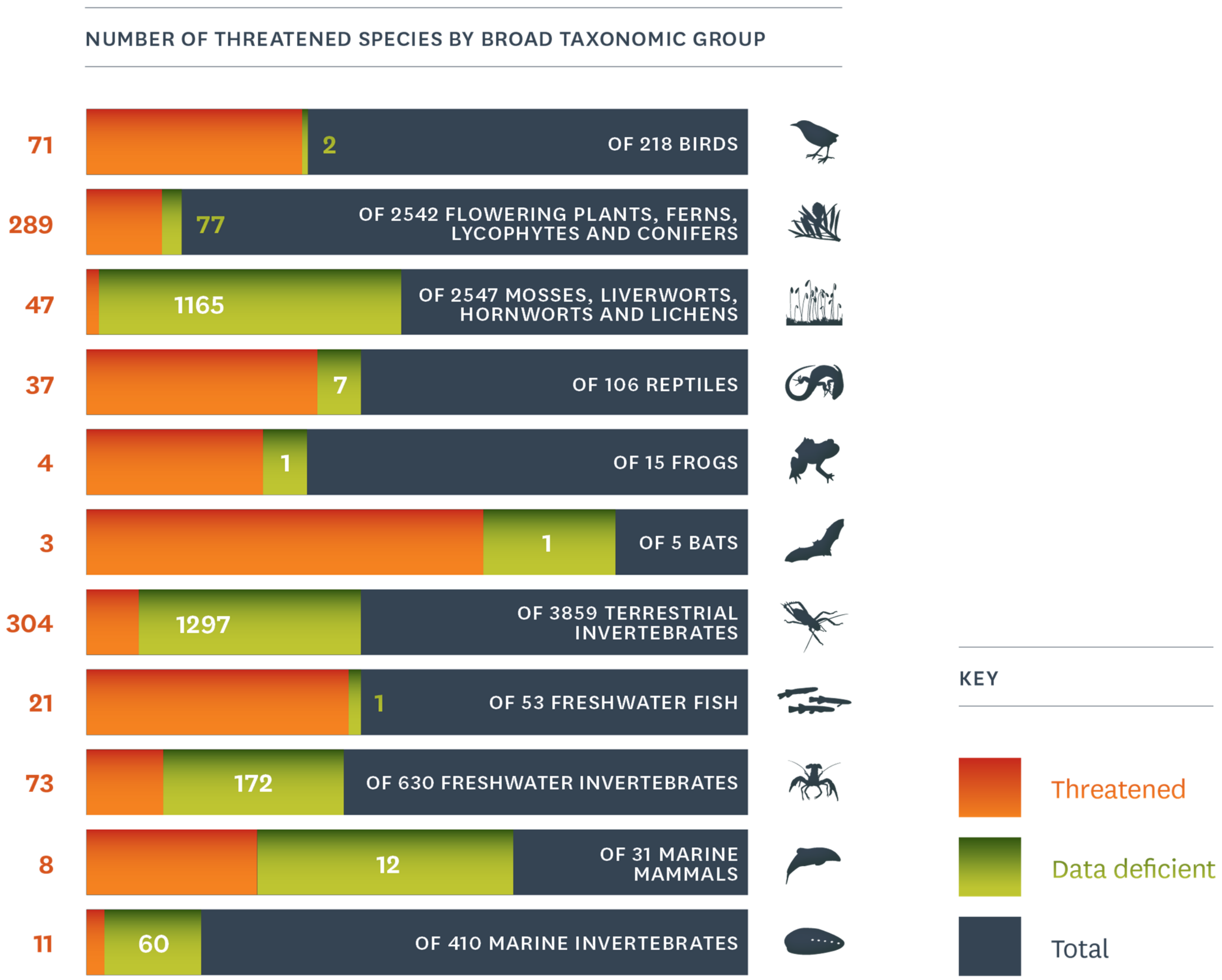


Figure 1. Number of threatened species by taxonomic group (Source: Environment Aotearoa, Ministry for the Environment / Statistics NZ, 2015)

Biodiversity: Supporting Information. E. McGruddy (FFNZ). Dec 2017

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
Review of Environment Aotearoa 2015 • Major indigenous landcover is broadly stable, < 1% change • No baseline for assessing contemporary trends of "naturally uncommon ecosystems" • Widespread forest trees are "doing OK" • Plants "in some trouble" are generally in non-forest communities • Native or recently self-introduced birds or birds of open habitats are "doing ok" e.g., tui • Other endemic birds are in "some trouble", e.g., kereru • Groups which are in "serious trouble" are mainly the deep endemic (ancient) species, eg, kiwi, wrybill • Populations of most native fish (diadromous species) are "doing ok"; the non-migratory galaxiids centred on the ancient Otago peneplain and recently identified as distinct species are in "serious trouble" • Exotic grassland declined by 175,000 hectares (-1.6%)	• Greatest single threat to terrestrial and freshwater ecosystems is from invasive introduced species (NZ Biodiversity Strategy 2000) - incontrovertible in respect of bird species; and well-supported in respect of critical and declining fish species • Wilding conifers are considered "enemy number one" for weeds (NZ Biodiversity Action Plan (2016-2020)) • Damage from introduced browsers (deer, goats, possums) is less of an issue in current times • Most vulnerable native plants, eg, small turf plants, may only survive or thrive with active management of the more vigorous introduced species • Systematic management of all major pressures (browsers, predators, weeds etc) more effective than removal of just one or two pest species • Connectivity between habitat patches may be hindered not only by structural barriers but	• For wetlands and sand-dunes, naturally uncommon ecosystems, work is in train to clarify extent of recent change • For the conservation estate, DOC been working towards prioritising Ecological Management Units, integrating species and ecosystem management in prioritised areas • For the private estate, DOC/MfE developed a Statement of National Priorities in 2007 to help align partnership investments, ie, to focus conservation efforts where the need is greatest. Predictably, the Statement highlighted non-forest systems (wetlands, sand-dunes, naturally uncommon ecosystems) but these categories are very broad, and little further work has been	• Relationship between intensification opportunities/implications for indigenous vegetation • Drivers behind indigenous cover changes in key regions • Mapping of naturally uncommon ecosystems and threatened plants • Reasons for "genuinely worse" status of threatened plants • Extent to which indigenous fish are prioritised within DOC EMUs, and/or within national priority places • Locations of priority ecosystems for legal protection and/or active management. • Understanding of collaboration of effort • "Major research issues to be resolved to determine the circumstances where comparing different versions of the LCDB is fit for purpose as a tool to estimate biodiversity loss" (LCR, 2016).	NPS and complementary measures should be • strongly informed by national strategy and prioritised places • strongly linked to central and regional government financial and operational resources and commitments • strongly emphasise the partnership principle Biodiversity strategies should operate across tenures – with DOC lead partner on the conservation estate, landowners lead partner on the private estate, and Regional Councils lead partner on coordinating integrated public/private operational projects Priority places (or special or significant places) should be spatially mapped. Need strategic coherence across related areas of government policy Need more fine-grained information to support cost-benefit analysis of a range of options before landing

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
• Urban land increased by 20,000 hectares (+10%) • Exotic forest increased by over 200,000 hectares (+11%) • No contemporary national trend data for wetlands is currently available. Some wetland types (eg, pākihi-gumland) may have increased in extent. • High level of legal protection for wetlands: 70% of all wetlands >100ha, and 30% of all wetlands <100ha are held in DOC or other conservation tenure. over 60% of wetlands have legal protection (Robertson, 2015) Of 800 "threatened" species: • 12 improved, 8 were birds (due to active management, ie, predator control and/or island translocations) • 60 worsened, 30 were plants (work in train to clarify reasons), 11 were birds, and 8 were fish (mainly non-migratory galaxiids) • For the balance – over 700 threatened species – no discernible recent trends reported The NZ Biodiversity Strategy noted that widespread clearance of native vegetation has stopped	also by the presence of invasive species	undertaken in the succeeding ten years to finetune these very broad "priorities".	• Anthropogenic v. non-anthropogenic causes of deforestation • National data on contemporary state and trends for non-forest ecosystems is very limited • Although conventional wisdom is that NZ is suffering ongoing and serious decline in biodiversity, there is actually a paucity of credible, comprehensive, "state and condition" data at the national or regional scales to support that assertion. Lacking a platform for open access to a comprehensive set of biodiversity information. (Enfocus, 2017)	recommendations for priorities, targets or methods • National priorities for an extended network of legally protected sites on private land with funding increased (or re-aligned) • National priorities for active management of ecosystems on private land, eg, finetuning/ mapping the naturally uncommon ecosystems, with partnership funding • National priorities for active revegetation/re-introduction/restoration on private land, eg, using a range of classification system overlays to identify "hotspot" opportunities for restoration • Active management of introduced plants/weeds may be required to maintain and/or restore threatened plants/uncommon ecosystems

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
Review of Landcare Research reports (Allen et al. 2013; Bellingham et al. 2014): • No native trees or shrubs known to have suffered extinction • Very little if any evidence that populations of common tree species are failing to regenerate, but also little change in the populations of these trees • Over the last 50 years, the area dominated by native woody species has increased				

Our Land 2018. MfE and Statistics NZ. April 2018.

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
1996-2012 • Net loss of 71,000 hectares of indigenous land cover: 31,000 hectares of tussock grassland (decr. 1.3%), 24,000 hectares of indigenous shrubland (decr. 1.3%), and 16,000 hectares of indigenous forests (decr. <1%), through clearance, conversion, and development. Although these areas represent a small proportion of each cover type, the ongoing loss continues to threaten indigenous biodiversity • Coastal and lowland ecosystems that were once widespread (including wetlands) continue to decline in extent • Wetlands have been reduced from around 2,470,000 hectares to around 250,000 hectares, and continue to decline in extent • 2001 and 2016: 214 wetlands (~ 1,250 hectares) were lost, with a further 746 wetlands declining in size. Canterbury (231 wetlands), West Coast (135 wetlands), Southland (97 wetlands), and Auckland (94 wetlands) lost or reduced (assessment did not capture new wetlands or any increases in extent). Vast majority of smaller wetlands, which contribute to the full diversity of lowland ecosystems in New Zealand, are on private land surrounded by agricultural landscapes	• Sand dunes: planting of marram grass to stabilise shifting sands for coastal development and farming, and the planting of radiata pine for commercial forestry • Habitat fragmentation creating habitat edges more vulnerable to pests, weeds, and disease • Impacts of pests, weeds, and disease vary across the country, for different ecosystems and different species • Predatory animals are a major cause of species decline • Possums are the major cause of declines in distribution canopy species (pōhutukawa, Hall's tōtara, kāmahi, māhoe, tawa, and rātā) and some smaller understory vegetation (such as patē, heketara) • More trees that are palatable to possums and goats are dying than are being replaced • Disease (e.g, Myrtle rust and Kauri dieback) • In Nelson Lakes National Park, several common and widespread indigenous bird species (bellbird, rifleman, grey warbler, New Zealand tomtit, and tūī) declined over a 30-year monitoring period. These	Nothing noted.	• Lacking a nationally agreed, quantitative, and scalable ecosystem classification and integrated national level monitoring system, to allow consistent assessment of state and risk at ecosystem level. • Limited information on the condition of the full range of indigenous ecosystems. Need better information to assess improvements, degradation, stability and changes in ecosystem processes. • Lacking a measure of habitat fragmentation and its impacts • Conservation status: We require more comprehensive information on the taxonomy, ecology, distribution, and abundance of some species (particularly invertebrates) to robustly assess their conservation status. We currently do not have information to assign a conservation status to 28 percent (2,440 taxa) of assessed terrestrial taxa. Threat: We lack a clear understanding of the distribution, abundance, density, and impacts of pests and weeds, particularly at finer scales.	Nothing noted.

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
• 2/3 of rare and naturally uncommon ecosystems are threatened • 83% (285 of 344 taxa) of indigenous terrestrial vertebrates are threatened or at risk of extinction • Most (see Table 3) reptiles and frogs (85 percent or 103 taxa), most bats (83 percent or five taxa), and most birds (82 percent or 177 taxa) were classified as threatened or at risk of extinction. Over one-third of plants, including vascular plants, mosses, hornworts, and liverworts (37 percent or 1,232 taxa) were threatened or at risk of extinction. These include many of New Zealand's culturally important and taonga birds (eg kākāpō, rock wren, fairy tern, and hoiho/yellowed-eyed penguin) and plants (eg Barlett's rātā and ngutukākā (kākā beak)) • Since humans arrived, at least 76 of our land species have become extinct: 59 bird, 8 plant, 2 reptile, 3 frog, and 4 insect species • Conservation status is worsening for 7 bird species, 3 gecko species, and 1 species of weta • Conservation status is improving for 20 bird species. More than half of these are dependent on intensive conservation management • Sand dunes declined in area by 80 percent between the 1950s and 2008, from around 129,000 hectares to 25,000 hectares	declines were attributed to the arrival of common wasps, which added to the existing impacts of rat and stoat predation • Many species are at risk because they are 'naturally uncommon', meaning they have a small population size and/or restricted geographic range (particularly snails, earthworms, spiders, and insects). • Wetlands: continued pressure from surrounding land use, including drainage, nutrient enrichment and pollution, grazing, and the impact of invasive weeds (eg exotic willows) and animals (eg koi carp		We are also limited in our understanding of diseases and pathogens, their taxonomy and origins, and factors that determine their spread and impacts. Better information would support understanding of where the greatest pressures are on our ecosystems, and their relative risks. • Many unknowns about diseases and pathogens. It can be difficult to identify which pathogens are causing a disease, whether a pathogen is indigenous or exotic, and to understand the source and spread of pathogens • We do not have enough information to assess the conservation status of more than one-quarter (28 percent or 2,440 taxa) of terrestrial taxa that have been considered by the New Zealand Threat Classification System, particularly invertebrates • No coordinated national approach exists to monitor and report on the ecological condition of wetlands in New Zealand, except for recent developments in mapping changes in wetland extent	

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
• 2013-2016: indigenous bird species outnumbered exotic bird species on 96 percent (739 of 771) of forested sites compared with 75 percent (223 of 298 sites) of non-forested sites distributed across public conservation land • Data indicates a strong connection between wetland loss and a decline in wetland condition • Australasian bittern is now threatened – nationally critical and faces an immediate high risk of extinction due to observed declines				

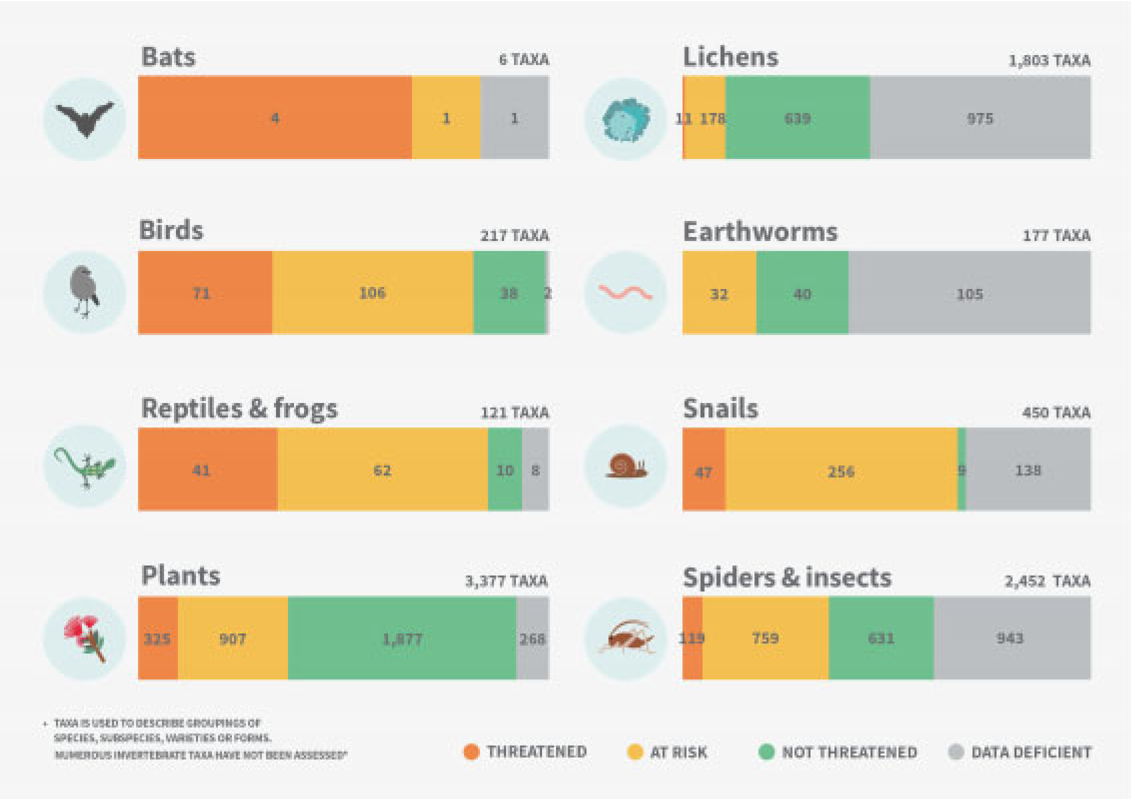


Figure 2. Conservation status of assessed land taxa by taxonomic group (Source: Our Land, Ministry for the Environment / Statistics NZ, 2018)

Critical factors to maintain biodiversity: what effects must be avoided, remediated or mitigated to halt biodiversity loss? Manaaki Whenua Landcare Research. May 2018.

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
New Zealand's indigenous biodiversity continues to decline despite documented intentions to maintain it (DOC & MfE 2000; DOC 2016). • 45 of 71 of naturally uncommon ecosystems classified as threatened (18 critically endangered, 17 endangered, 10 vulnerable). • 40% of known taxa of plants[8], 80% of freshwater fish, and 90% of lizards and birds[9] that are not already extinct are Threatened or At Risk. Many large invertebrates also threatened (e.g. snails, wētā). Threat status is known for only the most easily observed and best-known biotic groups, so it is likely that other less well-known groups (e.g. fungi) are also in serious decline.	The degradation and loss of ecosystems and species habitats occurs through: • direct clearance (e.g. clearing of indigenous vegetation for urban development and agricultural and forestry production, damming of rivers, drainage of wetlands) • modification of critical ecosystem properties and drivers as a result of a very wide variety of activities and agents • competition from and resource capture by invasive species • Small mammal predators • Climate change. Biodiversity will not be maintained if irreversible – and therefore permanent – adverse effects on it continue. Biodiversity decline will not be halted if adverse effects that occur today are not remediated until sometime in the future. This is because: • even genuinely temporary effects result in interim ecosystem or habitat loss and interruption of ecological	Nothing noted.	• Focus of report is on new activities but states: decline is unlikely to be halted if only new pressures and activities are avoided, because it can take time for the adverse effects on biodiversity of ongoing and legacy activities to be fully realised. Furthermore, loss or decline as a consequence of invasive species or climate change will not necessarily be prevented by avoiding effects now, although maintaining habitat will buffer some of their inevitable impacts.	To maintain indigenous biodiversity it will be necessary to prevent irreversible reductions in the extent and quality of ecosystems and the habitats of indigenous species. Limits on habitat clearance and other activities that alter the properties and processes of ecosystems and habitats of indigenous species must therefore be a central component of policies intended to prevent further loss of biodiversity. *See tables in Manaaki Whenua Landcare Research Report*. Table A. Avoid: effects that are irreversible (loss is permanent or feasibility of full replacement within 25 years is low) on biodiversity features that are much reduced, threatened or at risk. Table B. Avoid if the effect cannot be fully remedied: effects are potentially reversible or the biodiversity feature is neither much-reduced nor at risk of extinction presently. We assume that for features in this category: i there will need to be an ecological assessment of the feasibility and probability of complete remediation within 25 years ii if complete remediation is improbable (which may be the case in a high

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
	processes that can have permanent consequences • as the length of time taken for restoration or remediation increases there is greater likelihood that adverse effects will be permanent, cumulative, or both, and eventual restoration (even if feasible) becomes more uncertain as responsibility for achieving restoration is passed to future generations, who may have different priorities (including coping with the effects of global warming), and different legal and regulatory frameworks. Many of New Zealand's remaining indigenous ecosystems and species habitats now cannot be replaced or re-created once lost to development, and it is not possible to remedy many forms of degradation within 25 years or even considerably longer timeframes.			proportion of the features in this category), Avoid would apply.

Habitats

Freshwater

Introductory reading: State, trends, pressures and values [Freshwater parts]. Report. MfE, March 2017.

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
• 72% of indigenous freshwater fish at risk or threatened with extinction (risk of extinction worsened for 8 of these species between 2005 and 2011) • Diversity of Indigenous fish species declined 1970-2007 • Many freshwater fish have localised distributions so at risk from ecosystem degradation or loss.	• Freshwater fish subject to larger impacts and rates of decline because they primarily occur outside protected areas • Freshwater habitat loss and modification still occurring, esp. in urban and agricultural areas. • Water allocation increased 50%, 1999-2006 • Total nitrogen levels in rivers increased 12%, 1989-2013, increasing periphyton • Nitrogen harmful to fish, but <1 % of monitored river sites have nitrate-nitrogen levels high enough to affect growth of fish species. However, sediment having impact on fish • 32% of monitored river sites currently have enough dissolved phosphorus to trigger nuisance periphyton growth. Phosphorus levels have increased in large rivers between 1989 and 2013, while levels have generally decreased in a broader sample of rivers between 1994 and 2013. • Agricultural land surrounds 46% of New Zealand's rivers, and estimated amounts of nitrogen leached into soil from agriculture have increased by 29% between 1990 and 2012. • Climate change likely to be biggest impact, eg, death of cold water-adapted freshwater fish and invertebrates	Nothing noted.	Nothing noted.	Nothing noted.

Summary on freshwater biodiversity and NPSFM. PowerPoint presentation and report. Kate McArthur (Catalyst). April 2017.

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
• Habitats for adult species and spawning of freshwater fish are in decline or degraded • Increase in number of species threatened	• Vegetation clearance in estuarine and riparian margins, earthworks, stock trampling and sedimentation • Excessive periphyton smothering habitat and affecting DO and pH • Fish barriers inhibiting / preventing lifecycle process of migratory fish	• NPSFM attributes addressing ecosystem health • MCI now in NPSFM • Fish barrier guidelines recently released	• Disjointed approach to freshwater and coastal management and regulation • Disjointed approach to fisheries management and regulation • Disjointed regulation of fish barriers • Disjointed approach to freshwater and natural character/landscape management and regulation • Planning gaps – Estuaries (gap between NPSFM and NZCPS) – Feeding and spawning habitat – Missing NOF attributes in NPSFM – Identification of areas of significance (SEAs)	• Additional attributes in NPSFM NOF, e.g., re habitat • Acknowledgement of threatened & vulnerable species and habitats and key habitat function • Address gaps in current legislation re connections, spawning, feeding areas by covering: – estuaries – fish barriers – setbacks – improved and standardised monitoring • SEA criteria • Use Environment Canterbury's (Land and Water Plan Change 4) īnanga spawning habitat model, and associated rules on stock exclusion, land disturbance and earthworks

Freshwater Biodiversity – Issues and management needs. PowerPoint presentation and report. David West, Paula Warren and Natasha Grainger (DOC) with input from Evan Harrison and Lauren Long (MfE). October 2017.

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
• Most lowland freshwater ecosystem types are extinct or threatened. • Ecosystems within protected areas at top of catchments are stable or slow deterioration. • Where land uses are intensifying, deterioration is often rapid, and complete loss of ecological integrity is a high risk. • Most lowland aquatic species facing increasing loss of habitat extent and quality.	• Most freshwater ecosystem values are more affected by direct human impacts (e.g. drainage, pollution) than introduced species • Slipping baselines • Land use change that affects hydrology and diffuse discharges • Abstraction, piping, channelization, reclamation etc. • Changes in connectivity • Logging, burning, grazing • Fish harvesting • Diseases • Loss of spawning sites • Species dependent on a threatened ecosystem type likely to be threatened with extinction. • Introduced species • Real or perceived problems in management of eeling and whitebaiting	• Preventing threats from operating (biosecurity controls, legal protection of waterbody, rules in RMA plans, fencing etc) • Restoration • Replacement (of limited value due to difficulty) • Clean up programmes • Some freshwater sites being restored by communities • Freshwater Fisheries Regulations under review • Fish Passage Advisory Group • Species recovery programmes • management of eeling and whitebaiting, being assessed by MPI and DOC	• Failures in management of cumulative impacts • Focus on water quantity and quality, not on waterbody physical form or ecosystem features • Difficulties reversing loss • Poor understanding of freshwater systems • Lack of ongoing representative biodiversity monitoring • Poor use and difficulty of using biosecurity tools; lack of public awareness; deliberate breaches • Difficulties with legal protection of waterbodies and adjacent land • few tools to help design restoration programmes; recover species • focus on wrong issues • WCOs only relate to the water itself, not catchment effects • Heritage orders not used	NPSFM: • Inclusion of wetlands and fish habitat in the NOF • Guidance on "significant values of wetlands" • Guidance on "outstanding waterbodies" • Guidance on where specific values are located and key parameters of the waterbody that need to be managed to maintain those values • National direction on matters such as channelization, alteration of banks, catchment vegetation, gravel extraction, etc • Better management of data and modelling • tools to develop cost-effective regional planning rules, and most cost-effective restoration activities • development, compilation and dissemination of best practice in restoration and waterbody management • legal protection levels, stock exclusion, public access, and

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
			• RMA plans generally not used to manage landuses that affect waterbodies; District plans do, but don't tackle cumulative effects • Lag time for NPSFM implementation (and doesn't address habitat effects) • Lack of active enforcement of Freshwater Fisheries Regulations 1983 • difficulties of wetland restoration within large catchments • little success at catchment scale restoration	support for community restoration • funding for smaller restoration projects • Biosecurity Act pathway plans to address key freshwater risks

Biodiversity: Supporting Information (Freshwater parts). E. McGruddy (FFNZ). Dec 2017

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
Populations of most native fish (diadromous species) are “doing ok”; the non-migratory galaxiids centred on the ancient Otago peneplain and recently identified as distinct species are in “serious trouble”. Majority of the threatened species occur in Canterbury and Otago (non-migratory galaxiids) Of 50 resident native fish, 40% (21 species) are threatened 2009-13 (change in status): • Critical 4 to 5 • Endangered 3 to 6 • Vulnerable 7 to 10 2005-11: 8 species worse (non-migratory galaxiids, plus Canterbury mudfish). Longfin eel: period of decline from the early 1990s to the late 2000s, followed by relatively stable abundance (Haro et al, 2015). • 1977-2015: All species with increasing trends were native, and all species with decreasing trends were exotic (Crow et al, 2016)	• 9 fish species, 11 invertebrate species and 41 plant species as pests of greatest concern (EA2015) • Key pressure being introduced predatory fish and mammalian predators	Nothing noted.	• Longfin eel: Further development is required before the adequacy and relevance of the results for management of the stock can be evaluated • lacking integration of the different information sources • lacking integration on state, trends and pressures on native fish	Key management action is maintaining barriers to trout passage

Wetlands

Introductory reading: State, trends, pressures and values (Wetlands parts]. Report. MfE, March 2017.

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
• Wetlands: 10 % of their original extent. • Wetland losses are continuing to occur.	• Wetlands - lowest levels in areas characterised by land favoured for agriculture e.g. the Waikato region. In Taranaki 63 small freshwater wetlands were drained between 1995 and 2013, in Waikato 600 ha of freshwater wetland were drained between 1995 and 2002 (Myers et al., 2013). In Southland, around 10% of wetlands on private land have been lost in the last 7 years. Remaining freshwater wetlands are heavily fragmented, and often in poor condition. Small remnants can be biodiversity cores for restoration.	Nothing noted.	Nothing noted.	Nothing noted.

Wetland extent. Handout. Landcare. 24 May 2017

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
		• Two contemporary databases map wetland extent at the national level: the Land Cover Database (LCDB) and Waters of National Importance (WONI). • WONI has the richer description. WONI depicts both pre-human and contemporary (c2003) wetland extent in a classification supported by a comprehensive set of evidential data.	• Mapping and monitoring wetland extent is critically impaired by the disconnection between national and regional databases, and the lack of regular updating to support national reporting. • WONI and LCDB have different wetland extents, exposing a potential for contradictory statistics	• Considerable value could be realised (at nominal cost) by reconciling differences between WONI and LCDB such that LCDB became the vehicle for updating WONI, and by strengthening the relationship of regional databases with WONI so that local detail could enrich the national databases.

Wetland Policy in NZ – are current approaches working? Report and presentation. Paper by S Myers presented by Jo Burton & Helli Ward, MFE. 14 February 2018.

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
• A review of current wetland management approaches in New Zealand including rules in regional and district plans restricting ecologically damaging activities in wetlands. • Wetland loss in NZ has been more significant than in many other parts of the world, and ecosystems in the fertile lowlands have been the most severely impacted.	• Majority of lowland wetlands are on private land and many are small (many plans allow clearance of smaller wetlands, e.g. up to 1000m2) • Half of regional plans don't have strong regulation for wetland drainage.	Nothing noted.	Nothing noted.	• NPS bottom lines for preventing drainage and modification of wetlands • Baseline for protection of diversity of wetlands • Mix of statutory and non-statutory methods • Monitoring of effectiveness • Better monitoring of wetland extent and condition • Continued restoration of wetlands and development of best practice. • Identification of wetlands on private land in partnership with communities and landowners • Resources for voluntary protection

Report on the implementation of the Ramsar Convention on Wetlands, NZ Government, 2018. Jo Burton & Helli Ward, MFE. 14 February 2018.

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
The condition of wetlands during the last triennium: • a) Ramsar Sites – no change • b) wetlands generally – status deteriorated • Wetland extent has greatly reduced since human arrival in New Zealand and losses continue. For example, a report published by Environment Southland (2016) reported that over 1200 ha of wetlands were lost between 2007 and 2015 in Southland, equivalent to a 10% loss in the Southland study area since 2007 • ¾ of fish, 1/3 of invertebrates, and 1/3 of wetland plants are threatened with, or at risk of, extinction.	• Complexity of wetland planning and management being under the jurisdiction of several agencies. • Urban and primary sector development have created legacy issues that need to be addressed by long term planning and management of wetlands • introduced mammals, fish, plants, invertebrates and other exotic life forms, including microbes	• National Wetland Inventory: (FENZ) geodatabase of inland palustrine wetlands, rivers/streams and lakes consists of a large set of spatial data layers and supporting information on New Zealand's rivers, lakes and wetlands. • Geospatial mapping of coastal wetlands, including their environmental values, has also been compiled as part of an inventory of New Zealand Coastal Hydrosystems and associated coastal classification framework (Hume et al. 2016). • A draft Communication, Education, Participation and Awareness (CEPA) Action Plan has been prepared to provide a national framework for coordinated delivery of wetland CEPA in New Zealand. It sets out actions and priorities for the next 10 years, identifying who might lead the action and who the target audience is. It covers all five components of CEPA with the overall strategic intent of empowering people to take action for wetlands. • New national guidelines to the assessment of potential Ramsar Sites in New Zealand being developed • Freshwater Improvement Fund, Arawai Kākāriki and Living Water • NPS for Indigenous Biodiversity to be developed • Wetland issues/benefits been incorporated into all national strategies and planning processes except urban development • More than 100 wetland dependent species (including river, lake, estuary, and wetland species) are currently targeted in large-scale control and surveillance programmes	• The National Wetland Inventory has not been updated in the last decade • Quantity and quality of water available to, and required by, wetlands has only been partially assessed	• Better tools and cost-effective approaches to reduce the impact of invasive species • Need a national inventory of invasive alien species that currently or potentially impact the ecological character of wetlands • Implement incentive measures and remove perverse incentive measures which discourage conservation and wise use of wetlands

Our Land 2018 (Wetlands parts]. Report. MfE and Statistics NZ, 2018

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
• Wetlands have been reduced from around 2,470,000 hectares to around 250,000 hectares, and continue to decline in extent • 2001 and 2016: 214 wetlands (~ 1,250 hectares) were lost, with a further 746 wetlands declining in size. Canterbury (231 wetlands), West Coast (135 wetlands), Southland (97 wetlands), and Auckland (94 wetlands) lost or reduced (assessment did not capture new wetlands or any increases in extent). • Data indicates a strong connection between wetland loss and a decline in wetland condition • Australasian bittern is now threatened – nationally critical and faces an immediate high risk of extinction due to observed declines	• Vast majority of smaller wetlands, which contribute to the full diversity of lowland ecosystems in New Zealand, are on private land surrounded by agricultural landscapes • Wetlands are under continued pressure from surrounding land use, including drainage, nutrient enrichment and pollution, grazing, and the impact of invasive weeds (eg exotic willows) and animals (eg koi carp)	Nothing noted.	• No coordinated national approach exists to monitor and report on the ecological condition of wetlands in New Zealand, except for recent developments in mapping changes in wetland extent	Nothing noted.

Biodiversity: Supporting Information (re Wetlands). E. McGruddy (FFNZ). Dec 2017

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
Drawing on Robertson, 2015 • Wetland loss was most significant during early European settlement, then another phase post the world wars • Some wetland types (eg, pākihi-gumland) may have increased[40] in extent whereas others diminished • High level of legal protection for wetlands: 70% of all wetlands >100ha, and 30% of all wetlands <100ha are held in DOC or other conservation tenure. • Over 60% of wetlands have legal protection	Nothing noted.	Nothing noted.	• Limited contemporary data on national state and trends	Nothing noted.

[40] Note that Robertson (2015) states the extent of some wetland types, e.g., pākihi-gumland, under DOC protection has increased, but not the extent of wetlands themselves.

Uncommon ecosystems and depleted environments

Naturally uncommon ecosystems. Handout. Landcare Research 24 May 2017.

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
Mostly small (<1 to 1000 ha), non-forested, support unique biodiversity. 18 (40 percent) are critically endangered • Coastal • Geothermal • Induced by native vertebrates • Inland and alpine • Subterranean or semi-subterranean • Wetlands.	Nothing noted.	DOC and Landcare Research are mapping. 34 have been mapped	Nothing noted.	Naturally uncommon ecosystems are recognised by DOC and MfE as national priorities for protecting rare and threatened native biodiversity on private land.

Restoration targets for biodiversity depleted environments in New Zealand. Bruce Clarkson. March 2018

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
• Urban centres have resulted in significant depletion of the indigenous biodiversity of the lowland zone and sixty acutely threated environments are represented within urban and peri-urban zones; • There is significant potential to contribute to protection, restoration and reconstruction of indigenous habitat within urban centres; • When ecosystem cover declines below 10%, an increasingly large proportion of biodiversity is lost; • Reconstruction of indigenous habitat is needed in all biodiversity depleted environments (< 10 % cover) in New Zealand if indigenous biota is to persist; • Ecosystem representation, species occupancy and spatial configuration (including isolation, connectivity) need to be considered at a range of scales in designing optimal interconnected networks for restoring indigenous biodiversity; • Considerations other than ecological are important in selling the concept of protecting our unique biological heritage.	Nothing noted.	Nothing noted.	Nothing noted.	• Accept and promulgate a minimum 10% indigenous target for depleted ecosystems in district and other plans; • Develop regional scale restoration plans addressing issues of spatial configuration and connectivity radiating out from urban centres and other depleted environments; • Monitor progress and restoration practice towards reaching the targets; • Adjust and adapt restoration plans in light of the monitoring and management results

Biodiversity: Supporting Information (re Uncommon Ecosystems). E. McGruddy (FFNZ). Dec 2017

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
• Landcare Research compiled a list of 72 "rare" ecosystems based on literature and discussions with ecologists (Williams et al, 2007) • Naturally uncommon ecosystems contain 145 (85%) of mainland threatened plant species…66 (46%) of which are confined to naturally uncommon ecosystems (Wiser et al, 2013)	Nothing noted.	Nothing noted.	• Data on current distributions of NZs naturally uncommon ecosystems and their current rates of change in area are scarce	Main suggestions referenced: • most threatened ecosystem types must be identified • further quantitative data are collected to test and improve the accuracy of the threat assessment • greatest conservation gains are likely to be obtained by concentrating conservation efforts on those most critically threatened

Biodiversity on private land

DoC's role on private land. Presentation and PowerPoint. Peter Brunt (DoC). 25 May 2017.

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
• 30% of NZ's land area is public conservation land (but not 30% of representative ecosystems) • Significant number of representative ecosystems and threatened species on private land • Trends are not necessarily certain e.g. climate change, land use choices, lag effects	• Legacy effects • Introduced species • Societal expansion and development • Habitat loss and fragmentation mostly in lowland and coastal areas • Some ecosystems and threatened species (esp. plants) will only be retained if managed on private land	• Trend towards landscape, place-based solutions across environments • Number of tools available and being used to differing extents: regulation, partnerships, community groups.	• Missing strategy to tie tools together • RMA tools not being used effectively e.g. spatial planning. • How to connect biodiversity with other objectives, e.g., urban development • Where to direction action • Difficulty of imposing on property rights • Inconsistency in classification, monitoring, implementation • How to prioritise, e.g., ecosystem v species	• Mandate DOC's development of a private land strategy • Define the roles of central and local govt • Looking to the Environment Act and the Conservation Act as well as the RMA

Species

Indigenous birds

Introductory reading: State, trends, pressures and values (re Birds). MfE. March 2017)

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
• 1/4 of the world's seabird species breed in NZ, and almost 10 % breed only in our marine environment. • 90% of indigenous seabird species and subspecies that breed in New Zealand are threatened or at risk of extinction; risk has increased for eight of the 92 seabird species since 2005	• Climate change likely to be biggest impact eg, flooding may increase egg/chick mortality for braided-river birds;	Nothing noted.	Nothing noted.	Nothing noted.

Threat classification and prioritisation (re Birds). Presentation and PowerPoint. Fiona Carswell (Landcare Research). 25 May 2017

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
• 71/218 native birds threatened	Nothing noted.	Nothing noted.	Nothing noted.	• Achieving healthy bird populations requires: large and connected habitat, rapid population growth (supported by food, predator control, and quality habitat), strong genetics.

Taonga of an island nation – Saving New Zealand's birds. Jan Wright (PCE) 30 August 2017

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter

• In serious trouble 32% • In some trouble 48% • Doing OK 20% • "Only 20% - one in every five - is in good shape. And one in every three is not far off from following the moa and many others into extinction. The situation is desperate" • Only 13% of the endemic birds are doing OK and 45% are in serious trouble • Three endemic birds have increased their ranges over the last few decades: tui, piwakawaka/fantail and riroriro/grey warbler	• Safety from predators is the most urgent	Nothing noted.	Nothing noted.	Goal: Restoring abundant, diverse, resilient birdlife on the mainland. Required: • Safety from predators • Somewhere to live - habitat • Genetic diversity - resilience Methods: • Predator Free 2050 plan • Predator research • Breakthrough genetic science • Habitat • Genetic diversity – resilience • Funding • Community groups

Biodiversity: Supporting Information (re Birds). E. McGruddy (FFNZ). Dec 2017

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
• Native or recently self-introduced birds or birds of open habitats "doing ok" e.g., tui • Other endemic birds are in "some trouble", e.g., kereru • Groups which are in "serious trouble" are mainly the deep endemic (ancient) species, eg, kiwi, wrybill • Of 400 living bird taxa, of which just under 20% (77) are assessed as "threatened" (DOC, 2013) PCE 2017: • "Only 20% - one in every five - is in good shape. And one in every three is not far off from following the moa and many others into extinction. The situation is desperate" • Only 13% of the endemic birds are doing OK and 45% are in serious trouble • Three endemic birds have increased their ranges over the last few decades: tui, piwakawaka/fantail and riroriro/grey warbler • Between 2008-2012, 8 species genuinely improved through active management; 11 species genuinely worsened	• Main pressure is mammalian predators (number of reports referenced) • Weed invasions are a serious threat to river birds (DOC, 2016) • Landuse in the catchments of braided rivers potentially impacts on habitats of threatened species, especially as intensification increases. (DOC, 2016)	Nothing noted.	• No research conducted in NZ to determine what the precise impacts of land use changes in braided river habitats would be on the viability of threatened species populations	The key management action is predator control (plus weed control in the braided rivers) Multi-species pest control in large areas with existing habitat and extant threatened species – potentially episodic control in the South Island, but sustained control in the North Island Restoration of viable endemic forest bird populations through predator management is more likely to be successful in large, continuous tracts of forest.

Environmental Reporting on land, coastal and marine biodiversity (re Birds). Presentation/ PowerPoint. Fiona Hodge & Pierre Tellier (MfE) 28 June 2017

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
• 2005-2011: – extinction risk worsened for 11 birds – risk improved for 8 birds • > 80% birds threatened or at risk of extinction • Many of our (known) marine species are at risk of extinction • 28% of marine mammals are threatened • 90% of seabirds threatened or at risk of extinction • 86% of shorebirds threatened or at risk of extinction • 2008-14, risk of extinction worsened for 8 seabirds; risk improved for 1 seabird and 1 marine mammal	• Terrestrial: Land use conversion is the key threat to indigenous cover. • Freshwater: land use impacts, sedimentation, barriers to fish passage, riparian habitat loss, introduced species. • Possums, rats and stoats in 94% of NZ; feral goats 30% and red deer 57% • Marine: habitat loss, pests & weeds, climate change (also overfishing). • More exotic plant species than indigenous plant species	• Protection focused on areas where humans haven't developed; now some ecosystems have minimal or no protection.	• Marine data gaps: 1/3 marine mammal species assessed for conservation status are data deficient	• Should prioritise by analysis of which ecosystems have been most heavily lost & which have the least representation on public conservation land. • Outcomes that should be sought: resilience, integrity, connections. • Should avoid fragmentation, loss of extent, loss of condition of threatened areas in particular.

Off-site Whio Mitigation. Genesis Energy. 26 October 2017

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
• < 3,000 left (cf. Kiwi ~ 70,000)	• Rivers utilised by the Tongariro Power Scheme have some of the most important populations in the country • Whio population declined due to reduced natural flow • Risk of ongoing population collapse on Tongariro as a result of volcanic activity	TPS Whio Mitigation (minimum flows, periphyton/invertebrate monitoring, whio monitoring, offsite mitigations, predator control): • population increase from 85 to >500 in ten years • Increased productivity (fewer single males) • 20% increase in the national Whio population in 10 years	Nothing noted.	Nothing noted.

Indigenous plants

Introductory reading: State, trends, pressures and values [re Plants]. Report. MfE. March 2017.

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
• Rate of loss of indigenous forests has slowed, but not stopped. • 1996-2012 – 10,000 ha of indigenous forest lost. Worst in lowlands where 57% of threatened plant species grow • 1990 2008: – 70,000 hectares indigenous grassland in SI converted to pasture • 2008-2012: Manuka/kanuka (10, 865 ha) and tall tussock grassland (8, 400 ha) greatest net losses. • Loss of naturally uncommon ecosystems where many threatened plant species grow is continuing. Almost two-thirds (45) of the rare ecosystems are also classified as threatened under the IUCN red-list criteria. Of these, 18 (40 %) are critically endangered	• Growth, development and land conversion – Urbanisation – Rural land use change (area of pastoral farming remained relatively stable 1996-2012 but intensification has occurred) – Infrastructure projects • Pest plants and animals • Direct human impacts - recreation, tourism, off-road vehicles and tramping threaten 12 of 18 critically endangered terrestrial ecosystems; tourism increases the chances of pests and disease • Climate change likely to be biggest impact, e.g., degradation of the alpine zone; • Risk that long lag times means negative impacts of human activities not apparent until too late	• Formal protection of high altitude grasslands has increased since 2000 as a result of the tenure review of high country leases. • Low to mid altitude systems are poorly protected and are undergoing rapid land transformation	Nothing noted.	Nothing noted.

Threat classification and prioritisation [re Plants]. Presentation and PowerPoint. Fiona Carswell (Landcare Research). 25 May 2017.

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
• 80% vascular plants are endemic Threatened: • 289/2542 flowering plants/ferns • 47/2547 mosses etc. (another 11065 data deficient) 1996-2012 land cover decline: indigenous forest, broadleaved indigenous hardwoods, tussock grassland, exotic grassland, scrub. Biggest increases in exotic forest, urban, cropping/hort.	6 key pressures: • introduced predators • herbivores • weeds • land use • illegal activities • industrialisation Also, pressure to provide opportunity to offset/compensate for loss but some effects cannot be offset or compensated e.g. very rare places.	• Number of classification systems can be used to generate pictorial images of current, past, future state. E.g LENZ map – PAN-NZ map = TEC map.	• Data from multiple sources (e.g. citizen science) is not standardised so compilation and use is difficult.	• Need standardised methods for monitoring that can be used across professional and citizen science actions. • Achieving healthy bird populations requires large and connected habitat, rapid population growth (supported by food, predator control, and quality habitat), and strong genetics. • Need a robust process and guidance around offsetting/compensation

Environmental Reporting on land, coastal and marine biodiversity [re Plants]. Presentation and PowerPoint. Fiona Hodge & Pierre Tellier (MfE). 28 June 2017

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter

Environment Aotearoa 2015:
• ~ 40% of vascular plants threatened or at risk of extinction
• Most land environments < than 10% of indigenous cover
• 46% land environments < 20% of indigenous cover
• Most threatened indigenous environments are coastal, wetland and lowland areas
• 1996 -2012:
  – ~ 10,000 (0.08%) hectares indigenous forest lost
  – 97,110ha increase in agriculture, forestry, and urban
	• Land use conversion is the key threat to indigenous cover.
	• Also possums, feral goats and red deer
	• More exotic plant species than indigenous plant species
		• Protection focused on areas where humans haven't developed; now some ecosystems have minimal or no protection.	Nothing noted.	• Should prioritise by analysis of which ecosystems have been most heavily lost & which have the least representation on public conservation land.
				• Outcomes that should be sought: resilience, integrity, connections.
				• Should avoid fragmentation, loss of extent, loss of condition of threatened areas in particular.

Biodiversity issues and solutions [re Plants]. Presentation and PowerPoint. Bruce Clarkson (University of Waikato). 28 June 2017

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
• Rare ecosystems contain 50% of NZ's threatened plant species	• Clearance rates decreased but pressure and severity of impact increased. • Legacy effects especially where habitat type is <10% of area. • Habitat isolation and fragmentation • Novel species assemblages	Nothing noted.	Monitoring issues: • Tier 1 monitoring: misses significant and nationally iconic ecosystems and has uncertain link to management action. Tier 2 is better but significant gaps/variations between regions. • Only 150/3000 threatened species monitored • Resource consent/RMA monitoring and enforcement is poor.	• Community monitoring and citizen science need co-ordination and standardisation and to be used more • Region scale action best. Different regions and cities will have different solutions. • Need regional restoration plans to coordinate action. • Urban restoration is key due to population density (+engagement & resourcing) – e.g., 28000 plants planted in 3 hours

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
	• Lack of ecological knowledge and acceptance • Varied values, human-wildlife conflicts		• Incentives for private protection insufficient/under resourced. • Lack of connectivity with QE2 covenants. • Variable monitoring and controls in place	• Aspiration target of at least 10% with structural requirements/criteria to where e.g. not fragmented. • Priority for action: ecosystems less than 10% with following outcomes / tools: buffering, linking, corridors, stepping stones – “reassemble”. • Monitoring: standardised and universal approach. • Connectivity is a key outcome: starting opportunity is connecting QE2 areas. • Aligned oceans management and governance. • Consistent SOE monitoring and reporting

Biodiversity: Supporting Information (re Plants). E. McGruddy (FFNZ). Dec 2017

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
• No native trees or shrubs known to have suffered extinction • Very little if any evidence that populations of common tree species are failing to regenerate, but also little change in the populations of these trees • Over the last 50 years, the area dominated by native woody species has increased Review of Landcare Research reports (Allen et al. 2013; Bellingham et al. 2014): • No forest species are known to have become extinct in NZ	• Wilding conifers are considered “enemy number one” for weeds (NZ Biodiversity Action Plan (2016-2020)) • Damage from introduced browsers (deer, goats, possums) is less of an issue in current times • Most vulnerable native plants, eg, small turf plants, may only survive or thrive with active	• For wetlands and sand-dunes, naturally uncommon ecosystems, work is in train to clarify extent of recent change • For the conservation estate, DOC been working towards prioritising Ecological Management Units, integrating species and ecosystem	• No explanations are provided for the changes to plants (DOC, 2013) • Drivers behind indigenous cover changes in key regions • Mapping of naturally uncommon ecosystems and threatened plants • Reasons for “genuinely worse” status of threatened plants	• Ordering (and mapping) to illuminate patterns and priorities and the extent to which priority threatened plants correlate with the priority “uncommon ecosystems” • Understand the extent to which threatened plants are located on private land • National priorities for an extended network of legally protected sites on private

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
• Populations of widespread forest trees are generally stable. • Threatened plant lists are dominated by non-forest plants; and a high level of overlap with uncommon ecosystems Change in plant threat status (from EA 2015) • Critical: 141 to 155 • Endangered: 55 to 62 • Vulnerable: 47 to 72 Some plants may be on the brink of extinction (De Lange et al, 2010). 20% threatened plants are found only on private land, while a further 60% occur on both public and private land, albeit with many having their largest populations on private land (Norton and Miller, 2000) • Major indigenous landcover is broadly stable, < 1% change • No baseline for assessing contemporary trends of "naturally uncommon ecosystems" • Widespread forest trees are "doing OK" • Plants "in some trouble" are generally in non-forest communities 2008-2012, of 800 "threatened" species: • 60 worsened, 30 were plants (work in train to clarify reasons) • For the balance – over 700 threatened species – no discernible recent trends reported	management of the more vigorous introduced species • Connectivity between habitat patches may be hindered not only by structural barriers but also by the presence of invasive species	management in prioritised areas • For the private estate, DOC/MfE developed a Statement of National Priorities in 2007 to help align partnership investments, ie, to focus conservation efforts where the need is greatest. Predictably, the Statement highlighted non-forest systems (wetlands, sand-dunes, naturally uncommon ecosystems) but these categories are very broad, and little further work has been undertaken in the succeeding ten years to finetune these very broad "priorities".	• "Major research issues to be resolved to determine the circumstances where comparing different versions of the LCDB is fit for purpose as a tool to estimate biodiversity loss" (LCR, 2016). • Anthropogenic v. non-anthropogenic causes of deforestation • National data on contemporary state and trends for non-forest ecosystems is very limited • Lacking a platform for open access to a comprehensive set of biodiversity information.	land with funding increased (or re-aligned) • National priorities for active management of ecosystems on private land, eg, finetuning/ mapping the naturally uncommon ecosystems, with partnership funding • National priorities for active revegetation/re-introduction/restoration on private land, eg, using a range of classification system overlays to identify "hotspot" opportunities for restoration • Active management of introduced plants/weeds may be required to maintain and/or restore threatened plants/uncommon ecosystems

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
The NZ Biodiversity Strategy noted that widespread clearance of native vegetation has stopped				

Bats

New Zealand Bats – An Overview. Paper. NZ Bat Conservation Network, August, 2018.

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
Long and short-tailed bats were once common and regularly seen by early European settlers. The greater short-tailed bat is probably extinct although some hope it remains on an island off Stewart Island. Short-tailed bats need large areas of old growth native forest but have been found in exotic pine plantations in the central North Island. The isolated populations that remain today are now found mainly on Public Conservation Land including two predator free islands (Te Hauturu-o-Toi/Little Barrier and Whenua Hou/Codfish Islands) and as such have protection from their major threats. The long-tailed bat however lives in much smaller social groups (20-100 bats) and can survive in fragmented landscapes in native and non-native forests. Long-tailed bats are found on a mixture of public and private land and have even been found in Auckland and Hamilton cities. Therefore,	Introduction of predators - rats, stoats, cats, possums as well as loss of habitat has had a devastating effect.	Nothing noted.	Long-tailed bats can be very long lived (>20 years) which means that there may appear to be a viable population of bats but demographics (i.e. the age and sex-ratio) can mean they suddenly disappear. They are slow breeding and have one pup a year, so they are slow to recover from population declines. They have very large home range requirements (110km²) and individuals can fly up to 35 km in a night. Any predator control therefore needs to be landscape wide and cover the roosting and foraging areas. Adult female bats congregate in maternity colonies every year to have their young. They choose specific trees to roost. They usually avoid roosting under bark and in caves and buildings. This means that tree removal can potentially take out a whole colony. They move roosts almost every night, so each colony needs a lot of suitable trees. The trees are not selected randomly – they tend to select the largest and oldest trees in the	See Work flowchart for NZ bat management in NZ Bat Conservation Network Report. Identifying roost areas is the key to understanding how to manage colonies. This process takes time. Development projects need to know where the maternity roosts. Even the smallest development project can have a devastating effect on colonies and cause local extinction. Removal of trees can include loss of critically important breeding trees (whether occupied or not at the time of felling), killing or injuring individual bats while felling trees, disturbance of bats and loss of feeding habitat.

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
management of the species is complicated and challenging.			landscape meaning that the availability of suitable trees is limited. They will not just move to another random tree if disturbed. Use of sub-optimal roosts leads to reduced breeding success. It is therefore very important to conserve traditional roost sites and reducing the number of roosts is likely to have negative impacts on population viability	Long-tailed bats cannot be translocated at present. Long-tailed bats have a strong homing ability, so translocations are likely to be unsuccessful. It is therefore better to manage current populations.

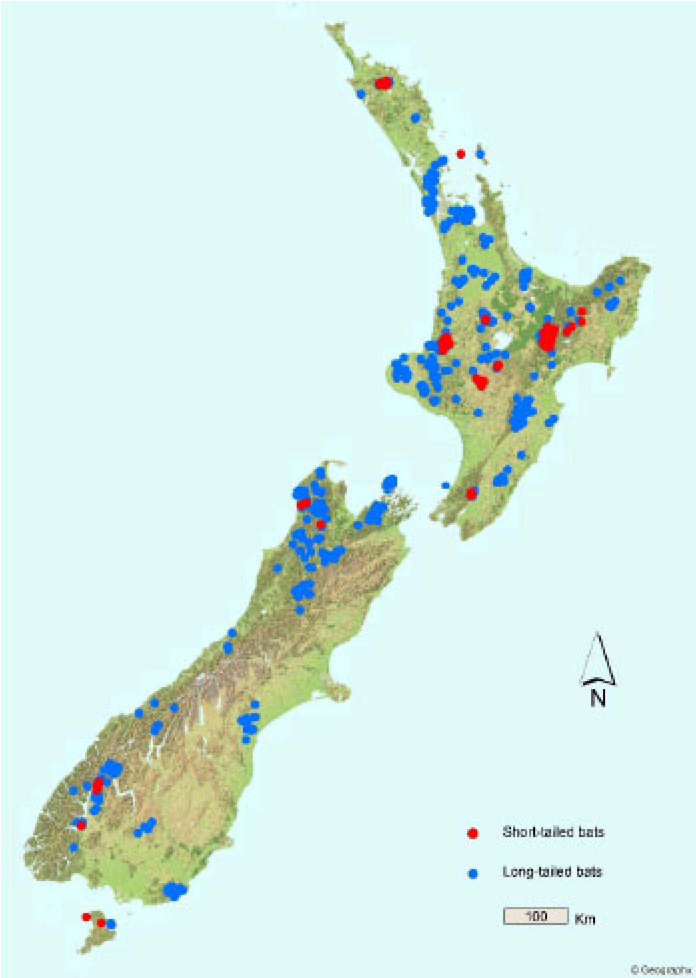


Figure 3. Known Presence of Bats in New Zealand (Source: NZ Bat Conservation Network, 2018).

Landcover, ownership and threatened environments

Analysis from data on land ownership, land cover, and the Threatened Environments Classification. Report. MfE, August 2018.

State & Trend	Pressures	Current actions	Gaps and Issues Raised	Solutions suggested by author / presenter
• As a proportion of total land area, General land and Māori Land Court Land both have the highest proportions of indigenous forest from the acutely threatened environments (0.5% of land area) which are those areas with less than 10% indigenous cover left. • There is also a higher proportion of indigenous forest that is chronically threatened (10-20% cover left) and at risk (20-30% cover left) on Māori Land Court Land (1.8% and 3.1% of land area respectively) than general land (0.6% and 1.1% of land area respectively).	• Māori landowners would be inequitably disadvantaged if less threatened types of forest (10-20% cover left and 20-30% cover left) were also to have increased protection • Regarding **indigenous scrub/shrubland** in environments that have less than 10% remaining, there is a four times greater proportion of this cover in general and Māori Land Court land than in other land ownership types.	Nothing noted.	Nothing noted.	Avoid temporary or permanent fragmentation, reduction in size, and/or degradation of the ecological integrity of indigenous vegetation in land environments with less than 20% indigenous cover remaining (pages 25–26 of the report). The total area of indigenous cover in this type of land environment is 513,705 hectares (2% of New Zealand's land area).

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Prepared for the Bay of Plenty Regional Council

Final report, forming delivery for Milestone 2A, 2B, 2C & 2D

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Executive summary

The purpose of this report is to present an assessment of the farm/orchard-gate economic impact of applying a range of mitigation practices to reduce losses of nitrogen, phosphorus, *E. coli* and sediment. The effectiveness of these practices in reducing losses of nitrogen, phosphorus and agricultural greenhouse gas emissions across various land uses, as estimated in OVERSEER, is also presented. The aim of this study is to support freshwater planning for the Rangitāiki and Kaituna-Pongakawa-Waitahanui Water Management Areas (WMAs), as part of the Bay of Plenty Regional Council's Plan Change 12 process.

There is a separate bio-physical catchment model (eSOURCE) developed to support this process, which estimates contaminant losses and resulting water quality outcomes in a greater level of detail. The contaminant losses reported in this document will not be used directly in the bio-physical model, although they may help to determine the level of effectiveness of different mitigation practices.

Following on from the evaluation of mitigation practices and preliminary bundling work, baseline (M0) system models were created from which to assess the economic impact of implementing the mitigations on representative farm and orchard systems in the Kaituna-Pongakawa-Waitahanui and Rangitāiki WMAs. The modelled systems comprised six pastoral dairy farm, four pastoral sheep, beef & deer farm, a single arable farm system and two kiwifruit (green & gold) systems. Two forestry systems were also modelled, but primarily to establish a basis for the impact of their adoption by landowners as a partial mitigation practice on suitable land.

The pastoral and arable systems were all modelled in Farmax Pro[1] software to generate status quo production models, while the permanent crop systems (kiwifruit and forestry) were modelled in Excel. Revenue and expense assumptions used to reflect medium term expectations for the relevant sectors. All of the analysed farm and orchard systems were modelled in OVERSEER 6.3.0[2] to estimate baseline N, P and biological greenhouse gas emissions (methane and nitrous oxide).

With the cost analysis of mitigation of sediment and other freshwater contaminants in the Rangitāiki and Kaituna-Pongakawa-Waitahanui WMAs primarily focussed on the "cost" [to profit] of applying mitigations *within* land use sectors, operating profit was determined as being the best KPI to utilise.

For this analysis, earnings before interest and tax (EBIT) was chosen as the preferred measure to allow consistency in the calculation of profitability between the pastoral, arable and permanent cropping land uses. In all instances, the cost of all the labour necessary within the land uses was accounted for by way of direct wages or salaries or as contracted inputs. All farm and orchard systems were assumed to be at status quo (with no impact on profitability via changes in feed or livestock inventory) and land rental (if any) was considered a finance cost and excluded.

The originally proposed mitigation bundles M1 through M3 had been refined via the community and stakeholder consultation process but underwent some slight further refinement as a result of preliminary modelling.

Sequential Farmax (and Excel) and OVERSEER models were then created to represent implementation of the mitigations in each bundle (if applicable to the farm system) in line with

[1] http://www.farmax.co.nz/
[2] https://www.overseer.org.nz/

standardized modelling protocols. At each modelling step, the farm models were adjusted to ensure the farm and orchard systems remained feasible. Any efficiency gains in the farm/orchard systems were limited to those created by the mitigations themselves, rather than via an improvement in farm management capability. Where a mitigation was not applicable for a given farm system, then it was not considered.

The outputs (physical and financial) from the farm systems from each sequential change were recorded to allow abatement curves of the mitigations to be created and to calculate the aggregated cost of each mitigation bundle when applied to each farm system.

When applied to the dairy farm systems, the bundles resulted in economic impacts broadly in line with cost expectations. For the non-dairy pastoral farm systems, some reallocation of mitigations to bundles is required due to the fact that some mitigations were not economically feasible.

As modelled, most of the proposed individual mitigations had relatively modest impacts on annual farm system profitability when considered as isolated practices. However, there were some key mitigation practices that had significant impacts on farm system profitability. This was similarly observed for N, P and GHG losses (as estimated by OVERSEER) albeit often for different practices.

For the dairy farm systems, the most-costly mitigations were:

- Development of stand-off pad infrastructure;
- Wetland developments;
- Creation of lined effluent storage;
- Substitution of autumn N fertiliser with supplementary feeds; and
- Reducing feed imported in the autumn.

On average, full adoption of the mitigation bundles (M1 through M3) on the dairy farm systems modelled reduced N losses by 44%, P losses by 21% and GHG losses by 17% - all for a reduction in profitability by 35%.

For the drystock farm systems, the most-costly mitigations were:

- Conversion of steep land to forestry (incorporating a conservative assumption on forestry revenues but excluding carbon);
- Wetland development;
- Elimination of N fertiliser that supported capital (breeding) livestock;
- Incorporation of low N forages into the farm system; and
- Gorse management.

Full adoption of the mitigation bundles (M1 through M3) on the drystock farm systems modelled reduced N losses between 14% and 35%, P losses between 0% and 38% and GHG losses between 8% and 34%. Profitability reduces between 53% and 183% from the current profits. Compared to dairy farm systems, the sheep, beef and deer farms are substantially affected by bundle implementation, particularly in the Kaituna-Pongakawa-Waitahanui WMA.

However, a special comment regarding the use of forestry as a mitigation is warranted here. The efficacy of forestry as a mitigation on steeper soils is more dependent on the "income" from the forested area rather than the cost of afforestation itself. While we are cognisant that we have used a very low annual "income" of $200/ha to represent the annual income stream from forestry over time, it is clear that using a figure closer to the equivalent annuity associated with forestry land use (see Appendix 5 and Appendix 6) has a significant impact on lowering the cost of mitigation.

Forestry has an opportunity to be a cost-effective tool for improving water quality where a longer-term view of returns can be made. Of course, the challenge of addressing land-owner's concerns about "how do I get enough income to live off if I change land use away from livestock farming to forestry?" is very real and not one that will easily be resolved.

For the arable farm system, the costliest mitigation was reducing N fertiliser inputs (which resulted in significant yield loss). For the orchards, converting the pasture into the vine canopies added significant per hectare costs, which are associated with mechanical pasture control beneath the vines.

Some of the mitigation, in addition to the impacts on farm operating profitability, had initial capital costs. For example, the net capital cost to fully implement through to M3 was in the vicinity of $369,000 ($3,000/ha) for non-irrigated dairy farms, $636,000 ($5,400/ha) for irrigated dairy farms and $394,000 for the sheep, beef and deer farms (c. $1,000/ha). In contrast, the capital costs of implantation were low for the arable and kiwifruit models, which are assessed at $14,000 ($350/ha) and $3,000 ($750/ha) respectively.

Some amendments to the mitigations in the bundles are probably warranted based on the analysis, as is more work on addressing the contrast and tensions between the cashflow impacts and the potential longer-term value uplift from using partial land-use change to forestry as a mitigation.

Table 1 overleaf summarises the results of the analysis for the different farming/growing systems and mitigation bundles.

Table 1: Summary of the cumulative impact of the mitigation bundles to the analysed farm and orchard systems

Land use	System	EBIT ($/ha/year)				N loss (kg/ha/year)				P loss (kg/ha/year)			
		Base	M1	M2	M3	Base	M1	M2	M3	Base	M1	M2	M3
Dairy	Lower KPW	1,983	1,970	1,852	1,506	51	38	31	23	3.4	2.8	2.7	2.6
	Mid KPW	1,413	1,328	1,287	843	54	40	40	32	1.4	1.3	1.3	1.2
	Upper KPW	1,115	933	922	529	68	49	55	30	4.0	3.4	3.2	3.1
	Lower Rangitāiki	2,582	2,490	2,462	1,958	67	49	49	36	1.2	1.1	1.1	1.0
	Mid-Upper Rangitāiki (irrigated)	2,121	2,118	2,026	1,489	62	49	48	35	1.1	1.0	0.9	0.9
	Mid-Upper Rangitāiki (unirrigated)	1,689	1,679	1,579	1,075	53	40	39	30	0.9	0.7	0.7	0.7
Drystock	KPW Dairy Support	421	310	96	10	28	28	22	18	2.0	1.8	1.2	1.2
	KPW Sheep & Beef	133	26	-75	-112	25	25	19	17	2.7	2.2	1.7	1.7
	Rangitāiki Sheep & Beef	219	138	112	90	36	35	33	31	1.0	0.94	0.91	0.9
	Rangitāiki Deer	229	148	126	64	25	25	24	22	1.2	1.1	1.1	1.1
Arable	KPW Maize	2,345	2,192	1,383	1,298	63	57	63	59	2.4	2.2	2.4	2.3
Kiwifruit	Gold	78,400	76,533	76,495		23	21	21		0.5	0.5	0.5	
	Green	19,500	17,608	17,570		19	18	16		0.5	0.5	0.5	
Forestry	Pinus radiata	530				2.5				0.1			
	Mānuka	130				3				0.1			

N and P loss figures as assessed by OVERSEER v6.3.0

1 Overview

A list of 42 rural land use management and land use change mitigations had been evaluated for their effectiveness and cost to the farm or orchard system in order to develop mitigation bundles for use in evaluating the cost of improving water quality in the Kaituna-Pongakawa-Waitahanui and Rangitāiki WMAs.

As reported in an earlier document (1A milestone v1.3 report), a cumulative three-layer framework, was developed to bundle the mitigations. However, in this case, bundles were primarily determined based on cost at the farm gate, filtered for effectiveness at reducing contaminant losses. These mitigation strategy bundles, designed to be applied cumulatively to farm and orchard systems, are:

(i) M1: low barrier to adoption; primarily defined by being of low cost (equivalent to less than 10% of Earnings Before Interest and Tax [EBIT]) with at least a low effectiveness for reducing contaminant/s in comparison to other bundles;
(ii) M2: moderate barrier to adoption; primarily defined by direct costs and/or reduced revenue equivalent to more than 10% but less than 25% of EBIT with a medium effectiveness for the targeted contaminant/s in contrast to M1 and M3;
(iii) M3: high barrier to adoption, primarily defined by significant reductions in pre-mitigation profitability (i.e. reduction in >25% of EBIT) and high effectiveness at contaminant reduction than the other mitigation bundles.

Total land use change mitigations were considered as a separate bundle (M4) and excluded from consideration. Existing current (baseline) practices were considered as M0.

The original bundles were evaluated at community group and separate industry meetings. The final list of bundles was compiled by the project management team for modelling the farm economic impact for the ten pastoral, two horticultural and one arable farm economic models developed for the two water management areas of interest.

In reaching these final bundles, it is important to highlight a number of the long list of specific mitigations that were invariably excluded from this analysis due to a lack of sufficient data of their impact on contaminant load to water. However, these mitigations have some promise with regards to cost-effectively lowering the loss of N, P, sediment and/or bacteria to water from our farm and orchard systems. These included:

- the "Spikey' technology;
- introduction of dung beetles to pastoral systems.

The final bundles for each of the land use types are presented in Table 2 through Table 5 below.

Table 2: Dairy farm system mitigation bundles

Bundle	Order	Mitigation
M0		Full stock exclusion from all waterways greater than 1m wide at any point adjacent to dairy farm (including drains) and wetlands
		[Paddock rotation and responsible break-feeding, some level of effluent management, current irrigation practice]
		Complete protection of gully heads
M1	1	Placement of feeding equipment
	2	Timing of effluent application in line with soil moisture levels (assumes sufficient storage)
	3	Reduced tillage practices
	4	Improved nutrient budgeting and maintenance of optimal Olsen P
	5	Laneway run-off diversion
	6	Grow maize on effluent blocks (if already growing maize)
	7	*Elimination of summer cropping*
	8	Reductions in seasonal stocking rate
	9	Efficient fertiliser use technology
	10	Efficient irrigation practices (soil moisture monitoring)
	11	Use of plant growth regulators [to replace N]
	12	Adoption of low N leaching forages
	13	Relocation of troughs
	14	Slow release phosphorus fertiliser RPR
	15	Reduce autumn N application - replace with appropriate low(er) N feed
	16	3m average vegetated and managed buffer around rivers, streams, lakes and wetlands subject to the Dairy Accord; 1m around drains; 5m average buffer on slopes between 8 and 16 degrees, 10m average buffer on slopes above 16 degrees
M2	1	Increase effluent application area
	2	Develop a detention bund
	3	Controlled grazing with stand-off pads (16 hours per day on pad in autumn), if they already have a stand-off pand
	4	Installing variable rate irrigators on existing pivot irrigators
	5	Reduce imported autumn supplement fed by 20%
	6	Reducing fertiliser N use (to 100kg N/ha)
	7	Full stock exclusion from permanently flowing waterbodies less than 1m wide (REC Order 2 and above) and average 2m vegetated and managed buffer; 3m average buffer on slopes between 8 and 16 degrees, 7m average buffer on slopes above 16 degrees
M3	1	Afforestation of erosion prone land (e.g. >26 degrees)
	2	Stock excluded from REC Order 1 watercourses less than 1m wide and 1m wide average vegetated buffer
	3	Impervious effluent storage and sufficient capacity to comply with soil moisture guidelines and low rate effluent application
	4	Restricted grazing in covered stand-off pad, with use extended to winter as well
	5	Put in standoff pad if they haven't got one and use for 16 hours per day in autumn
	6	Switching from manual (e.g. K-line) to pivot irrigators with variable rate irrigators – irrigated dairy farms with manual irrigation systems only
	7	Creation of new wetlands
	8	Reducing stocking rates down by 0.3 cows/ha

Table 3: Drystock farm system mitigation bundles

Bundle	Order	Mitigation
M1	1	Improved nutrient budgeting and maintenance of optimal Olsen P
	2	Efficient fertiliser use technology
	3	Stock class management within landscape
	4	Adopt M1 arable cultivation practices for winter cropping
	5	Laneway run-off diversion
	6	Relocation of troughs
	7	Appropriate gate, track and race placement, design (where possible)
	8	Targeted space planting of poles
	9	Slow release phosphorus fertiliser RPR
	10	Adoption of low N leaching forages
	11	Full stock exclusion from all waterbodies greater than 1m wide at any point adjacent to farm (including drains) and wetlands. 2m average vegetated and managed buffer around rivers, streams, lakes and wetlands; 1m around drains; 3m average buffer on slopes greater than 8 degrees; 5m average buffer on slopes greater than 16 degrees.
M2	1	Eliminate N that supports capital livestock
	2	Detention bunds
	3	Complete protection of gully heads
	4	Management of gorse
	5	Whole paddock space planting of poles
	6	Full stock exclusion from permanently flowing waterbodies less than 1m wide (REC Order 2 and above) and 1m average vegetated and managed buffer; 2m average buffer on slopes greater than 8 degrees, 3m average buffer on slopes greater than 16 degrees [with associated stock water reticulation, if any].
	7	Convert steep land (e.g. LUC class 7-8, >26 degrees) into forestry/mānuka and fenced
	8	Changing stock ratios to reflect lower N leaching potential
M3	1	Full stock exclusion from REC Order 1 watercourses less than 1m wide and 1m wide average vegetated buffer.
	2	Creation of new wetlands
	3	Eliminate N that supports trading livestock

Table 4: Arable farm system mitigation bundles

Bundle	Order	Mitigation
M1	1	Grass or planted buffer strips
	2	Complete protection of existing wetlands
	3	Maintain optimal Olsen P
	4	Efficient fertiliser use and technology
	5	Cover crops between cultivation cycles
	6	Manage risk from contouring
	7	Reduced tillage practices
M2	1	Use of silt fencing
	2	Complete protection of gully heads -N/A
	3	Reducing fertiliser N use
	4	Strip tillage
M3	1	Creation of new wetlands
	2	Sediment traps

Table 5: Kiwifruit orchard system mitigation bundles

Bundle	Order	Mitigation
M1	1	Complete protection of existing wetlands
	2	Maintain optimal Olsen P
	3	Laneway run-off diversion
	4	Efficient fertiliser use and technology
	5	Efficient irrigation practices (soil moisture monitoring, not following fertiliser application)
	6	Grass swards under canopy, minimise bare ground and vegetated buffers around waterways.
M2	1	Detention bunds in gullies (assuming gullies occur in kiwifruit properties, perhaps mid KPW?)

It is important to note that not all of the mitigation practices in each bundle apply to every farming/growing system for the various land uses. Table 6 below shows which practices apply each farming/growing system.

Table 6: Application of mitigation practices to the farm and orchard models

		Dairy						Drystock				Arable	Kiwifruit	
		Lower KPW	Mid KPW	Upper KPW	Lower Rangitāiki	Mid-Upper Rangitāiki (irrigated)	Mid-Upper Rangitāiki (unirrigated)	KPW Dairy Support	KPW Sheep & Beef	Rangitāiki Sheep & Beef	Rangitāiki Deer		Gold	Green
M1	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	✓	✓
	3	×	×	×	×	×	×	✓	✓	✓	✓	×	✓	✓
	4	✓	✓	✓	✓	✓	✓	×	×	✓	✓	✓	✓	✓
	5	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	✓	✓	✓
	6	×	×	×	×	×	×	✓	✓	✓	✓	×	✓	✓
	7	Excluded						✓	✓	✓	×	✓		
	8	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
	9	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
	10	×	×	×	×	✓	×	✓	✓	✓	✓			
	11	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
	12	✓	✓	✓	✓	✓	✓							
	13	✓	✓	✓	✓	✓	✓							
	14	✓	✓	✓	✓	✓	✓							
	15	✓	✓	✓	✓	✓	✓							
	16	✓	✓	✓	✓	✓	✓							
M2	1	✓	✓	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	✓
	2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×		
	3	✓	×	×	×	×	×	✓	✓	×	×	✓		
	4	×	×	×	×	×	×	✓	✓	×	×	Excl.		
	5	✓	✓	✓	✓	✓	✓	✓	✓	×	×			
	6	✓	×	×	×	×	×	✓	✓	✓	✓			
	7	✓	✓	✓	✓	✓	✓	✓	✓	✓	×			
	8							×	✓	✓	×			
M3	1	✓	✓	✓	×	✓	✓	✓	✓	✓	✓	✓		
	2	×	✓	✓	×	✓	✓	✓	✓	✓	✓	✓		
	3	✓	✓	✓	✓	✓	✓	✓	×	✓	✓			
	4	✓	×	×	×	×	×							
	5	×	✓	✓	✓	✓	✓							
	6	×	×	×	×	✓	×							
	7	✓	✓	✓	✓	✓	✓							
	8	✓	✓	✓	✓	✓	✓							

2 Methodology

2.1 Description of economic and physical analysis modelling

Baseline (M0) system models were created for the six pastoral dairy, four pastoral sheep, beef and deer and a single arable representative farms, two kiwifruit orchards and two forestry systems in Farmax and/or Excel and OVERSEER 6.3.0 software.

Sequential Farmax and OVERSEER models were created to represent implementation of the mitigations in each bundle (if applicable to the farm system) in line with the modelling protocols outlined in Appendix 8 to Appendix 11. In cases where the economic impact of the mitigation was unable to be modelled in Farmax (i.e. capital expenditure), Excel models were used.

2.1.1 Farm system modelling

The pastoral and arable systems were modelled in Farmax Pro software to generate status quo production models. The financial modelling capability within the Farmax software was utilised to generate the financial outputs, with revenue and expense assumptions used to reflect medium term expectations for the relevant sectors.

2.1.2 Orchard and forestry modelling

The permanent crop systems (kiwifruit and forestry) were financially modelled in Excel. The P. radiata and mānuka modelling was undertaken to assist the analysis of when forestry was applied as a mitigation practice for the pastoral land uses. No mitigation modelling on forestry practices themselves (with regard to lowering impacts on water quality) was undertaken.

2.1.3 OVERSEER modelling

All of the analysed pastoral and arable farm and horticultural systems were modelled in OVERSEER 6.3.0 to estimate baseline N, P and biological greenhouse gas emissions (methane and nitrous oxide).

All of the systems were modelled according to the OVERSEER Best Practice Data Entry Standards (with the exception of constructed wetlands) and the additional requirements of the Bay of Plenty Regional Council. Geophysical inputs (climate data and soil type) were generated based on GPS coordinates for each farm systems, utilising the climate station tool in OVERSEER and S-map soil data.

Constructed wetlands were modelled in OVERSEER using the Wetland model, which is currently under review. This is a departure from the recently released OVERSEER 6.3.0 data input standards, which recommends wetland areas are input as Riparian blocks. The use of the Wetland model in this analysis (and associated input assumptions as presented in Appendix 8 to Appendix 10) generates greater estimate in reductions of N losses to water than from the Riparian model.

2.1.4 Mitigation bundle modelling

Mitigations were applied sequentially i.e. mitigation M1.1 was applied to the M0 model, then renamed and saved as M1.1. The M1.2 mitigation was then applied to the M1.1 model, renamed, saved and so on. At each step, the farm models were adjusted to ensure agronomic feasibility in line with a static management capability horizon. Where a mitigation was not applicable for a given farm system, then it was missed out.

The impact of capital expenditure associated with mitigations was accounted for by the adjustment to calculated EBIT the corresponding opportunity cost of capital and increases to depreciation (for infrastructure assets). Where capital in livestock was realized through reductions in stocking rate, the capital benefit of this was also accounted for. The economic value of mitigation options was accounted for as the change from the economic value without the mitigation option (i.e. the net change in economic value from the baseline situation with introducing mitigation option). This reflects the economic benefits (e.g. forestry) and costs of mitigations.

The modelled outputs (physical and financial) from the farm systems from each sequential change were recorded to allow abatement curves of the mitigations to be created and to calculate the aggregated cost of each mitigation bundle when applied to each farm system. These are the following:

- Physical production (i.e. kg MS, kg saleable product)
- N fertilizer inputs
- N losses to water
- Biological greenhouse gas emissions
- P losses to water
- Percentage change in operating profit
- Capital movements

2.2 Limitations of the approach

While OVERSEER is generally accepted as a reliable indicator of N and biological greenhouse gas emissions from pastoral and arable systems, P loss estimates from OVERSEER don't account for the spatial connectivity of critical source areas in the way that other models can and estimates of sediment and *E. coli* loss are absent in the model.

As a result, the analysis undertaken for this report likely underestimates the impact that mitigations could have on P losses and is unable to quantify the impact that any of the mitigations have on sediment and bacterial losses. Estimates of sediment and bacterial losses are expected to be derived from the BOPRC's concurrent study to this on bio-physical catchment modelling (eSOURCE).

OVERSEER estimates of N losses from horticultural production are potentially less reliable than those estimated from the pastoral and arable systems due to more limited due to the extremely limited amount of direct measurement of N losses to water from orchards (Benge & Clothier 2016), the results of this singular study being described as highly variable (New Zealand Kiwifruit Book 2017). In the interests of consistency, we have reported on these nonetheless recognising that estimates of N losses from kiwifruit orchards using SPASMO (Soil Plant Atmosphere System Model) are not dissimilar to those generated from OVERSEER (Benge & Clothier 2016, McIntosh 2009). However, we note that "a new Zespri-funded project being undertaken by Plant & Food Research has just commenced to measure N losses from orchards and to eco-verify kiwifruit practices". It is also important to note that there is general acceptance that kiwifruit will have a significantly lower N loss footprint to water than dairying.

2.3 Choice of financial KPIs

The choice of the financial KPIs to model in farm or property scale analyses such as these is often contentious, and the preferred measure tends to vary depending on the desired use of the output. Typical KPIs used include:

- Gross margin
- Operating profit
- Net profit before tax
- Net present value
- Internal rate of return
- Return on assets

Each is described briefly below.

2.3.1 Gross margin

Gross margin is the total revenue of an enterprise less its variable (direct) costs and reflects a given enterprise's contribution to a business's fixed costs and profits (Kay & Edwards, 1994). It is a useful measure to assess the relative profitability of a given enterprise to another within a business and typically utilised when considering how a business can maximise profit.

2.3.2 Operating profit

Operating profit is a measure of business profitability, independent of ownership or funding. It comprises both cash and non-cash elements (i.e. to account for gradual loss in value of assets used to generate profit) and provides a measure of how much profit a given business generates to meet financing costs, taxation, capital investment and returns to owners outside of that earned from participation in the operations of the business.

Earnings before interest and tax ("EBIT") tends to be the standard measure of enterprise performance. However, economic farm surplus ("EFS"), which also includes the value of unpaid labour and changes in feed inventory on hand, has tended to be the preferred measure in assessing the profitability of New Zealand farm businesses. This has been due to the dominance of owner-operator businesses where owners tend to take their reward for labour out of tax-paid business profit as opposed it being a wage or salary that forms part of operating expenses. As a result, the true cost of running a farm business would be underestimated using a conventional accounting approach.

Operating profit is a useful measure to assess how the relative profitability of a business, irrespective of how it's financed, might change because of changes to its operating systems. This could be useful when evaluating different management systems for a dairy farm or when looking at how a kiwi fruit orchard's profit is impacted by applying mitigations to reduce the risk of PSA.

2.3.3 Net profit before tax

Net profit before tax ("NPBT") is operating profit adjusted for financing costs (interest). This measure considers an individual business' financing requirements and represents the profit available to meet taxation, capital investment and returns on an owner's equity.

NPBT is a key metric for assessing how system change might affect an individual business' financial position. However, as NPBT is heavily influenced by the extent of any debt equity utilised by the business, it is not a useful measure for assessing the underlying profitability of a farming system.

2.3.4 Net present value and internal rate of return

Net present value is the sum of the present values for each year's net cash flow for the term of an investment, less the initial cost of the investment, at an assumed interest rate. An investment with a positive NPV indicates a rate of return higher than the assumed interest rate.

Internal rate of return ("IRR") is the interest rate at which the NPV of an investment is zero i.e. the implied return of the investment.

These metrics are useful for evaluating the relative returns between different businesses over time, particularly those with significant differences in the timing of cashflows (such as between pastoral farming and forestry).

2.3.5 Return on assets

Return on assets ("RoA") is operating profit divided by the total value of all the assets employed in a business.

It is a key metric for assessing the relative [status quo] profitability of investments between business types with similar temporality of revenue and expenses (i.e. between sheep & beef farms and dairy farms) and within business of the same type (i.e. between System 1 and System 5 dairy farms).

2.3.6 Choice of KPI for this analysis

With the cost analysis of mitigation of sediment and other freshwater contaminants in the Rangitāiki and Kaituna-Pongakawa-Waitahanui WMAs primarily focussed on the "cost" [to profit] of applying mitigations *within* land use sectors, then operating profit is the best KPI to utilise.

On this analysis, EBIT was chosen as the preferred measure to allow consistency in the calculation of profitability between the pastoral, arable and permanent cropping land uses. In all instances, the cost of all the labour necessary within the land uses was accounted for by way of direct wages or salaries or as contracted inputs. All farm and orchard systems were assumed to be at status quo (with no impact on profitability via changes in feed or livestock inventory) and land rental (if any) was considered a finance cost and excluded.

Discounted cashflow analysis (utilising a discount rate of 5%) was used to estimate profitability of the forestry land uses considered in the wider study, but as alluded to above, is not able to be directly compared with the annual per hectare profitability estimates derived from pastoral agriculture or established permanent horticulture.

2.4 Variations to proposed mitigation bundles

During the modelling process, a number of changes were made to the mitigation sequencing and a number of the mitigations themselves. These are briefly described in the next subsections.

2.4.1 Excluding the "Elimination of summer cropping (Dairy M1.7)"

The recent version of OVERSEER (6.3.0) is now generating N losses from fodder crop blocks (that rotate within pastoral blocks) on pumice and allophanic soils that are significantly lower than those estimated in earlier versions of OVERSEER. The Chicory fodder crops modelled in a number of the dairy farm models are generating only 8kg N/ha of loss, which is intuitively incorrect. As a result, when the chicory crops are eliminated, N losses to water as estimated by the OVERSEER version actually increase, which is counter-intuitive and would confound the outputs. Accordingly, it was decided to exclude this mitigation from the current analysis. We expect OVERSEER to be in a position to verify the validity of these outputs before the end of the year.

2.4.2 Changing the order of Dairy M3.2 and M3.3

Due to the relative capital cost and environmental impact of the mitigations, it was decided to move the priority of the exclusion of stock from waterways that are less than 1m wide and River Environment Classification (REC) Order 1 (now M3.2) ahead of the installation of lined effluent storage and the installation of low rate effluent application spreaders (now M3.3).

2.4.3 Revising the N fertiliser mitigations (Drystock M2.1 and M3.3)

Preliminary modelling of the farm systems required a re-think of these mitigation protocols. In the end, the reality was that while the analysis suggested that reducing numbers of capital (breeding) livestock in response to reductions in N fertiliser was likely to be profitable, this crude analysis overlooks the reality that breeding systems tend to have feed demand curves that best match feed supply. As a result, the reduced ability to harvest "free" spring and summer pasture with the demand derived from lactating ewes and cows can have a great impact on the farm system than might initially be suspected. Autumn N tended to support livestock numbers used to take advantage of spring surplus, while spring N tends to be used tactically to overcome early spring feed deficits and allow faster weight gain in growing livestock (but also potentially inadvertently "feed" surpluses).

As a result, it was decided to redefine M2.1 to "Elimination of N fertiliser applications used to accelerate liveweight gain" and M3.3 to "Elimination of N fertiliser used to support capital livestock".

2.4.4 Incorporating the reticulation of stock water in place of surface water bodies (Drystock M2.5) within the various stock exclusion mitigations

The exclusion of livestock from the three levels of surface water bodies in each of the three drystock mitigation bundles would have a commensurate requirement to provide reticulated stock water in paddocks where the relevant water body provided drinking water. The author's experience in the subject WMAs has formed the view that that there will be little reliance on natural water course for stock water and as such, no allowance has been made for reticulation costs. Should evidence to the contrary come forward, a cost assumption for this could be easily introduced into the analysis.

2.4.5 Excluding "Reductions in seasonal stocking rate (Drystock M2.5)"

After further reflection on this mitigation (lowering stocking rates during the season through early culling or grazing stock off-farm), it was decided this was moderately impractical to implement and hence model in most of the dry stock systems. This is because most culling actions occur as soon as is practicable on breeding properties and actively "exporting" nutrient loss to other catchments through the contract grazing of lower priority/higher N loss livestock is unlikely to be a sustainable activity given an assumption that the capacity of other catchments to assimilate increased loads of N is likely to be limited. As a result, this mitigation was excluded from the study, which is in line with both the approach increasingly adopted in analyses of this type and feedback from the community groups.

2.4.6 Excluding "Reducing stocking rate (Drystock M3.4)"

Given the assumption made within the models that farm management couldn't be "improved" to generate operational efficiencies, reducing stocking rate in drystock systems essentially requires a commensurate reduction in the pastoral area to ensure the farm system stays economically viable. This due to other management options to lower feed supply (i.e. reducing N fertiliser, reduce imported feed) having already been applied. As this is therefore essentially a land use change option and it was the last sequential mitigation to be applied, it was decided to exclude it from the bundle.

2.4.7 Excluding "Strip tillage (Arable M2.4)"

There is limited data in a New Zealand context of the impact strip tillage will have on both the cost of cropping and the impact on reduced contaminants to water. OVERSEER currently has no further options beyond "minimum tillage" for its cropping model, so no further reductions in N loss to water will be generated in that model. As to the cost of strip tillage, there is some anecdotal evidence that such techniques can lower cultivation costs. However, these aren't quantified. As such, the decision to exclude this mitigation was made, but recognising that it, like some other "edge of field" and emerging mitigations are worthy of investigation as they could have great potential to reduce contaminant load to water from agricultural activities.

3 Dairy farm systems

3.1 Methodology

Six dairy farm systems were modelled. The chosen farm variants and their primary parameters were based on the work of Green et al (2017), which had utilised input from BOPRC land management personnel and DairyNZ staff. The adjustments in farm variants and their parameters were made after consultation with community stakeholders and industry representatives.

The farms were all modelled as long-term feasible models in Farmax Dairy Pro software, utilising base pasture production curves (derived from cage cuts) that were subsequently adjusted to better reflect observed regional parameters. Stocking rates were based on regional dairy statistics, again slightly modified based on input from local industry experts. Operating profit (earnings before interest and tax) utilised a $6.00/kg MS milk price, with operating expenses (including an arms' length adjustment for [unpaid] wages of management) based on the latest published DairyNZ Economic Survey data (Dairy NZ 2018) for the Bay of Plenty region. All grazing was assumed to be sourced externally, with all young stock assumed grazed off the farm area from weaning until returning as in-calf heifers. Effluent areas were initially assumed at a minimum of 4 ha per 100 cows and then adjusted to ensure N applied in dairy effluent was less than 150kg N/ha/year. Maintenance fertiliser and nitrogen expenditure was based on modelled requirements. The key parameters of the six farm systems are each described briefly below and then summarised in Table 13. The baseline economic output for the dairy farm systems is presented in Appendix 1. All analysis currently excludes the [financial] impact of Fonterra supplier shares (if any).

The impact of having to account for biological greenhouse gas ("BGHG") emissions has currently been excluded from this analysis. But we note that at a $25/t CO_2 price, the financial impact of having to pay for 10% of BGHGs would reduce EBIT from between $19 to $38/ha/year across the analysed dairy farms. Full offset at $25/t CO_2 price might reduce EBIT by $196 to $386/ha/year, being up to 20% of operating profit.

3.2 Kaituna-Pongakawa-Waitahanui dairy farms

3.2.1 Lower KPW dairy (System 3)

This model is designed to be representative of the higher stocked dairy farms on the coastal flats of the KPW catchment. Comprising of gley and organic soils with open drain systems, this 122 ha farm calves down 390 cows (3.2 cows/ha), peak milking 374 cows (3.1 cows/ha) and producing 1,062 kg MS/ha. No silage is made on farm and 50% of the milking herd are grazed off for six weeks. Palm kernel expeller is fed to cows in early and late lactation. Annual N fertiliser usage averages 173 kg N/ha. A stand-off area (comprised of an inert base) was assumed to be used by all cows on farm for an average of 3 days per month during the winter and early spring to protect soil from pugging. Operating profit is calculated at $1,983/ha. N and P losses to water were assessed in OVERSEER 6.3.0 at 50.7 kg N/ha/year and 3.4kg P/ha/year respectively and biological greenhouse gas (BGHG) emissions estimated at 15.4 t CO_2e/ha/year. Table 7 shows the sensitivity of operating profit to milk and urea prices for the Lower KPW dairy model.

Table 7: Sensitivity of operating profit to milk and urea prices for the Lower KPW dairy model

Urea price ($/t)	Milk price ($/kg MS) 4.50	5.00	5.50	6.00	6.50	7.00
500	413	944	1,475	2,006	2,538	3,069
564	390	921	1,452	**1,983**	2,514	3,045
600	376	907	1,438	1,969	2,500	3,031
700	339	870	1,401	1,932	2,463	2,994
800	302	833	1,364	1,895	2,426	2,957

3.2.2 Mid KPW dairy (System 3)

Representative of the farms on higher ground but less than 100m above sea level, the Mid KPW dairy model comprises 122ha of pumice soil, calving down 304 cows to peak milk 290. Milk production is 837kg MS/ha, but all cows are wintered on. With improved drainage, 3ha of maize silage is grown on-farm to help extend lactation in autumn. Palm kernel is fed to cows in both shoulders of the season and 19.2ha of grass silage is cut in late December and subsequently fed to dry cows over winter. N fertiliser use applied to pasture averages 131kg N/ha/year. Operating profit is calculated at $1,413/ha. N and P losses to water were assessed in OVERSEER 6.3.0 at 53.8kg N/ha/year and 1.4 kg P/ha/year respectively and biological greenhouse gas (BGHG) emissions estimated at 8.1 t $CO2_e$/ha/year. Table 8 shows the sensitivity of operating profit to milk and urea prices for the Mid KPW dairy model.

Table 8: Sensitivity of operating profit to milk and urea prices for the Mid KPW dairy model

Urea price ($/t)	Milk price ($/kg MS) 4.50	5.00	5.50	6.00	6.50	7.00
500	175	594	1,013	1,431	1,850	2,268
564	157	576	994	**1,413**	1,831	2,250
600	147	566	984	1,403	1,821	2,240
700	118	537	956	1,374	1,793	2,211
800	90	509	927	1,346	1,764	2,183

3.2.3 Upper KPW dairy (System 3)

The 122ha Upper KPW model is similar to the mid KPW model, but the farm system reflects lower pasture growth potential, both from the increased altitude but also from the steeper contour. A summer chicory crop is utilised to buffer poorer summer growth rates and lower pasture quality and palm kernel expeller is used to feed milkers in the shoulders of the season. Lower winter pasture growth rates are buffered with 50% of dry cows grazed off for six weeks. N fertiliser use averages 123kg N/ha/year. Milk production is 805kg MS/ha. Operating profit is calculated at $1,115/ha. N and P losses to water were assessed in OVERSEER 6.3.0 at 68.1 kg N/ha/year and 4.0 kg P/ha/year respectively and BGHG emissions estimated at 7.9 t CO_2e/ha/year. Table 9 shows the sensitivity of operating profit to milk and urea prices for the Upper KPW dairy model.

Table 9: Sensitivity of operating profit to milk and urea prices for the Upper KPW dairy model

Urea price ($/t)	Milk price ($/kg MS) 4.50	5.00	5.50	6.00	6.50	7.00
500	- 76	326	729	1,131	1,534	1,936
564	- 93	310	712	**1,115**	1,517	1,920
600	- 102	300	703	1,105	1,508	1,910
700	- 128	274	677	1,079	1,482	1,884
800	- 154	248	651	1,053	1,456	1,858

3.3 Rangitāiki dairy farms

3.3.1 Lower Rangitāiki dairy (System 2)

The 117ha Rangitāiki dairy model is designed to be representative of the non-irrigated dairy farms in the lower Rangitāiki plains, with 30% of the farm area comprising gley soils. High pasture growth potentially results in average production of 1,035 kg MS/ha from 330 cows calved down. Only small amount of maize silage needs to be imported into the farm system in autumn to extend lactation and all cows are wintered on. N fertiliser use is 120 kg N/ha, with surplus pasture harvested in February that is subsequently fed to dry cows over winter. Operating profit is calculated at $2,582/ha. N and P losses to water were assessed in OVERSEER 6.3.0 at 67.4 kg N/ha/year and 1.2 kg P/ha/year respectively and biological greenhouse gas (GHG) emission estimated at 9.9 t CO_2e/ha/year. Table 10 shows the sensitivity of operating profit to milk and urea prices for the Lower Rangitāiki irrigated dairy model.

Table 10: Sensitivity of operating profit to milk and urea prices for the Lower Rangitāiki irrigated dairy model

Urea price ($/t)	Milk price ($/kg MS) 4.50	5.00	5.50	6.00	6.50	7.00
500	1,046	1,564	2,081	2,599	3,116	3,634
564	1,030	1,547	2,065	**2,582**	3,100	3,617
600	1,020	1,538	2,055	2,573	3,090	3,608
700	994	1,512	2,029	2,547	3,064	3,582
800	968	1,486	2,003	2,521	3,038	3,556

3.3.2 Mid Rangitāiki dairy (System 2)

Modelled to represent an unirrigated dairy farm in the Galatea valley, this 117ha farm system produces 954kg MS/ha from 315 cows to calve down. The low winter growth rates require 75% of the herd to be grazed off over winter (7 weeks) and calving date is assumed to be later than the other farm models. Summer chicory (5.2ha) and maize crops (3.5ha) are grown on the farm each year, with the maize fed to milkers both in the autumn and again in the spring. Palm kernel expeller (PKE) is used to supplement milkers in early lactation and late summer and a small amount of surplus pasture is harvested as silage to feed dry cows over autumn and winter. A total of 118kg

N/ha is applied to pasture. Operating profit is calculated at $1,689/ha. N and P losses to water were assessed in OVERSEER 6.3.0 at 53.1 kg N/ha/year and 0.9 kg P/ha/year respectively and BGHG emissions estimated at 8.6 t CO_2e /ha/year. Table 11 shows the sensitivity of operating profit to milk and urea prices for the Mid Rangitāiki dairy model.

Table 11: Sensitivity of operating profit to milk and urea prices for the Mid Rangitāiki dairy model

		Milk price ($/kg MS)					
		4.50	5.00	5.50	6.00	6.50	7.00
Urea price ($/t)	500	274	751	1,228	1,705	2,182	2,659
	564	257	734	1,211	**1,689**	2,166	2,643
	600	248	725	1,202	1,679	2,156	2,633
	700	223	700	1,177	1,654	2,131	2,608
	800	197	674	1,151	1,628	2,105	2,582

3.3.3 Mid Rangitāiki irrigated dairy (System 2)

Modelled off a partially (50%) irrigated (K line) dairy farm in the Galatea valley, this 117ha farm system produces 1,072 kg MS/ha from 315 cows to calve down. The low winter growth rates require 50% of the herd to be grazed off over winter (7 weeks) and calving date is assumed to be later than the other farm models. Summer chicory (5.2 ha) and maize crops (3.7 ha) are grown on the un-irrigated portion of the farm each year, with the maize fed to milkers both in the autumn and again in the spring. PKE is used to supplement milkers in early lactation and silage harvested off the irrigated portion of the farm fed to dry cows over autumn and winter. A total of 132 kg N/ha is applied to pasture. Operating profit is calculated at $2,121/ha. N and P losses to water were assessed in OVERSEER 6.3.0 at 61.7 kg N/ha/year and 1.1 kg P/ha/year respectively and biological greenhouse gas (GHG) emissions estimated at 9.5t CO_2e/ha/year. Table 12 shows the sensitivity of operating profit to milk and urea prices for the Mid Rangitāiki irrigated dairy model.

Table 12: Sensitivity of operating profit to milk and urea prices for the Mid Rangitāiki irrigated dairy model

		Milk price ($/kg MS)					
		4.50	5.00	5.50	6.00	6.50	7.00
Urea price ($/t)	500	531	1,067	1,603	2,139	2,675	3,210
	564	513	1,049	1,585	**2,121**	2,656	3,192
	600	503	1,039	1,575	2,110	2,646	3,182
	700	474	1,010	1,546	2,082	2,618	3,153
	800	446	982	1,518	2,053	2,589	3,125

Table 13: Base parameters for the five dairy farm systems modelled

Model name	Lower KPW	Mid KPW	Upper KPW	Lower Rangitaiki	Mid Rangitaiki	Mid Rangitaiki irrigated
System	3	3	3	2	2	2
Effective area (ha)	122	122	122	117	117	117
No. cows (to calve)	390	304	304	330	315	315
Cows peak milked	374	290	290	316	301	301
Stocking rate (SR; cows ha^{-1})	3.1	2.4	2.4	2.7	2.6	2.6
Comparative stocking rate	85	84.1	87.4	82.6	83.6	84
Pasture yield (t DM ha^{-1})	14.2	11.3	10.4	15.6	12.7	13.4
Pasture consumed (t DM ha^{-1})	11.9	9	8.5	12.1	9.6	10
Imported feed/total feed (%)	16%	13%	14%	3%	8%	7%
Annual milk solids production (kg)	129,569	102,122	98,215	121,102	111,627	125,376
MS (kg cow^{-1})	346	352	339	383	371	417
MS (kg ha^{-1})	1,062	837	805	1,035	954	1,072
MS (as a % of liveweight; LW)	83.6	84.9	80.2	91.7	88	98.3
Feed conversion efficiency (kg DM eaten kg MS $produced^{-1}$)	13	12.8	13.1	12.3	12.5	11.2
Financial indicators						
Operating profit ($ ha^{-1})	1,983	1,413	1,115	2,582	1,689	2,121
Area receiving effluent (% total)	16%	13%	13%	16%	15%	17%
Area irrigated (% total)	-	-	-	-	-	50%
Fertiliser inputs applied to pasture						
N (kg ha^{-1})	173	131	123	120	118	132
P (kg ha^{-1})	45	37	35	50	44	50
Average soil Olsen P (mg L^{-1})	32	31	30	32	45	45
Stand-off pad in use	Yes	No	No	No	No	No
Environmental losses						
N (kg ha^{-1})	50.7	53.8	68.1	67.4	53.1	61.7
P (kg ha^{-1})	3.4	1.4	4.0	1.2	0.9	1.1
Biological GHG (t CO_2e ha^{-1})	15.4	8.1	8.0	9.8	8.6	9.5

4 Non-dairy pastoral and arable systems

4.1 Methodology

Three sheep & beef farms were modelled in Farmax Pro, two for the KPW WMA and a single model for the Rangitāiki catchment. As noted in Green et al (2017), sheep & beef farming in the Rangitāiki catchment is dominated by Landcorp's Rangitāiki Station, with Lochinver Station and Landcorp's Goudies Station also having land in the Upper Rangitāiki catchment. While it is important to recognise the modelled farm system is unlikely to be representative of the smaller family operations that still occur in the catchment, it is difficult to ignore the specifics of this farm system given the scale of this operation. The partial integration of this property's deer operation with its cattle operation makes the specific modelling of this system to align with the parameters of the APSIM model impossible. As a result a representative Rangitāiki farm system with a low sheep:cattle ratio has been modelled to complement the exclusive Rangitāiki deer system (see below). While only a single KPW S+B model, comprising dairy support, had been proposed, a second farm system model was subsequently developed, comprising a breeding ewe flock and breeding cows, in addition to dairy heifer grazing.

The size of the modelled farms was informed by the annual Beef + Lamb New Zealand Economic Service Sheep & Beef Farm Survey (Beef & Lamb NZ 2018), with general parameters for the Class 3, 4 and 5 survey farms providing base physical and economic parameters for the Rangitāiki S+B (Class 3), KPW S+B and Rangitāiki D (Class 4) and KPW DS (Class 5) models respectively. Maintenance fertiliser and nitrogen expenditure were based on modelled requirements.

Operating profit was defined as earnings before interest and tax and included an adjustment for the market value of all labour (paid and unpaid) in the farm system, based off the FTE parameters in the B+L NZ survey. Income was assessed using base schedule relationships in Farmax Pro, with the sheep schedule set at $5.50 (per kg carcass weight), prime bull $5.50, prime steer $5.55 and venison at $8.00. Wool was set at a base price of $3.40/kg greasy and velvet at $100/kg. Grazing rates per head per week were set at $6.50 for calves, $9.00 for yearlings and $25 for cows.

As with the dairy farm models, the impact of having to account for BGHG emissions has currently been excluded from this analysis. However, we note that at a $25/t CO_2 price, the financial impact of having to pay for 10% of BGHGs would reduce EBIT from between $9 to $11/ha/year. However, full offset at $25/t CO_2 might reduce EBIT by as much as 80% of assessed operating profit, depending on the farm system.

4.2 Sheep & beef farms

4.2.1 KPW Dairy Support (DS)

This 234ha property has an average slope of 12.6 degrees, comprising 22 ha of flats, 155 ha of rolling land, 52 ha of easy country and 5 ha of steep land. It's assumed this farm operation grazes 445 dairy heifer replacements from 4 months of age through to 21 months of age and winters 334 cows on pasture and silage for 8 weeks. N use is limited to 30 kg N/ha to 120 ha in the autumn to build up covers ahead of the grazing dairy cows arriving in late May.

Operating profit was estimated at $421/ha. N and P losses to water were assessed in OVERSEER 6.3.0 at 28.2 kg N/ha/year and 2 kg P/ha/year respectively and BGHG emissions estimated at 4.4t CO_2e/ha/year.

Table 14: Sensitivity of operating profit to grazing and urea prices for the KPW dairy support model

Urea price ($/t)	Yearling heifer grazing price ($/head/week)					
	8.00	8.50	9.00	9.50	10.00	10.50
500	216	319	423	527	629	733
564	214	317	**421**	525	627	731
600	213	315	420	524	626	730
700	210	312	416	520	623	727
800	207	309	413	517	620	724

4.2.2 KPW Sheep + Beef (S+ B)

This is a 324ha farm, with a similar area of flats, but a greater proportion of steeper land (16.4 degrees) to the KPW dairy support model below. The farm runs a flock of 1,250 MA ewes and 540 ewe hogget replacements. Lambing at 128%, all non-replacement lambs are finished before the start of winter at an average carcass weight of 17.3 kg, including 700 trade lambs purchased in December. The cattle policy comprises 50 Hereford x Friesian breeding cows, mated to a terminal sire and with all progeny sold store at weaning. Replacement in-calf cows are bought in the autumn. In addition to the breeding cows, 300 dairy heifer replacements are contract grazed from 4 months of age to 21 months of age. N fertiliser is applied at 30kg N/ha to the 94a of flats and rolling country in the autumn.

Table 15: Sensitivity of operating profit to lamb and beef prices for the KPW S+B model

Beef price ($/kg cwt)	Lamb price ($/kg cwt)					
	4.50	5.00	5.50	6.00	6.50	7.00
4.50	-131	-82	-32	18	68	118
5.00	-53	-3	47	96	146	196
5.55	33	83	**133**	183	233	282
6.00	104	154	203	253	303	353
6.50	182	232	282	332	382	431

Operating profit was estimated at $133/ha. N and P losses to water were assessed in OVERSEER 6.3.0 at 25.1kg N/ha/year and 2.7kg P/ha/year respectively and biological greenhouse gas (BGHG) emissions estimated at 4.3t CO_2e/ha/year.

4.2.3 Rangitāiki Sheep + Beef (S+B)

The Rangitāiki sheep & beef model is a 584 ha farm system, with a low (35%) sheep component and a diverse cattle policy; an Angus breeding cow herd (all male progeny finished, non-replacement heifers sold store at weaning), additional yearling steers purchased and finished, a bull beef operation and a dairy heifer grazing operation. The breeding ewe flock lambs at 135%, with all non-replacement lambs finished to a carcass weight of 17.2kg by May each year. The bulls are purchased as 100kg weaner calve each spring and all taken through two winters and slaughtered in late spring/early summer at 308kg carcass weight. Steers are killed at an average carcass weight of 320kg. Winter crops (4% of the farm area) are sown each year and 92 ha of surplus pasture is harvested in early summer for winter feed and a further 84 ha is sold as standing silage. Over 80% of the farm receives an N application of 30 kg N/ha; 40% in the spring and 60% in the autumn.

Table 16: Sensitivity of operating profit to lamb and beef prices for the Rangitāiki S+B model

Beef price ($/kg cwt)	Lamb price ($/kg cwt) 4.50	5.00	5.50	6.00	6.50	7.00
4.50	-22	7	36	65	94	124
5.00	65	94	123	152	182	211
5.55	161	190	**219**	248	277	307
6.00	239	268	297	327	356	385
6.50	326	355	385	414	443	472

Operating profit is estimated at $219/ha. N and P losses to water were assessed in OVERSEER 6.3.0 at 36.1kg N/ha/year and 1kg P/ha/ year respectively and BGHG emissions estimated at 3.8t CO_2e/ha/year.

4.3 Deer farm

4.3.1 Rangitāiki Deer (D)

The modelled deer farm is a breeding-finishing system modelled off that of Rangitāiki Station. At an assumed size of 324ha, the farm system winters 874 Ma and R2 hinds, fawning at 90% and 75% respectively. All non-replacement progeny is finished before their second winter, with the stags and hinds finished to 55kg and 54kg carcass weight respectively. As with the Rangitāiki sheep & beef model, 4% of the farm area is sown into winter crop and the 50% of the farm area gets an application of N fertiliser in the spring, with the other 50% receiving an autumn application. Approximately 500 trade lambs (28kg liveweight) are purchased in each year and sold in Jan/Feb. Surplus pasture (48ha) is conserved for use in the winter and a further 40ha of standing silage sold to third parties.

Table 17: Sensitivity of operating profit to venison and urea prices for the Rangitāiki Deer model

		Venison price ($/kg cwt)					
		7.00	7.50	8.00	8.50	8.00	9.50
Urea price ($/t)	500	93	164	234	305	234	446
	564	88	158	**229**	299	229	440
	600	85	155	226	296	226	437
	700	76	147	217	288	217	429
	800	68	138	209	279	209	420

Operating profit was estimated at $229/ha. N and P losses to water were assessed in OVERSEER 6.3.0 at 61.7kg N/ha/year and 1.1kg P/ha/year respectively and biological greenhouse gas (GHG) emissions estimated at 9.5t CO_2e/ha/ ear.

4.4 Arable farm

4.4.1 KPW Arable

A single variant arable model was developed, based around a 40ha maize silage production system (yielding 20 tDM/ha sold for $0.26/kg DM harvested [excl. freight]), with the maize followed by an annual ryegrass crop that is able to support 300 dairy cows contract grazed for eight weeks and then used to produce 300 wrapped bales of silage before being re-sown into maize again. Total N fertiliser applied is 290kg N/ha, but despite this amount of N, we note that the OVERSEER nutrient budget still indicates a loss of N from the organic/plant pool of 242kg N/ha, which suggests these applications will be insufficient to maintain productivity in the long term.

Table 18: Sensitivity of operating profit to maize silage and urea prices for KPW Arable model

		Maize silage price ($/t DM)					
		200	220	240	260	280	300
Urea price ($/t)	500	1,186	1,586	1,986	2,386	2,786	3,186
	564	1,145	1,545	1,945	**2,345**	2,745	3,145
	600	1,123	1,523	1,923	2,323	2,723	3,123
	700	1,060	1,460	1,860	2,260	2,660	3,060
	800	997	1,397	1,797	2,197	2,597	2,997

Operating profit was estimated at $2,345/ha. N and P losses to water were assessed in OVERSEER 6.3.0 at 62.7kg N/ha/year and 2.4kg P/ha/year respectively and biological greenhouse gas (GHG) emissions estimated at 3.1t CO_2e/ha/year.

Table 19: Base parameters for the five dry stock and arable farm systems modelled

Model	KPW DS	KPW S+B	Rangitaiki S+B	Rangitaiki D	KPW A
Effective area (ha)	234	324	584	324	40
Stocking rate (RSU ha^{-1})	12.8	12.9	11	10.5	6.7
Pasture yield (t DM ha^{-1})	9.4	8.8	7.69	7.7	9
Pasture consumed (t DM ha^{-1})	7.05	7.12	6.03	5.76	3.7
Number of livestock carried through winter (1 July)					
Breeding ewes	-	1,250	1,454	-	-
Total sheep	-	1,826	1,786	-	-
Breeding cows	-	50	67	-	-
Dairy heifers	445	300	276	-	-
Dairy cows	334			-	300
Total cattle	779	352	693		-
Hinds	-	-	-	874	-
Total deer	-	-	-	1,681	-
Animal production					
Meat (kg net carcass weight ha^{-1})	336	239	233	152	86
Wool and velvet (kg net wool /velvet ha^{-1})	-	38	22	0	-
Total (kg net product ha^{-1})	336	277	255	152	86
Feed conversion efficiency (kg DM eaten kg $product^{-1}$)	21	26	24	38	43
Animal reproduction					
Ewe efficiency index (%)	-	55%	55.7%	-	-
Cow efficiency index (%)	-	39.5%	39%	-	-
Hind efficiency index (%)	-	-	-	41%	-
Financial indicators					
Operating profit ($ ha^{-1})	421	133	219	229	2,345
Fertiliser inputs applied to farm area					
N (kg ha^{-1})	15	9	27	32	290
P (kg ha^{-1})	22	22	19	18	12
Soil Olsen P (mg L^{-1})	17	17	17	17	
Environmental losses					
N (kg ha^{-1})	28.2	25.1	36.1	25.2	62.7
P (kg ha^{-1})	2.0	2.7	1.0	1.2	2.4
Biological GHG (t CO_2e ha^{-1})	4.4	4.3	3.8	3.9	3.1

5 Kiwifruit

Two status quo kiwifruit models have been completed to date – a green (Haywards) and a gold (G3) model. Both are based on standard planting densities with 3.6m x 6m bays.

Operating profit was again defined as earnings before interest and tax and assumed arms' length/contract orchard management. The breakdown in operating costs were based off data from NZ Kiwifruit Growers Inc. (pers. comm) and adjusted based on recent ANZ data. Harvesting costs were separated out from the operating expenses and depreciation was calculated on the assumed orchard infrastructure and machinery investment over 20 years. The opportunity cost of any proprietary licence for G3 has been excluded from the EBIT estimates. Yields (as per the below) and a tray price of $5.50/tray for green and $9/tray for gold were used to calculate the orchard gate returns. Full breakdown is provided in Appendix 4 below.

Deurer et al (2011) note that 30% of BOP orchards are irrigated. To account for this in the model, we have assumed a typical irrigation practice of 20mm of irrigation water being applied every time the water stored in the top 2m of soil is less than just 75% of plant available water (PAW)(300mm applied between November and February) and then applying only 30% of this quantum. We recognise that where irrigation is used for frost protection such activity to mitigate late frosts occurring after nitrogenous fertiliser applications have commenced might result in drainage losses of N to water. However, this wasn't modelled, with the occurrence of this issue considered low.

We recognise that the status quo water and nutrient requirements of developing orchards will likely be different to those assumed, just as will the economic outputs and contaminant losses. However, considering the transition impact of land use change (say from converting dairy farms to kiwi fruit) was outside the scope of this work.

5.1 Green

The green kiwi fruit model is based on a Haywards orchard managed to 25 winter buds/m^2 and 55 flower buds/m^2. Yields are assumed to be 10,500 trays/ha on the basis of 43 class 1 fruit/m^2. A total of 110kg/ha of N fertiliser is applied in two applications of CAN (250kg/ha in Sep, 150kg/ha in Nov). Operating profit was estimated at $19,500/ha. N and P losses to water were assessed in OVERSEER 6.3.0 at 19kg N/ha/year and 0.5kg P/ha/year respectively and biological greenhouse gas (GHG) emissions estimated at 0.52t CO_2e/ha/year.

Table 20: Sensitivity of operating profit to OGR and yield for Green kiwifruit model

Yield (trays/ha)	OGR green kiwifruit ($/tray) 4.50	5.00	5.50	6.00	6.50	7.00
9,500	1,875	7,938	14,000	20,063	26,125	32,188
10,000	4,125	10,438	16,750	23,063	29,375	35,688
10,500	6,375	12,938	19,500	26,063	32,625	39,188
11,000	8,625	15,438	22,250	29,063	35,875	42,688
11,500	10,875	17,938	25,000	32,063	39,125	46,188

Table 21: Sensitivity of operating profit to OGR and labour costs for Green kiwifruit model

Labour costs ($/hour)	OGR green kiwifruit ($/tray) 4.50	5.00	5.50	6.00	6.50	7.00
17.5	9,845	16,407	22,970	29,532	36,095	42,657
20.0	8,110	14,673	21,235	27,798	34,360	40,923
22.5	6,375	12,938	19,500	26,063	32,625	39,188
25.0	4,640	11,203	17,765	24,328	30,890	37,453
27.5	2,906	9,468	16,031	22,593	29,156	35,718

5.2 Gold

The gold kiwi fruit model is based on a G3 orchard managed to 35 winter buds/m^2 and 70 flower buds/m^2. Yields are assumed to be 14,000 trays/ha on the basis of 70 class 1 fruit/m^2. A total of 120kg N/ha of N fertiliser is applied in two applications of CAN (300kg/ha in Sep, 150kg/ha in Oct). Operating profit was estimated at $78,400/ha (Table 22) and with labour costs of $22.5/hour (Table 21). N and P losses to water were assessed in OVERSEER 6.3.0 at 23kg N/ha/year and 0.5kg P/ha/year respectively and biological greenhouse gas (GHG) emissions estimated at 0.62t CO_2e/ha/year.

Table 22: Sensitivity of operating profit to OGR and yield for Gold kiwifruit model

Yield (trays/ha)	OGR gold kiwifruit ($/tray) 8.00	8.50	9.00	9.50	10.00	10.50
13,000	52,900	61,150	69,400	77,650	85,900	94,150
13,500	56,900	65,400	73,900	82,400	90,900	99,400
14,000	60,900	69,650	78,400	87,150	95,900	104,650
14,500	64,900	73,900	82,900	91,900	100,900	109,900
15,000	68,900	78,150	87,400	96,650	105,900	115,150

Table 23: Sensitivity of operating profit to OGR and labour costs for Gold kiwifruit model

Labour costs ($/hour)		OGR gold kiwifruit ($/tray)					
		8.00	8.50	9.00	9.50	10.00	10.50
	17.5	64,869	73,619	82,369	91,119	99,869	108,619
	20.0	62,884	71,634	80,384	89,134	97,884	106,634
	22.5	60,900	69,650	78,400	87,150	95,900	104,650
	25.0	58,915	67,665	76,415	85,165	93,915	102,665
	27.5	56,930	65,680	74,430	83,180	91,930	100,680

6 Forestry

Two forestry models were considered – one a radiata plantation model and the other a mānuka plantation established for honey production. Unlike the farming and orchard models, the lack of annual cashflows for a pine forest make status quo profitability comparisons with the non-pastoral land uses on an annual EBIT basis impossible to achieve. A status quo planted mānuka model can be developed, but similar to an orchard situation, the initial lag in production and potentially a date at which plants will need to be renewed make a long-term investment analysis a better mechanism to compare the relative performance of mānuka as a land use. The models below in Appendix 5 and 6 are provided for completeness, not to allow a direct comparison with orchard or farm returns.

6.1 Pinus radiata

The radiata model is based on a 28-year non-pruned (framing) rotation under contract management. The base model excludes the financial impact of carbon, but 169 tCO_2 permanently sequestered would be available to sell on a one-off basis at year 10 (based on ETS sequestration profiles), assuming the forest was going to be replanted after harvest at year 28. Net stumpage at $43,490/ha and an establishment cost of $1,500/ha delivers an NPV of $6,827/ha (excluding land costs) at a discount rate of 5%. This would be equivalent to an annuity payment of $530/ha/year at the same discount rate over the same time frame.

The inclusion of the value of the sale of permanently sequestered carbon in the modelling increases the NPV of this model to $9,420/ha (excluding land costs); taking the equivalent annuity payment up to $630/ha/year.

The OVERSEER model estimates N losses to water at 2.5kg N/ha/year from exotic plantation forest and P losses at 0.1kg P/ha/year. These estimated nutrient losses are the average annual losses over the course of rotation.

6.2 Mānuka

The mānuka model is based on establishing mānuka trees at a cost of $2,000/ha and then a ground rent receivable for hives ($100/hive/year at a hive density of 1.5 hives/ha) plus a 10% share of any honey profits payable at the end of the season. Annual operating profit (EBIT) for the established stand is estimated at $130/ha, but this potentially being a ($20)/ha loss in a year where poor flowering result in negligible honey yields.

Mānuka will sequester carbon, but as a supposed permanent crop, the impact of the sale of this carbon within the ETS reporting periods after establishment are one-off permanent sales and impossible to capture in an annual operating profitability estimate. The quantum of the CO_2 sequestered by a managed mānuka stand will depend on the extent of biomass the stand will be permitted to accumulate.

The OVERSEER model estimates N losses to water at 3kg N/ha/year from native forest and P losses at 0.1kg P/ha/year.

7 Results and discussion of mitigation modelling

Key findings from the analysis of the farming systems are presented below.

7.1 Dairy farm systems

7.1.1 Summary of bundle implementation

On average, across the six representative dairy farm systems analysed, implementation of M1 lowered profitability by $64/ha, M2 by $65/ha and M3 by $448/ha. While the financial impact of implementing M3 was significant across all of the six models, the "cost" of M1 and M2 was variable. M1 actually had a higher cost than M2 for three of the farm systems, while for the other three M1 effectively had no impact on farm profitability.

Table 24: Change in annual dairy farm gate profitability ($/ha) from the implementation of mitigation bundles

	Lower KPW	Mid KPW	Upper KPW	Lower Rang	Mid Rang	Irrigated Rang	Average
M1	-13	-85	-182	-92	-10	-3	-64
M2	-118	-41	-11	-28	-100	-92	-65
M3	-346	-444	-393	-504	-454	-537	-446
Total	-476	-570	-587	-624	-564	-632	-576

The financial impact of implementing M1 tended to be heavily influenced by one main factor - the capacity of the farm to generate savings in fertiliser inputs as a result of proper nutrient budgeting and mining excessive soil P reserves;

All the farm models assumed baseline fertiliser applications determined by the historical "rules of thumb"[3] that discussion with local farmers and practitioners and the author's own observations of this practice in the field suggest are still in common use. This is as opposed to nutrient requirements being formally assessed using a nutrient budget to balance for production and nutrient coming in from other sources (i.e. feed) and for soil type [which would be best practice]. Our professional experience and anecdotal observations would suggest that (i) the quality of soil testing is often variable (due to poor technique), (ii) it hasn't been historical practice to make recommendations based on nutrient budgets, (iii) many farms still have soil P levels well above those required to optimise pasture production and (iv) P fertiliser applications regularly exceed those needed to maintain soil test levels. While we are not aware of any independent data to support an assertion that such mismatched fertiliser applications would be observed across all farms, we feel this assumption to be appropriate for use in this analysis, given our common observance of this and that it does serve to both (a) highlight the potential financial benefit of accurate nutrient budgeting and (b) the influence it could have on the "cost" of the M1 bundle.

[3] Like those presented in Morton & Roberts (1993)

Table 25: Relative changes in annual dairy farm gate profitability and water and atmospheric contaminants as measured in OVERSEER 6.3.0 from the implementation of mitigation

Lower KPW				
Bundle	Δ EBIT	Δ N	Δ P	Δ GHG
M1	-1%	-26%	-17%	-9%
M2	-7%	-39%	-20%	-11%
M3	-24%	-54%	-25%	-23%

Mid KPW				
Bundle	Δ EBIT	Δ N	Δ P	Δ GHG
M1	-6%	-25%	-9%	-4%
M2	-9%	-26%	-9%	-5%
M3	-41%	-41%	-15%	-17%

Upper KPW				
Bundle	Δ EBIT	Δ N	Δ P	Δ GHG
M1	-16%	-18%	-16%	-4%
M2	-17%	-19%	-19%	-5%
M3	-53%	-38%	-23%	-17%

Lower Rang				
Bundle	Δ EBIT	Δ N	Δ P	Δ GHG
M1	-4%	-27%	-12%	-5%
M2	-5%	-28%	-12%	-5%
M3	-25%	-46%	-16%	-15%

Mid Rang				
Bundle	Δ EBIT	Δ N	Δ P	Δ GHG
M1	-1%	-24%	-17%	-4%
M2	-7%	-26%	-19%	-5%
M3	-35%	-43%	-25%	-15%

Irrigated Rang				
Bundle	Δ EBIT	Δ N	Δ P	Δ GHG
M1	0%	-21%	-13%	-4%
M2	-4%	-22%	-14%	-5%
M3	-31%	-44%	-21%	-15%

Average				
Bundle	Δ EBIT	Δ N	Δ P	Δ GHG
M1	-5%	-23%	-14%	-5%
M2	-8%	-26%	-15%	-6%
M3	-35%	-44%	-21%	-17%

The aggregation of mitigations into bundles would probably also be enhanced by moving the substitution of autumn N fertiliser with imported feed into M2.

In general, reductions in N losses were achieved by M1 and M3, P loss reduction largely by M1 and BGHG emissions by M3. On average, full adoption of the mitigation bundles on the dairy farm systems modelled reduced N losses by 44%, P losses by 21% and BGHG losses by 17% - all for a reduction in profitability by 35%.

7.1.2 General observations

In general:

- The adoption of "proof of placement" fertiliser application technology on farm to reduce the coefficient of variance (CV) of spread and replacement of an early spring application of N fertiliser through the use of gibberellic acid in the preceding N application tended to be cost neutral result in reducing the nitrate leaching;
- The adoption of low solubility P fertiliser resulted in the single largest drop in farm P losses as modelled in OVERSEER, with wetland development, riparian buffers and afforestation (all reducing farm area) and reducing stocking rates and P losses;
- The substitution of autumn N fertiliser with imported supplementary feed (i.e. using maize silage to replace the pasture grown with fertiliser N) lowered losses, but always resulted in a reduction in profitability, such that it probably warrants inclusion of M2;
- All investment in stand-off and effluent infrastructure resulted in significant reductions in profitability when system intensity was held constant, but increasing/expanding the use of existing infrastructure (with a sunk cost) improved environmental performance for little negative financial cost;
- The exclusion of livestock from first-order (smaller) waterways generally had no negative productive impact (same production for slightly less area was almost always achieved), but could require significant capital investment;
- As modelled, the development of wetlands resulted in improved (reduced) N and P losses, but were expensive and generally required some reduction in stock numbers;
- Other than significant land use change, as modelled in OVERSEER, the adoption of low solubility P fertiliser provided a good mechanism to reduce P loss risk. A reduction in profitability was expected to occur because of the need for an initial capital application of slow-release reactive phosphate rock (RPR) fertiliser to counter the impact of 30% of the P content becoming available in any given year;
- Albeit the last mitigation applied, lowering stocking rate could improve [the already significantly reduced] farm profitability in some of the cases without assuming improvement in farm management capability. This suggests that there may be scope for some farm systems to reduce intensity (stocking rate and associated inputs) and actually experience minimal profitability loss. It is likely this could be achieved at earlier stages of the mitigation sequencing (i.e. optimising stocking rate after other significant mitigations).
- Improving the efficiency of irrigation, improved environmental performance (largely through a reduction in drainage) but the impact on profitability depended on the relative capital outlay;

- The impact of the bundles on BGHG emissions profiles of farms tended to correlate directly with reductions in N fertiliser usage (which lowered estimated N_2O emissions) and stock numbers (which lowers methane emissions). Introducing a stand-off pad (as modelled) typically increased emissions of both CH_4 and N_20, as result of the assumption of a carbon base (woodchip) for the stand-off area;
- The net capital cost (including capital released from livestock reductions) of implementing all three bundles averaged $369,000 for the unirrigated farms and $636,000 for the irrigated farm system. The opportunity cost of such capital (a discount rate of 5% was used) was accounted for in the change in profitability (as was any increase in depreciation associated with infrastructure).

7.1.3 Sensitivity analysis of bundle cost

The cost of implementing all the bundles was considered against a number of variables that might be expected to have some impact. Bundle cost was sensitised against the cost of a key input (N fertiliser), the prices for a key output (milk price), the cost of carbon and the extent to which farming might have to account for its biological emissions and the impact of council co-investment in the cost of fencing and planting riparian buffers and detention bund activities. The results are presented in Table 26 through Table 28.

Table 26: Cumulative average cost ($/ha) of implementing M1 - M3 with changes in milk and urea price

Urea price ($/t)	Milk price ($/kg MS) →	4.5	5	5.5	6	6.5	7
	500	-404	-465	-526	-588	-649	-710
	564	-392	-453	-514	**-576**	-637	-698
	600	-385	-446	-508	-569	-630	-691
	700	-366	-428	-489	-550	-611	-673
	800	-348	-409	-470	-531	-593	-654

Table 27: Cumulative average cost ($/ha) of implementing M1 - M3 with changes in carbon price and ETS accountability

Carbon price ($/t CO^2e)	% CO_2e emissions needing to be paid for →	0%	10%	20%	30%	40%	50%
	10	-576	-574	-572	-570	-569	-567
	21	**-576**	-572	-568	-565	-561	-557
	30	-576	-570	-565	-560	-555	-550
	40	-576	-569	-562	-555	-548	-541
	50	-576	-567	-558	-550	-541	-533

Table 28: Cumulative average cost ($/ha) of implementing M1 - M3 with changes in council funding

% funding for detention bunds	% funding for fencing and planting activities: 0%	25%	50%	60%	70%	75%
0%	-584	**-576**	-567	-564	-560	-559
25%	-583	-574	-566	-563	-559	-557
50%	-582	-573	-565	-562	-558	-556
75%	-581	-572	-564	-560	-557	-555
100%	-580	-571	-563	-559	-556	-554

The following observations were made:

- As the price of product (i.e. milk) increased, the cost of bundle implementation increased. This is unsurprising as the quantity of farm output (kg MS) decreased as the mitigations were sequentially applied and the opportunity cost of lost production becomes greater as the price increased;
- As the price of an input (N fertiliser) increased, the cost of mitigation reduced. For an input like N fertiliser, which is heavily linked to one of the contaminants targeted by the mitigation bundles, lowering its use saves the farm system more at higher prices;
- As carbon price increased and the extent to which agriculture had to account for its emissions increased, the cost of the bundle implementation reduced, but not substantially. As modelled, the water quality mitigation bundles delivered a reduction in BGHG emissions to the six dairy farm systems between 15% and 23%, so this limited impact wasn't surprising. However, the impact was greater where the underlying BGHG footprint of the farm was higher and the mitigations had greater impact on lowering emissions. For example, assuming dairying had to account for 50% of their BGHG emissions, for the Lower KPW dairy farm (15 t CO_2e/ha/year) as carbon price increased to $50/t, the cost of bundle implementation reduced by 15% compared to the Upper KPW dairy farm (8 t CO_2e/ha/year), where costs only lowered by 5%;
- The impact of council co-investment [subsidy] for [the chosen] environmental works was quite low for the dairy farms modelled. Lifting the proportion of council funding for riparian fencing and planting from the assumed 25% level to 75% only reduced the average cost of bundle implementation by 3%. This reflects the generally limited scope of the riparian works needing to be implemented and the lower cost of the fencing needed to exclude dairy cattle from riparian areas compared with sheep, cattle and deer systems (see 7.2.3 below). Similarly, increased council funding for detention bund works had limited impact on cost (in the order of 1% reduction in bundle cost), again due to the limited component of the bundle that such works comprise.

The individual abatement curves for the six farm systems are presented below in Figure 1-Figure 12. On a nominal output basis, the change in profitability is charted on the left vertical axis and the change in environmental outputs is charted on the right vertical axis. The relative changes in outputs are graphed on a percentage basis against each other.

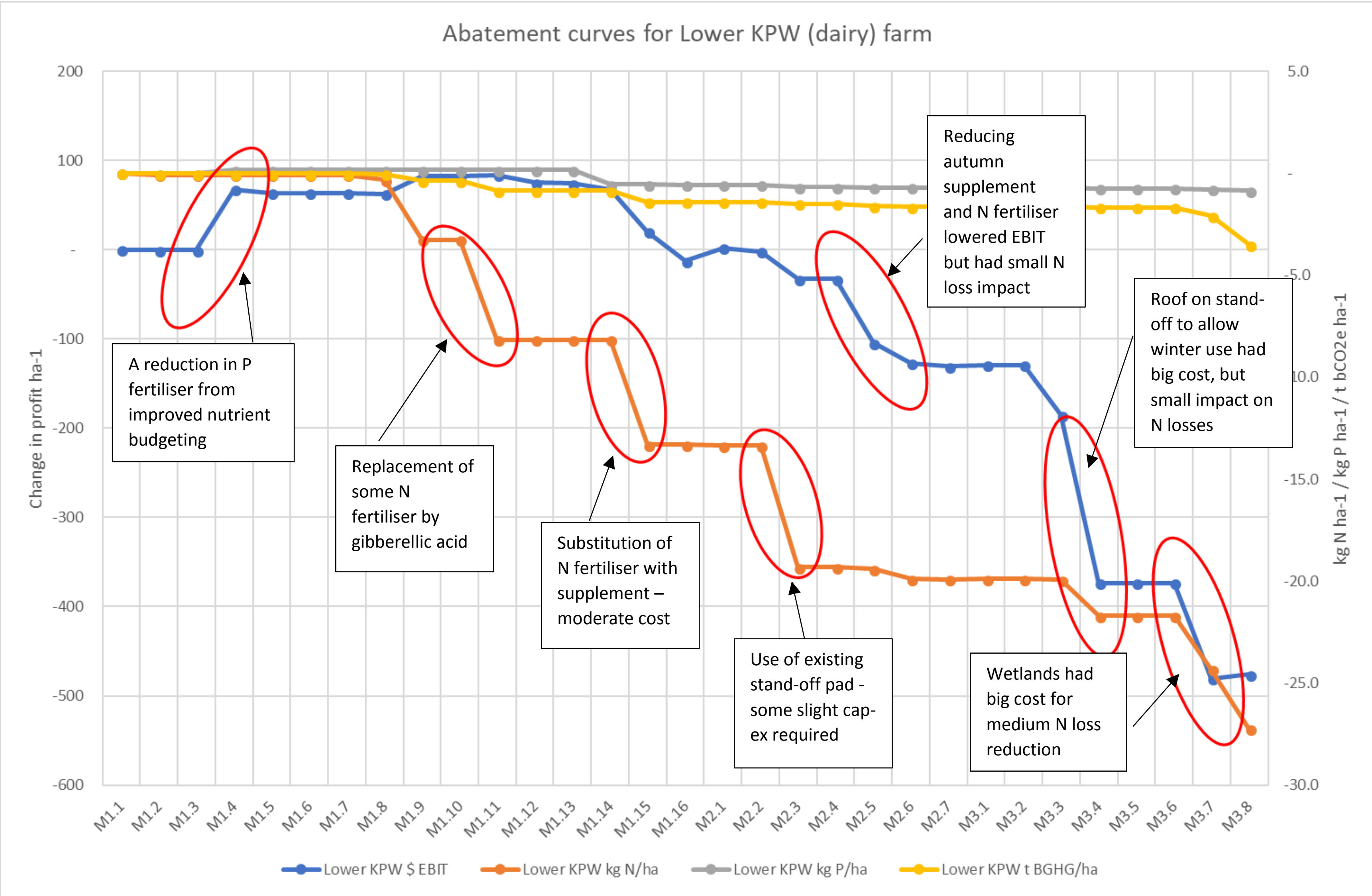

Figure 1: Sequential abatement curves for change in profit (LHS) and change in contaminant output (RHS) for the Lower KPW dairy farm system

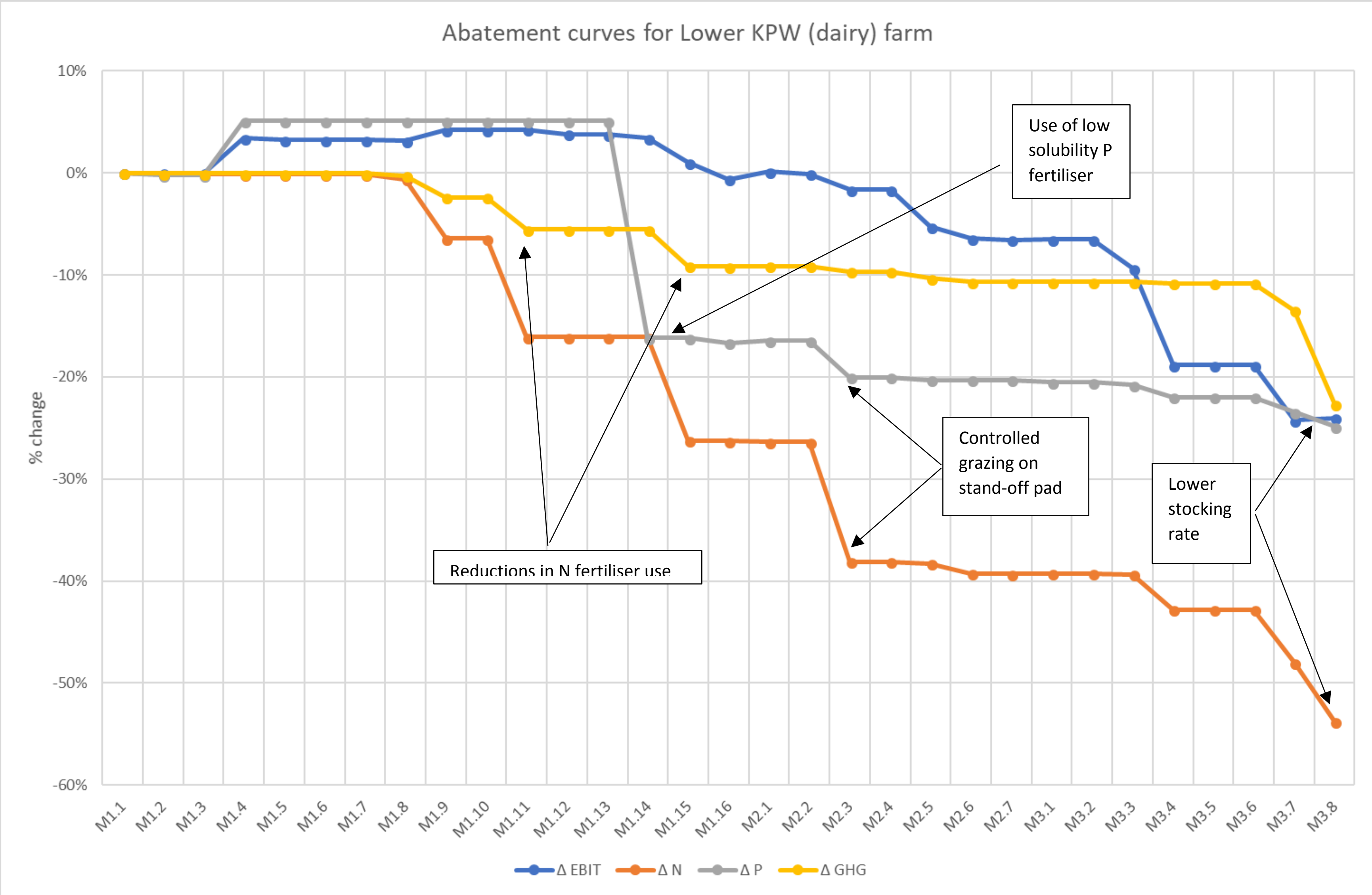

Figure 2: Sequential abatement curves for relative (%) change in profit and in contaminant output for the Lower KPW dairy farm system

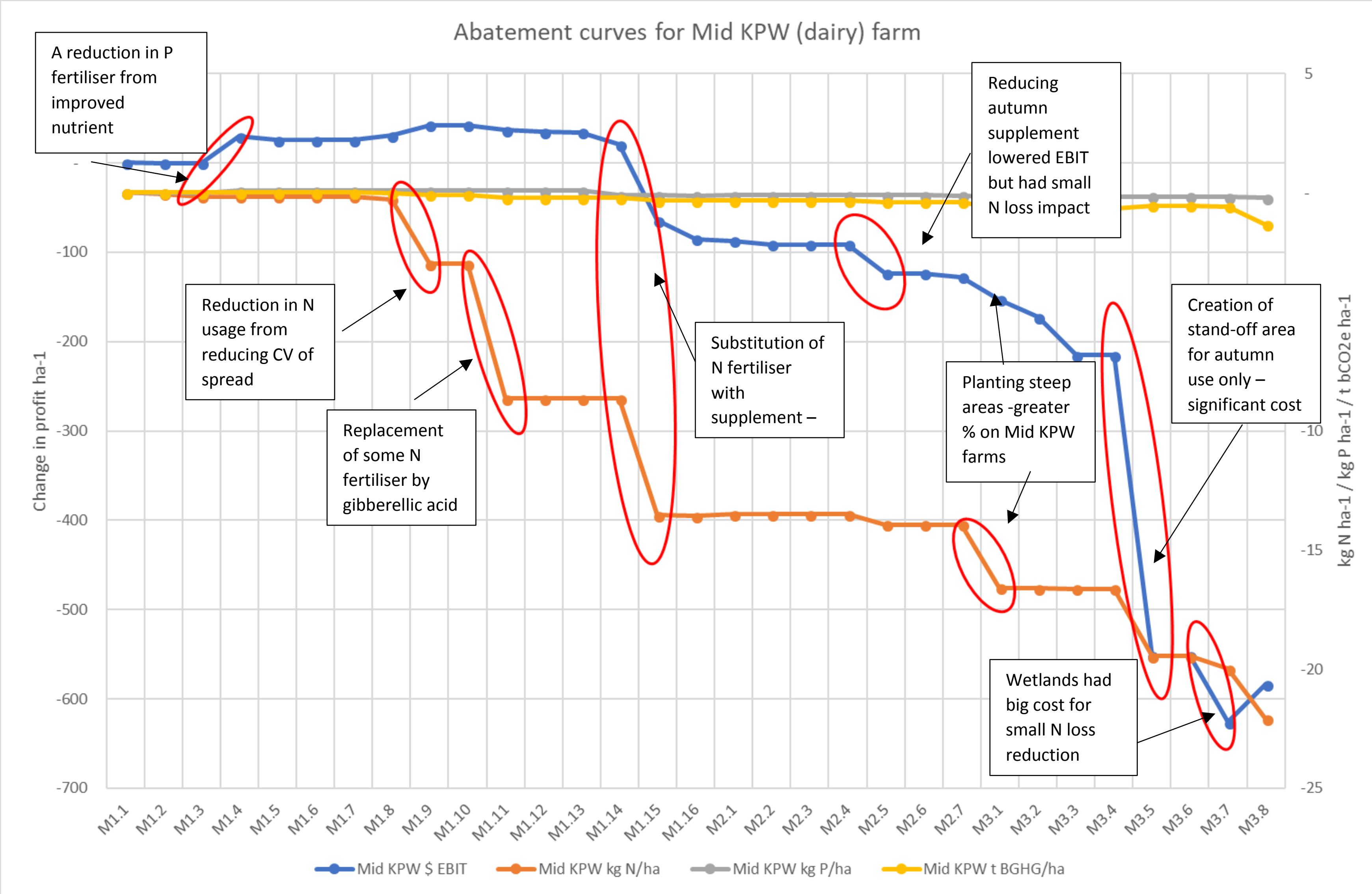

Figure 3: Sequential abatement curves for change in profit (LHS) and change in contaminant output (RHS) for the Mid KPW dairy farm system

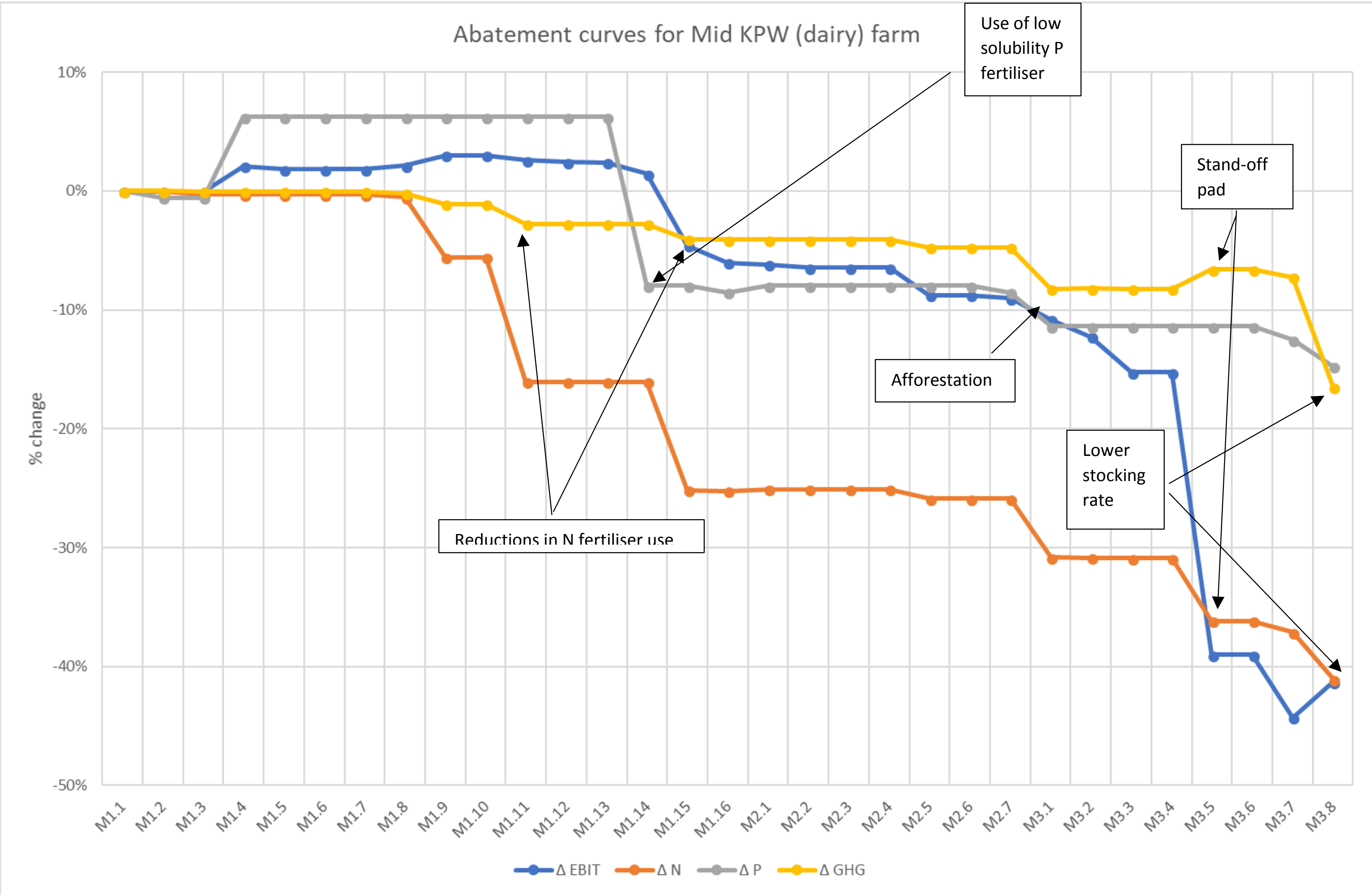

Figure 4: Sequential abatement curves for relative (%) change in profit and in contaminant output for the Mid KPW dairy farm system

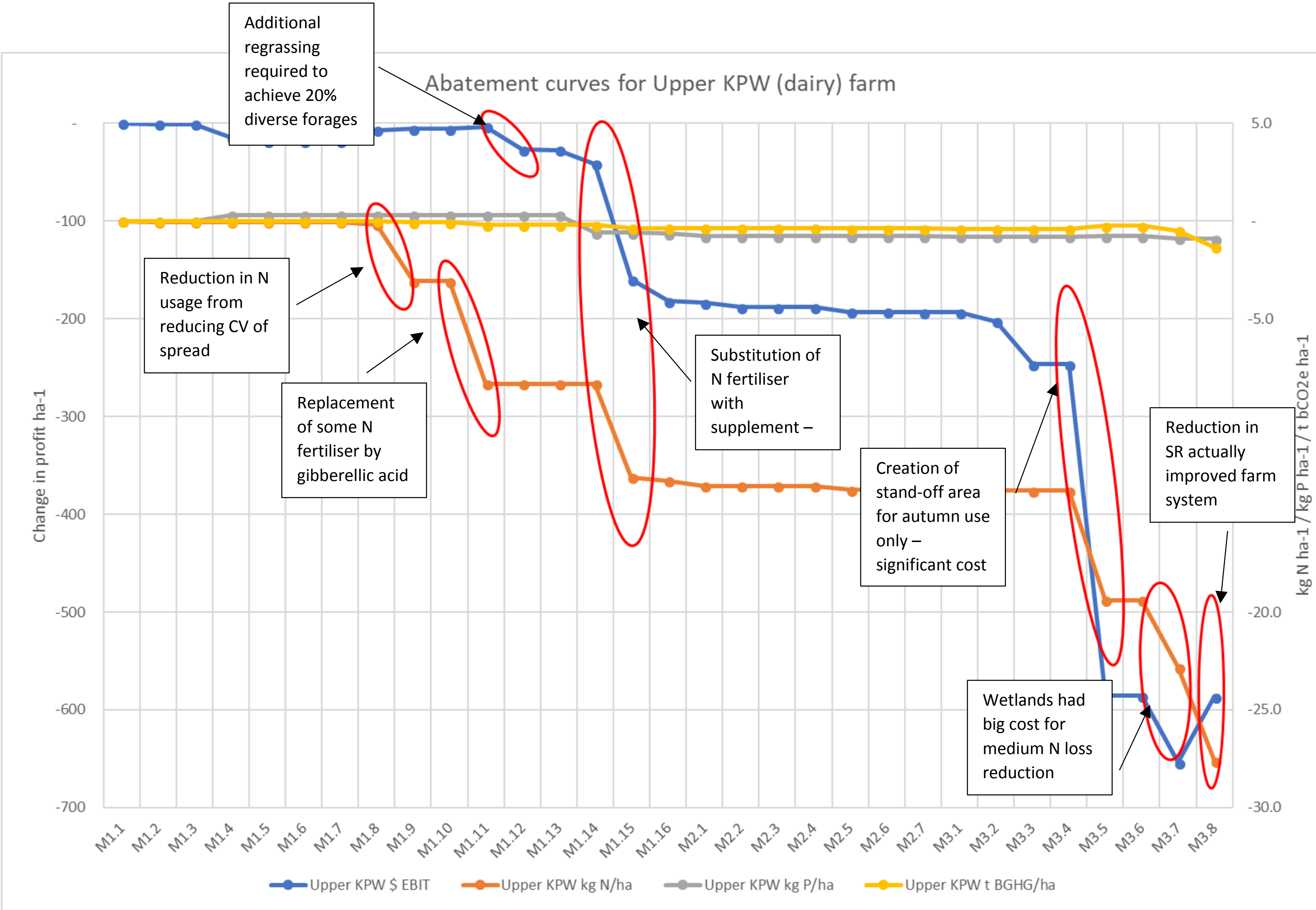

Figure 5: Sequential abatement curves for $ change in profit (LHS) and change in contaminant output (RHS) for the Upper KPW dairy farm system

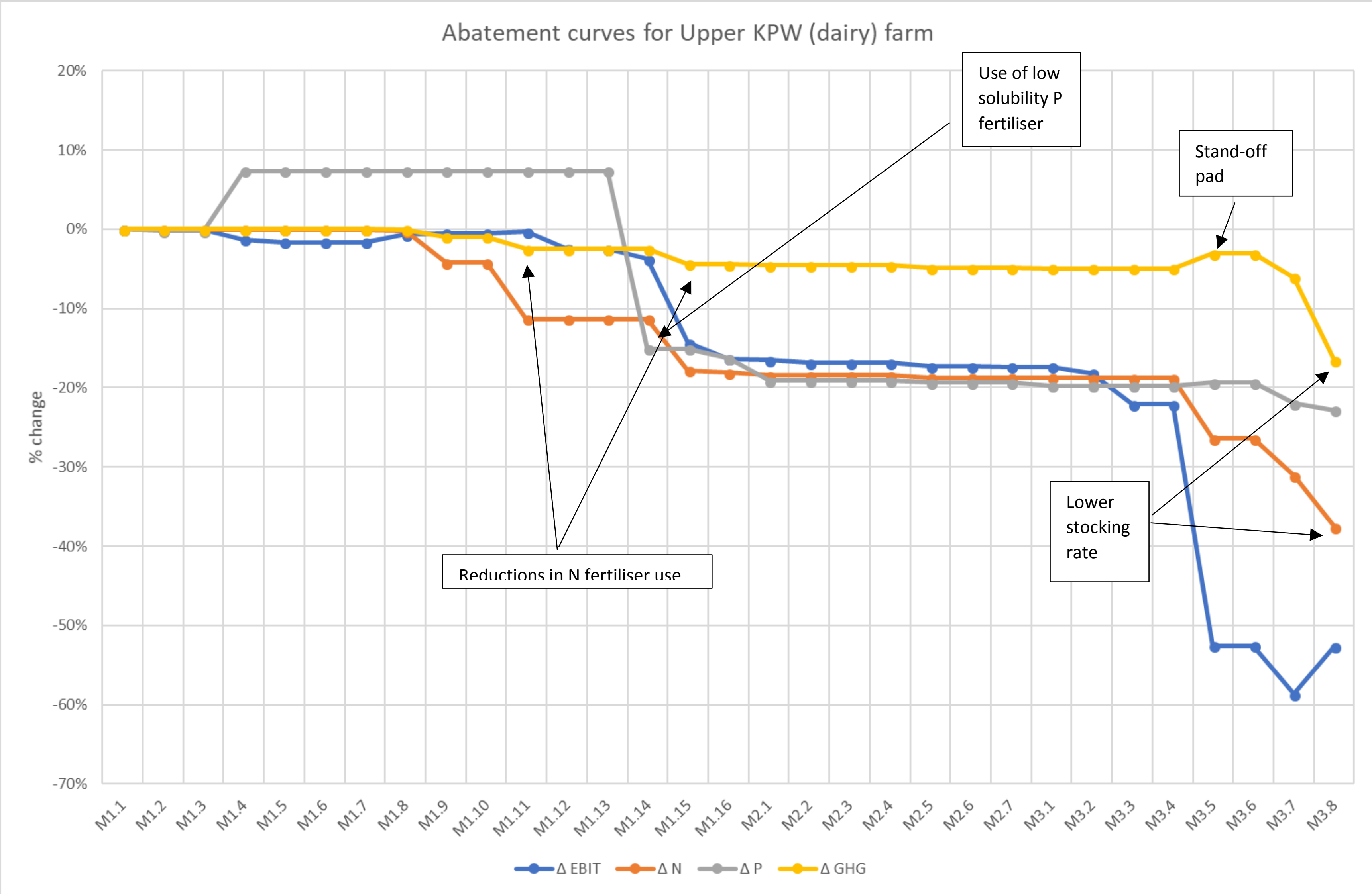

Figure 6: Sequential abatement curves for relative (%) change in profit and in contaminant output for the Upper KPW dairy farm system

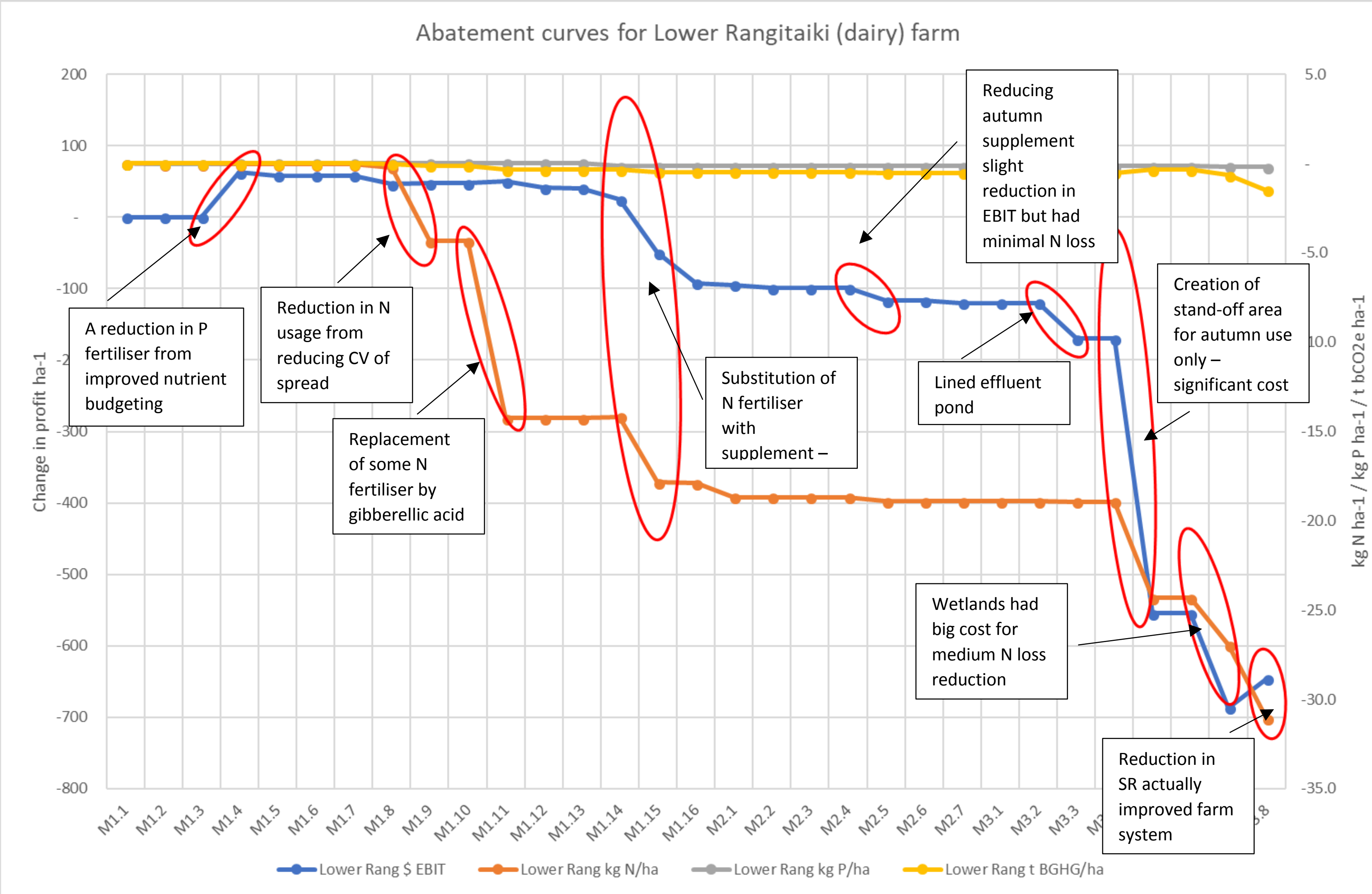

Figure 7: Sequential abatement curves for $ change in profit (LHS) and change in contaminant output (RHS) for the Lower Rangitāiki dairy farm system

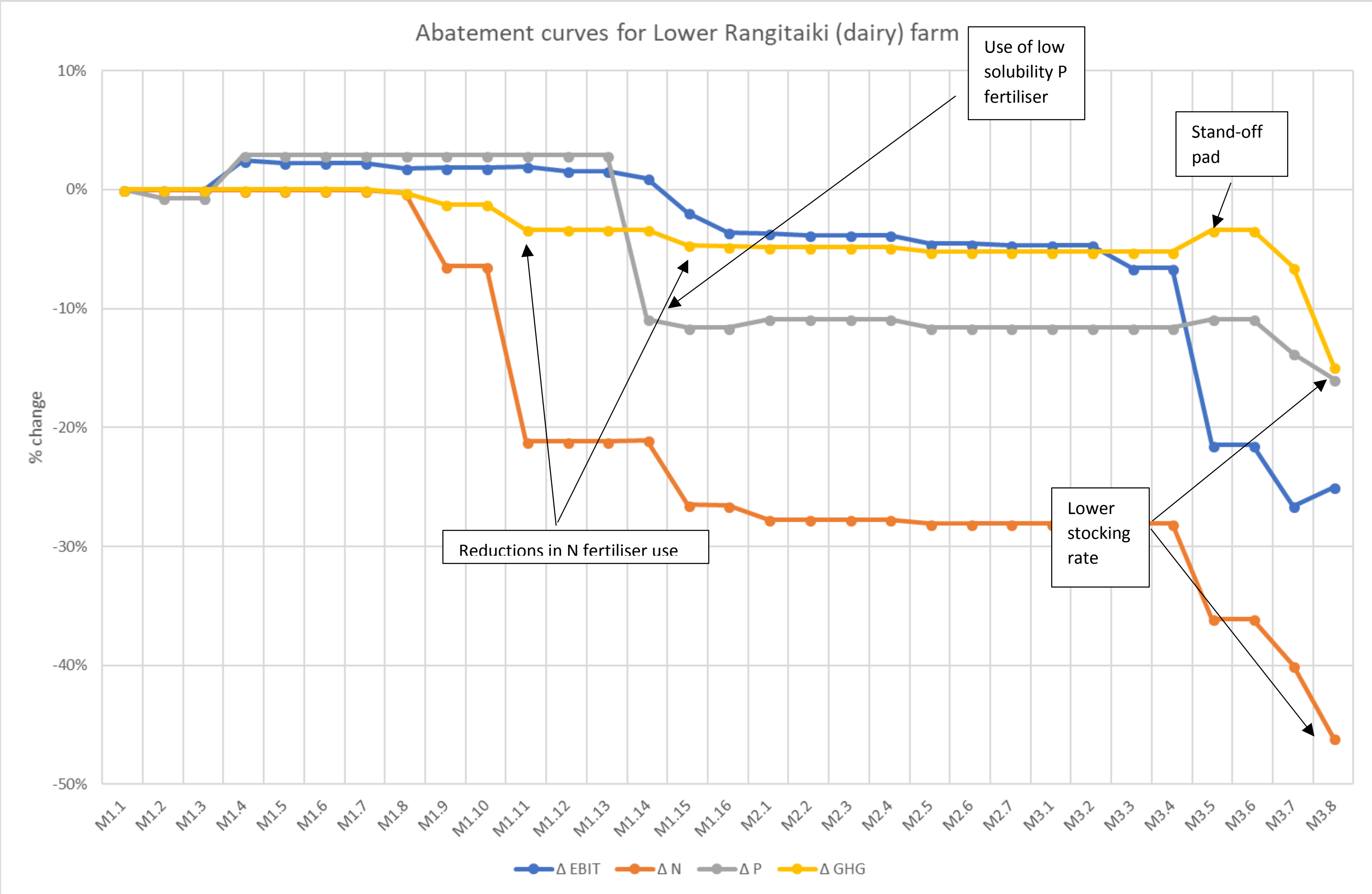

Figure 8: Sequential abatement curves for relative (%) change in profit and in contaminant output for the Lower Rangitāiki dairy farm system

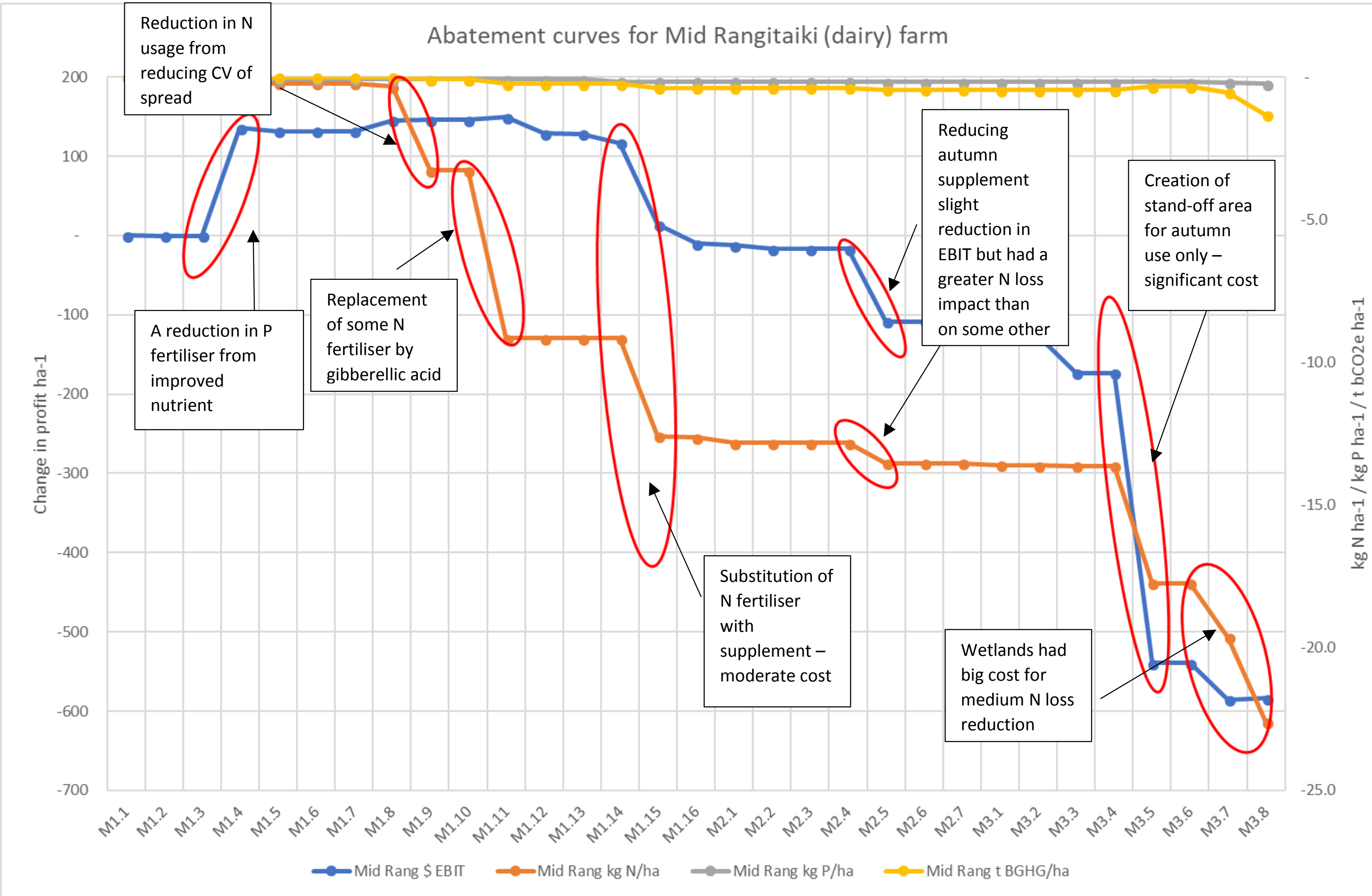

Figure 9: Sequential abatement curves for $ change in profit (LHS) and change in contaminant output (RHS) for the Mid Rangitāiki dairy farm system

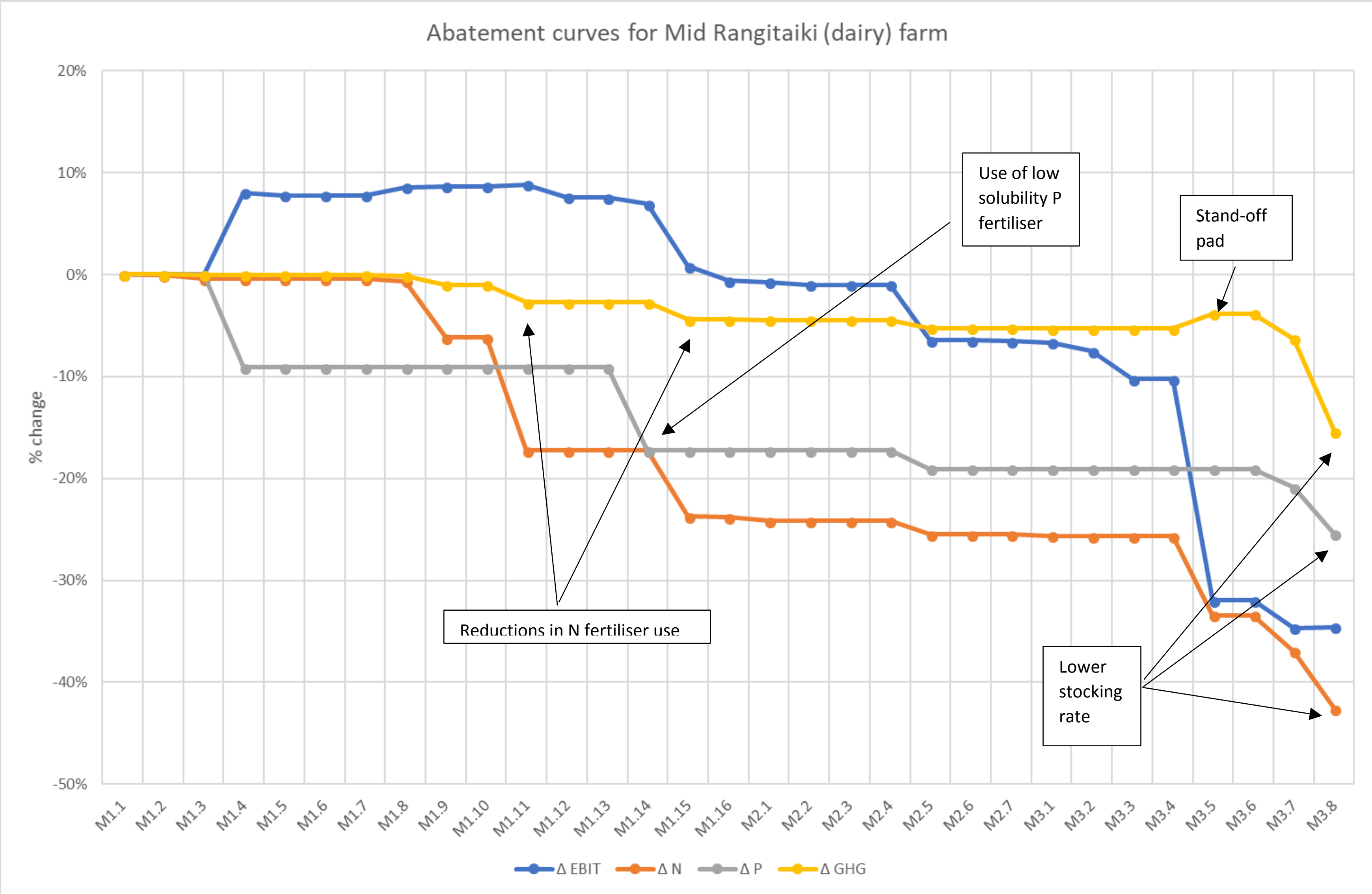

Figure 10: Sequential abatement curves for relative (%) change in profit and in contaminant output for the Mid Rangitāiki dairy farm system

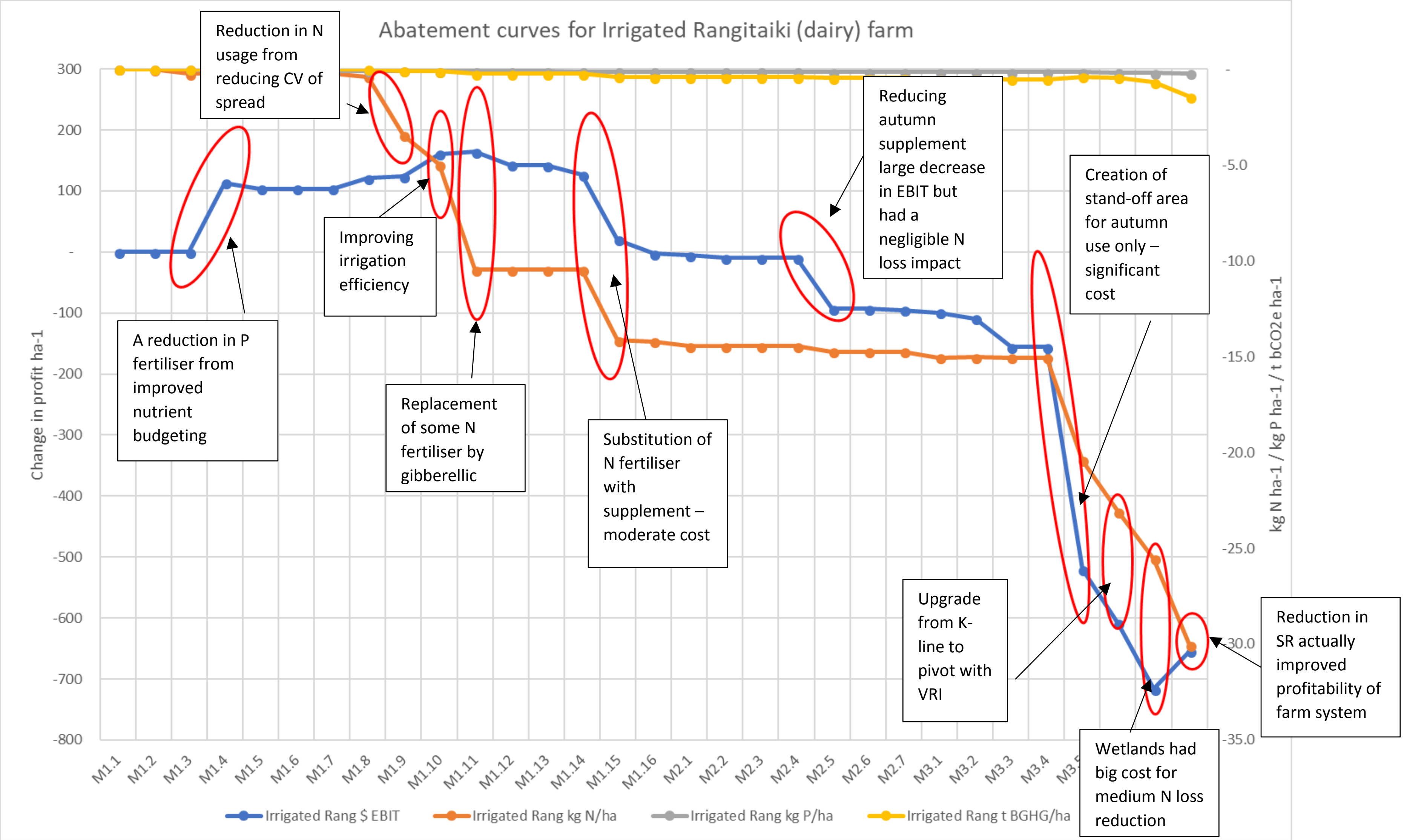

Figure 11: Sequential abatement curves for change in $ profit (LHS) and change in contaminant output (RHS) for the Irrigated Rangitāiki dairy farm system

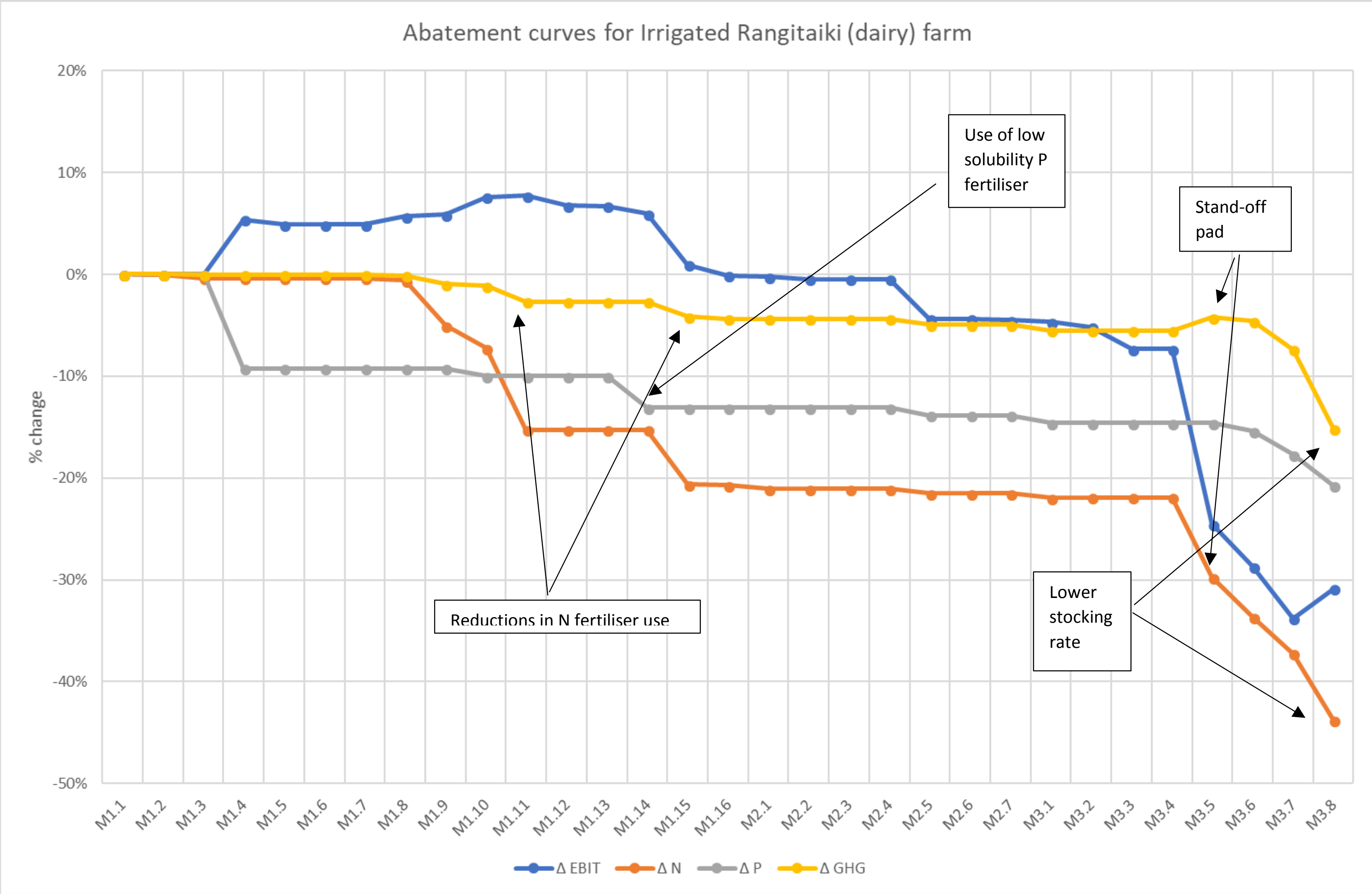

Figure 12: Sequential abatement curves for relative (%) change in profit and in contaminant output for the Irrigated Rangitāiki dairy farm system

7.2 Drystock farm systems

7.2.1 Summary of bundles

On average across the four drystock farm systems analysed, implementation of M1 lowered profitability by $95/ha, M2 by $80/ha and M3 by $51/ha. While the overall financial impact of implementing the full bundle across the farm systems was significant, this was more so for the systems in the Kaituna-Pongakawa-Waitahanui WMA, particularly for the KPW sheep and beef farm system that was essentially unprofitable after M1 had been implemented. Unlike the dairy farm systems, where the mitigation sequencing and the aggregation into bundles resulted in bundles with economic outcomes in line with expectations, those for the dry stock systems performed quite differently, with the financial impact of applying the mitigation differing from our expectations. This suggests a review of the bundling will be required and/or that a strict mitigation bundling approach to any measures designed to improve water quality will be more challenging for drystock farm systems.

Table 29: Change in annual drystock farm gate profitability ($/ha) from the implementation of mitigation bundles

	KPW DS	KPW S+B	Rangitaiki S+B	Rangitaiki Deer	Average
M1	-111	-107	-81	-81	-95
M2	-214	-101	-26	20	-80
M3	-86	-37	-22	-62	-52
Total	-411	-244	-129	-122	-227

The financial impact of implementing M1 tended to be heavily influenced by one main factor - the incorporation of low N forages into the farm system – modelled here as the development of diverse swards to comprise at least 20% of the pasture. At this scale this imposed significant costs on the farm system that were not recouped through productivity gains. Excluding this mitigation would have seen the cost of M1 reduce to an average reduction in profit of $41/ha.

The inclusion of afforestation of steep land within the M2 bundle for the dry stock systems (versus M3 for the dairy farm systems) had the greatest impact on the cost of the M2 bundle for the KPW farms. For the Rangitāiki deer model, the apparent use of unprofitable N fertiliser in spring had a large positive impact on the "cost" of M2 implementation.

The variation in bundle impact for these farms is likely to be greater than for the dairy farms, which exhibited greater homogeneity in system parameters.

The bundle aggregation could potentially be enhanced for the drystock systems by moving low N forages into M2 and afforestation into M3. We'd recommend this approach be considered.

As can be seen from Table 30 overleaf, the percentage reductions in farm system profitability outstrip the reduction in the three "contaminants" estimated by OVERSEER, being N, P and biological greenhouse gas emissions (CH_4 and N_20). Full adoption of the mitigation bundles on the drystock farm systems modelled reduced N losses by 14%-35%, P losses by 0%-38% and BGHG emissions by 8%-34%% - all for a reduction in profitability ranging between 53% and 183% of existing profits.

Table 30: Relative changes in annual drystock farm gate profitability and water and atmospheric contaminants as measured in OVERSEER 6.3.0 from the implementation of mitigation

KPW DS				
Bundle	Δ EBIT	Δ N	Δ P	Δ GHG
M1	-20%	-1%	-12%	0%
M2	-66%	-22%	-38%	-25%
M3	-83%	-35%	-38%	-34%

KPW S+B				
Bundle	Δ EBIT	Δ N	Δ P	Δ GHG
M1	-81%	-1%	-18%	-1%
M2	-156%	-25%	-38%	-22%
M3	-184%	-31%	-38%	-25%

Rangitaiki S+B				
Bundle	Δ EBIT	Δ N	Δ P	Δ GHG
M1	-37%	-2%	-6%	-1%
M2	-49%	-8%	-9%	-6%
M3	-59%	-14%	-10%	-9%

Rangitaiki Deer				
Bundle	Δ EBIT	Δ N	Δ P	Δ GHG
M1	-35%	-2%	-9%	0%
M2	-27%	-4%	-9%	-2%
M3	-53%	-14%	-10%	-8%

7.2.2 General observations

In general:

- The elimination of N fertiliser that was deemed to support capital livestock lowered overall profitability in each of the three times it was implemented, even though crude marginal analysis would suggest this not to be the case. Part of the reason for this is the stickiness of some farm costs, primarily labour and fixed overheads;
- Other than significant land use change, as modelled in OVERSEER, the adoption of low solubility P fertiliser provided a good mechanism to reduce P loss risk. A reduction in profitability was expected to occur because of the need for an initial capital application of the RPR to counter the impact of only 30% of the P content becoming available in any given year;
- In the absence of any carbon liability, planting the steep land (as modelled) typically resulted in a reduction in profitability, particularly for the higher value pastoral land uses (dairy support). This is again due to the stickiness of fixed costs and labour, the conservative approach taken to account for longer term tree income and the difference between the breakdown of contour in our study and that derived by the GIS analysis of the BOPRC. As suggested in earlier reports, comparing livestock enterprises with forestry using annual

profit measures is also fraught with problems and we really need a discounted cashflow approach to adequately analyse this. We suspect the approach necessitated in this analysis undervalues the longer-term value of forestry as a mitigation on steeper pastoral land.

- The integration of sufficient low N forages in the farm system (a minimum area of 20%) was a significant cost to these farm systems where limited re-grassing was assumed to occur. The often-limited areas within these drystock farms that could be successfully re-sown into diverse swards provide some logistical challenges and it is likely these areas would already have the highest performing pastures on the farm, limiting any productive gain from these pastures. As a result, there was a cost of $691/ha over 10% of the farm area that delivered no “measurable” improvement in environmental performance;
- Wetland development at a nominal 3% of farm area required significant capital expenditure and the associated cost of capital represented a significant proportion of farm profit;
- Where the exclusion of livestock from waterways was required, the financial impact was greater where sheep (7 wire fencing) or deer (1800mm netting fencing) had to be excluded;
- As modelled, gorse management on steeper land can be expensive. The cost could be defrayed by a reclamation of effective grazing area, but this wasn’t modelled. In practice this can be hard to achieve from large but scattered stands as a result of long-term suppression of clover growth after 2-4-D or metsulfuron applications and the ongoing challenge of regrowth in these areas.
- Improving cropping practices for winter cropping, while having a slight negative impact in profit had the potential to deliver moderate improvements in environmental outputs, despite the often-low area of the farm this related to.
- Increasing sheep to cattle ratios lowered N losses, but lowered profitability as well. This directly relates to the relative profitability of the sheep and cattle systems modelled;
- The net capital cost (including capital released from livestock reductions) of implementing all three bundles averaged $394,000 for these farms (a range of $835/ha to $1,297/ha). The opportunity cost of such capital was accounted for in the change in profitability (as was any increase in depreciation associated with infrastructure). The majority of these costs were associated with riparian fencing and planting, capital RPR fertiliser and then afforestation costs.

7.2.3 Sensitivity analysis of bundle cost

The cost of implementing all the bundles was considered against a number of variables that might be expected to have some impact for a number of the farm systems. Bundle cost was sensitised against the cost of a key input (N fertiliser), the prices for key outputs (beef, lamb and venison prices), the cost of carbon and the extent to which farming might have to account for its biological emissions, the impact of council co-investment in the cost of fencing and planting riparian buffers and detention bund activities and the cost of and annual income associated with commercial forestry as a partial land use change. The results are presented in Table 31 through Table 36.

Table 31: Cumulative cost ($/ha) of implementing M1 - M3 for Rang S+B with changes in lamb and beef price

Beef price ($/kg cwt)		Lamb price ($/kg cwt)					
		4.50	5.00	5.50	6.00	6.50	7.00
	4.50	-113	-111	-108	-106	-104	-102
	5.00	-122	-120	-118	-116	-114	-111
	5.55	-133	-131	**-129**	-127	-124	-122
	6.00	-142	-140	-137	-135	-133	-131
	6.50	-152	-149	-147	-145	-143	-141

Table 32: Cumulative cost ($/ha) of implementing M1 - M3 for KPW DS with changes in N fertiliser and "beef" price[4]

Urea price ($/t)		Beef price ($/kg cwt)					
		4.94	5.24	5.55	5.86	6.17	6.48
	500	-340	-376	-413	-450	-487	-524
	564	-338	-374	**-411**	-448	-484	-522
	600	-336	-373	-410	-447	-483	-520
	700	-333	-370	-407	-444	-480	-517
	800	-330	-366	-403	-440	-477	-514

Table 33: Cumulative cost ($/ha) of implementing M1 - M3 for Rang D with changes in N fertiliser and venison price

Urea price ($/t)		Venison price ($/kg cwt)					
		7.00	7.50	8.00	8.50	8.00	9.50
	500	-118	-122	-126	-131	-126	-139
	564	-114	-118	**-122**	-127	-122	-135
	600	-111	-116	-120	-124	-120	-133
	700	-105	-109	-114	-118	-114	-127
	800	-99	-103	-107	-112	-107	-121

Table 34: Cumulative average cost ($/ha) of implementing M1 - M3 with changes in council funding

% funding for detention bunds		% funding for fencing and planting activities					
		0%	25%	50%	60%	70%	75%
	0%	-236	**-225**	-215	-211	-206	-204
	25%	-236	-225	-214	-210	-206	-204
	50%	-235	-225	-214	-210	-205	-203
	75%	-235	-224	-214	-209	-205	-203
	100%	-235	-224	-213	-209	-205	-203

[4] With carcass weight equivalent a key output in the biophysical modelling used (Farmax), a change in beef price has been used here as a proxy for the changes in grazing prices that would ultimately affect the profitability of dairy support systems. The beef prices used here approximate to a range in heifer grazing rates of $8-$10.50/head/week (with calf and winter cow grazing prices relative to these)

Table 35: Cumulative cost ($/ha) of implementing M1 - M3 for KPW S+B with changes in carbon price and ETS accountability

Carbon price ($/t CO²e)	% CO_2e emissions needing to be paid for					
	0%	10%	20%	30%	40%	50%
10	-244	-243	-242	-241	-240	-239
21	**-244**	-242	-240	-238	-235	-233
30	-244	-241	-238	-235	-232	-228
40	-244	-240	-236	-232	-227	-223
50	-244	-239	-234	-228	-223	-218

Table 36: Cumulative cost ($/ha) of implementing M1 - M3 for KPW S+B with changes in forestry income and cost of establishment

Establishment cost ($/ha)	Annual "income" from P. radiata forestry					
	200	300	400	500	600	700
0	-229	-209	-189	-169	-149	-129
500	-234	-214	-194	-174	-154	-134
1000	-239	-219	-199	-179	-159	-139
1500	**-244**	-224	-204	-184	-164	-144
2000	-249	-229	-209	-189	-169	-149

The following observations were made:

- As the price of product (i.e. milk) increased, the impact on the cost of bundle implementation depended on impact of mitigation on production. Where implementation of the mitigation bundles resulted in reductions of output (as with lowered venison, beef or cattle liveweight production), then mitigation costs increased. This is unsurprising with the opportunity cost of lost production becoming greater as the price increased. However, where, as with the Rang S+B system the net output of a product (sheep meat) actually increased because of the mitigation framework, bundle cost decreased as product prices increased. (see Table 31);
- As the price of an input (N fertiliser) increased, the cost of mitigation reduced. For an input like N fertiliser, which is heavily linked to one of the contaminants targeted by the mitigation bundles, lowering its use saves the farm system more at higher prices (see Table 33);
- As carbon price increased and the extent to which agriculture had to account for its emissions increased, the cost of the bundle implementation reduced, but not substantially. As modelled, the water quality mitigation bundles delivered a reduction in biological greenhouse gas emissions to the four drystock systems between 8% and 34%. For the KPW sheep & beef model sensitised in this way (Table 35), the BGHG reduction was 25%, so a greater extent of impact than for the dairy farm models that averaged a 17% BGHG reduction wasn't surprising;

- The impact of council co-investment [subsidy] for [the chosen] environmental works was greater for the drystock farming systems than for the dairy farms. Lifting the proportion of council funding for riparian fencing and planting from the assumed 25% level to 75% reduced the average cost of bundle implementation by 10% (Table 34). This reflects the greater cost of the fencing needed to exclude sheep, beef cattle and deer from riparian areas compared with dairy farms and the fact that a higher degree of riparian fencing is already assumed to be in place on dairy farms as a result of the Dairy Water Accord. Increased council funding for detention bund works had limited impact on cost (in the order of <1% reduction in bundle cost), due primarily to the limited component of the bundle that such works comprise;
- The efficacy of forestry as a mitigation on steeper soils is more dependent on the "income" from the forested area rather than the cost of afforestation itself (Table 36). While we are cognisant that we have used a very low annual "income" of $200/ha to represent the annual income stream from forestry over time, it is clear that using a figure closer to the equivalent annuity associated with forestry land use, as per Appendix 5 and Appendix 6, has a significant impact on lowering the cost of mitigation (27% improvement) where moderate areas of tree planting is potentially required (65ha / 20% of farm area in the KPW S+B model). This is only a crude sensitivity analysis, given the cost of establishment has a significant impact on the returns from forestry given the time value of money, but it clearly illustrates the opportunity forestry has to be a cost-effective tool for improving water quality where a longer-term view of returns can be made. The challenge of addressing land-owner's concerns about "how do I get enough income to live off if I change land use away from livestock farming to forestry?" is very real and not one that will easily be resolved.

The individual abatement curves for the four farm systems are presented below (Figure 13 - Figure 20). On a nominal output basis, the change in profitability is charted on the left vertical axis and the change in environmental outputs is charted on the right vertical axis. The relative changes in outputs are graphed on a percentage basis against each other.

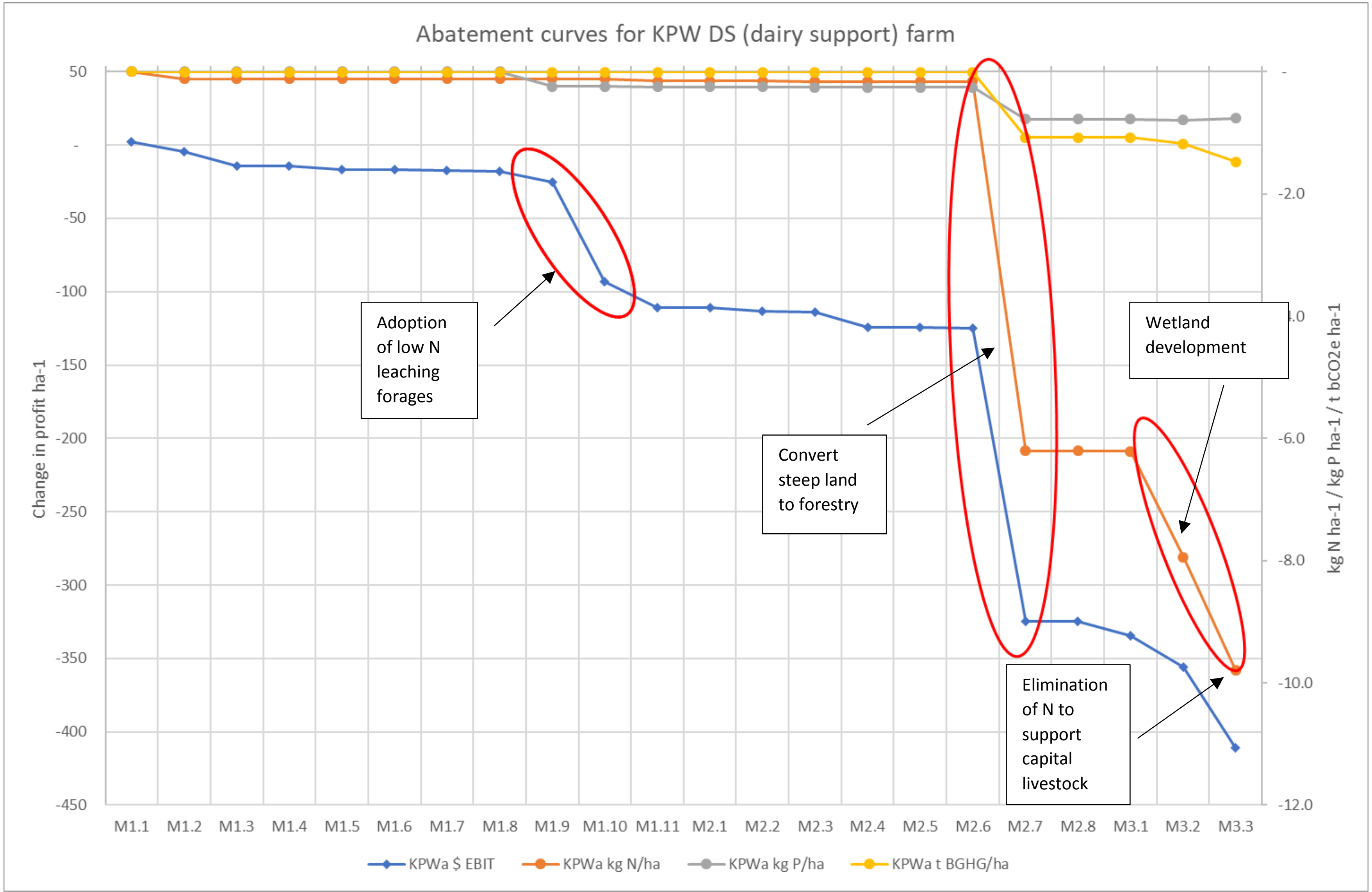

Figure 13: Sequential abatement curves for $ change in profit (LHS) and change in contaminant output (RHS) for the KPW dairy support farm system

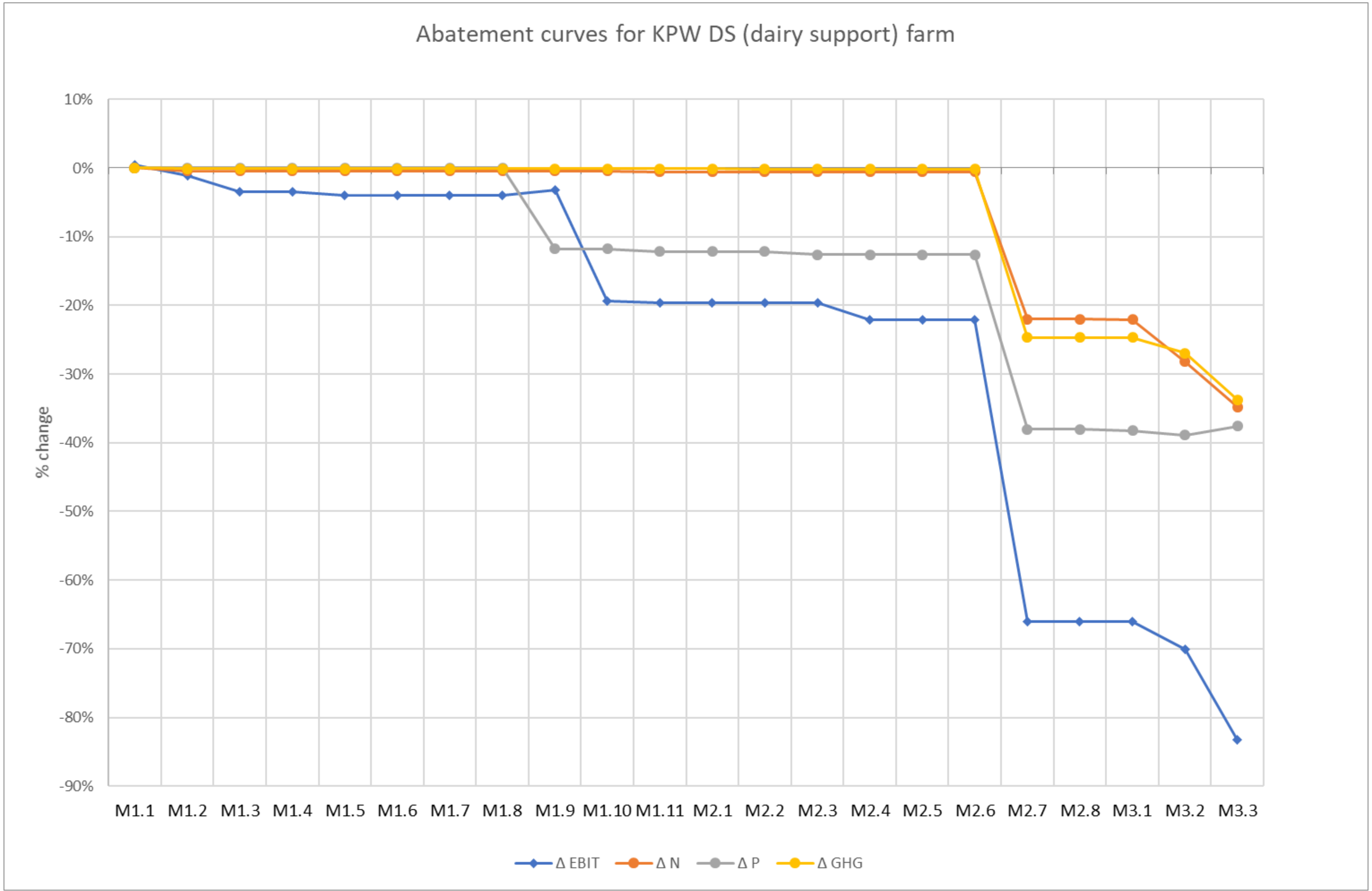

Figure 14: Sequential abatement curves for relative (%) change in profit and in contaminant output for the KPW dairy support farm system

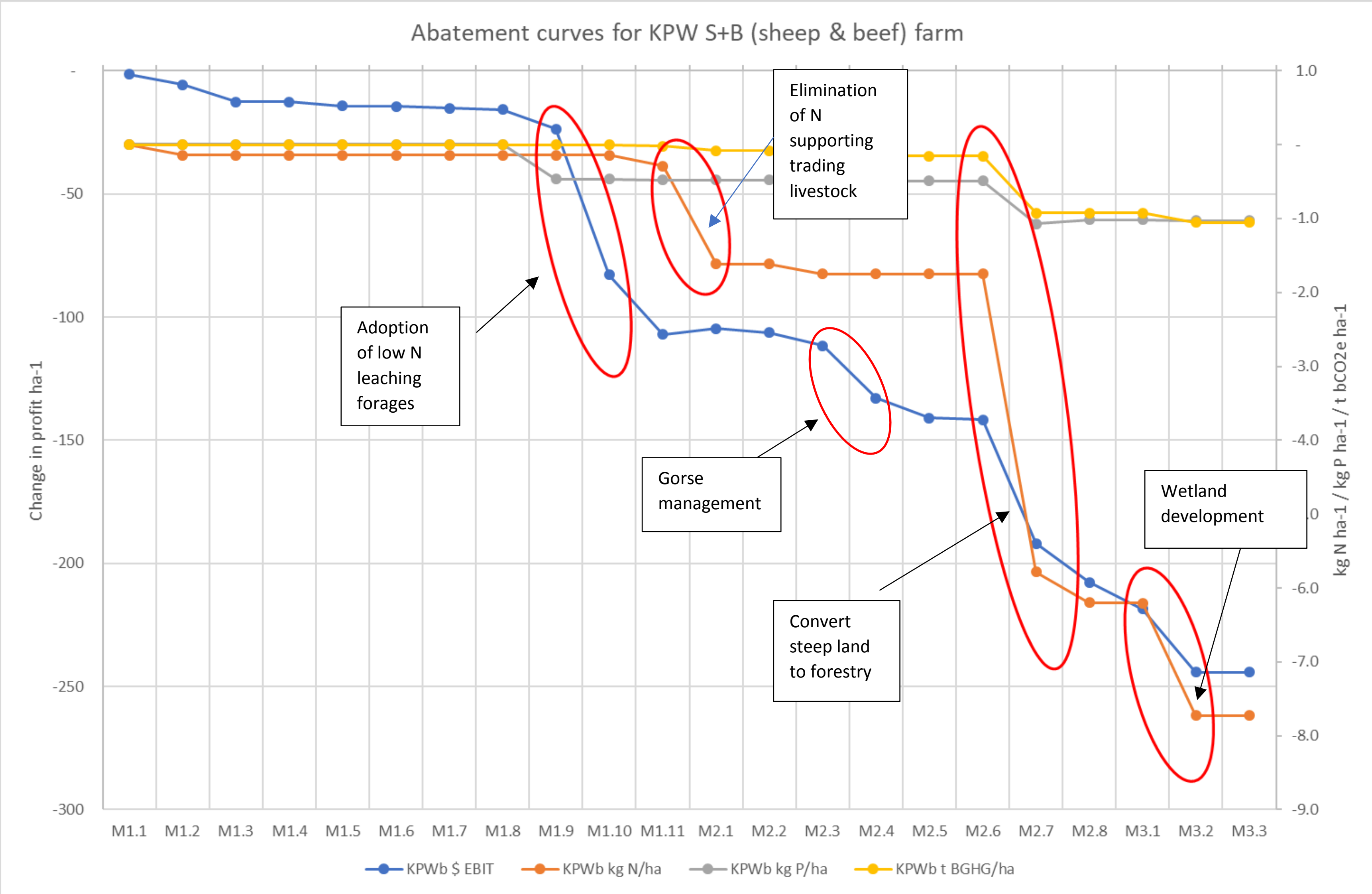

Figure 15: Sequential abatement curves for $ change in profit (LHS) and change in contaminant output (RHS) for the KPW sheep & beef farm system

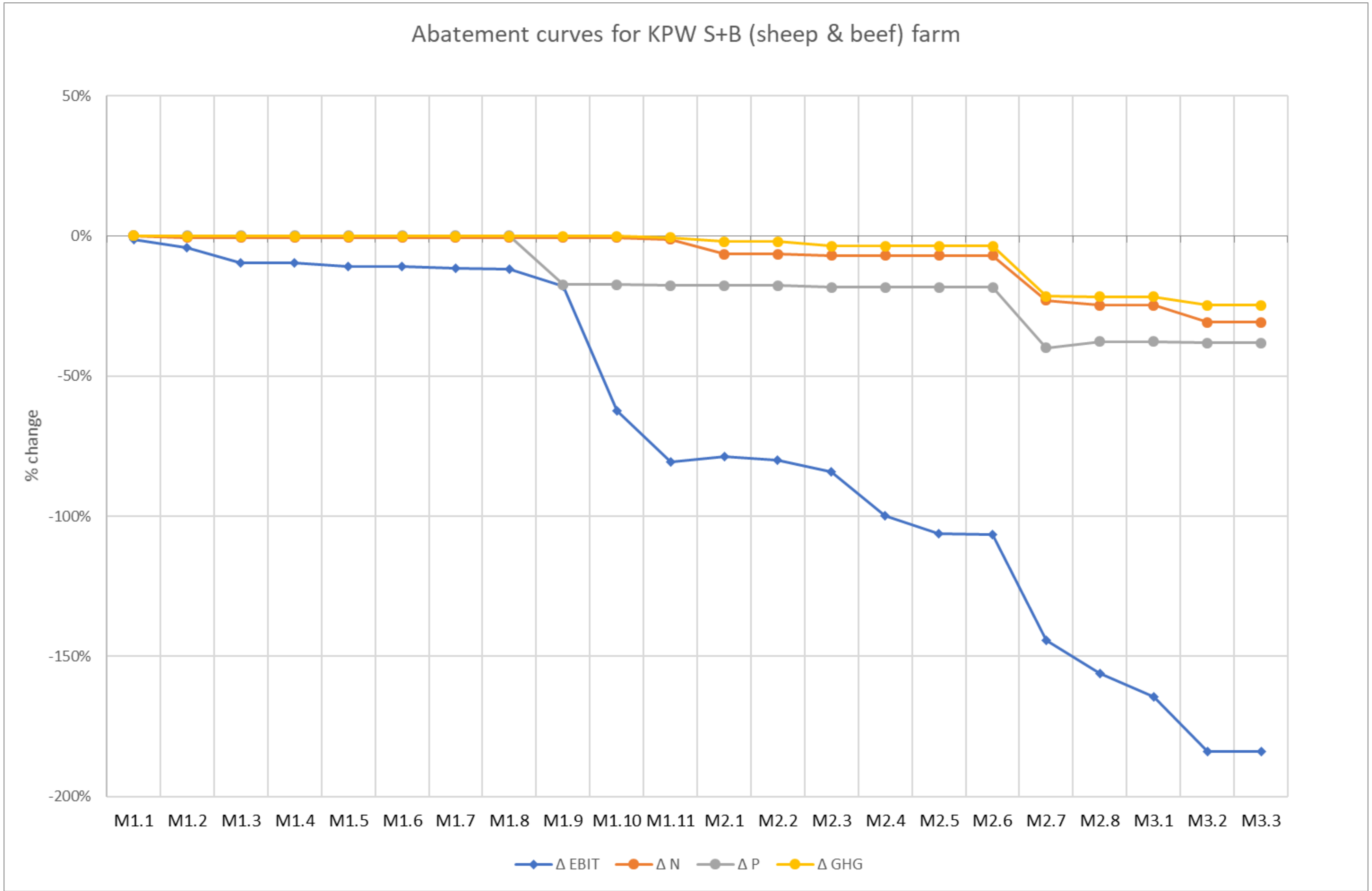

Figure 16: Sequential abatement curves for relative (%) change in profit and in contaminant output for the KPW sheep & beef farm system

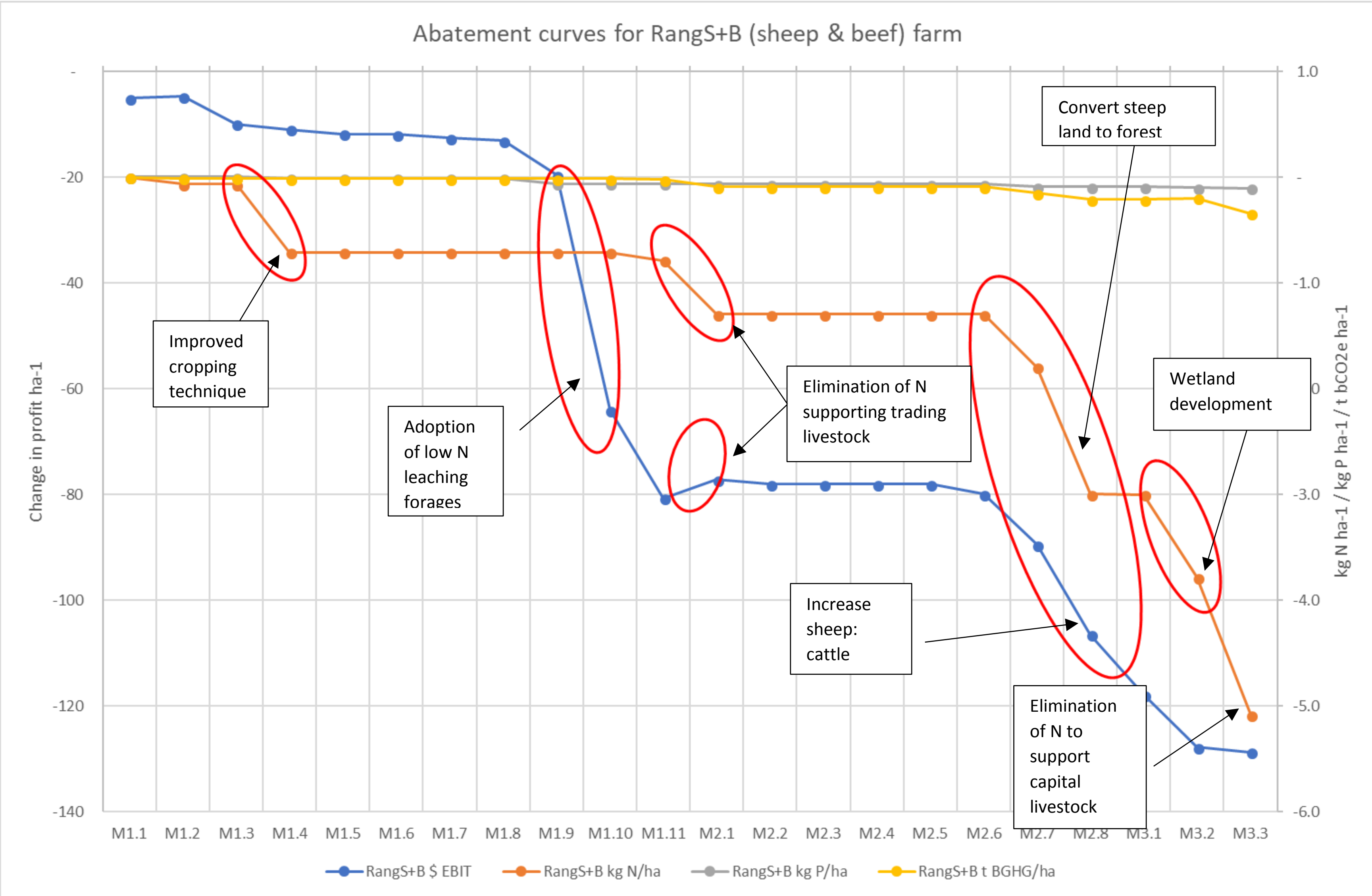

Figure 17: Sequential abatement curves for $ change in profit (LHS) and change in contaminant output (RHS) for the Rangitāiki sheep & beef farm system

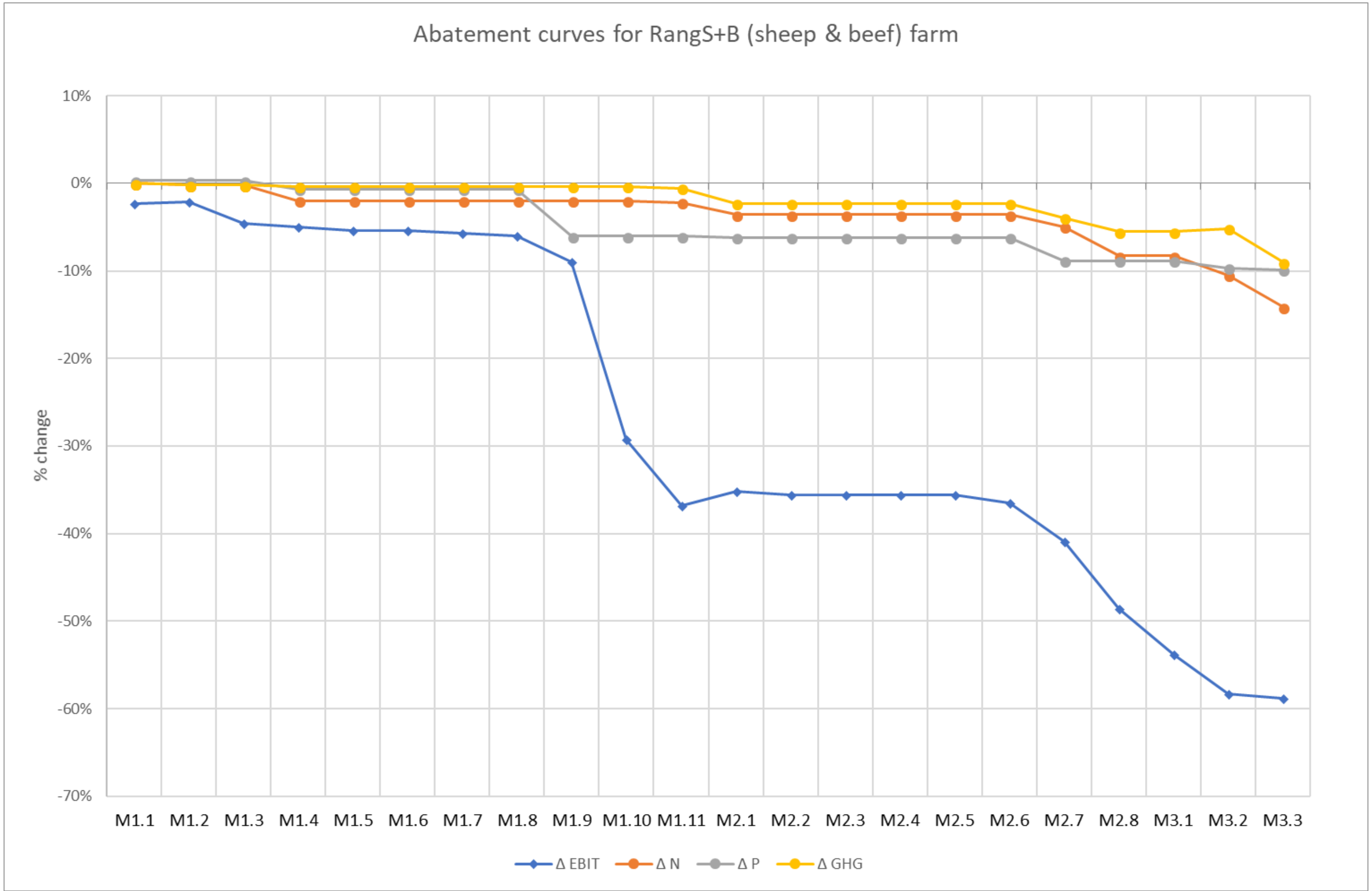

Figure 18: Sequential abatement curves for relative (%) change in profit and in contaminant output for the Rangitāiki sheep & beef farm system

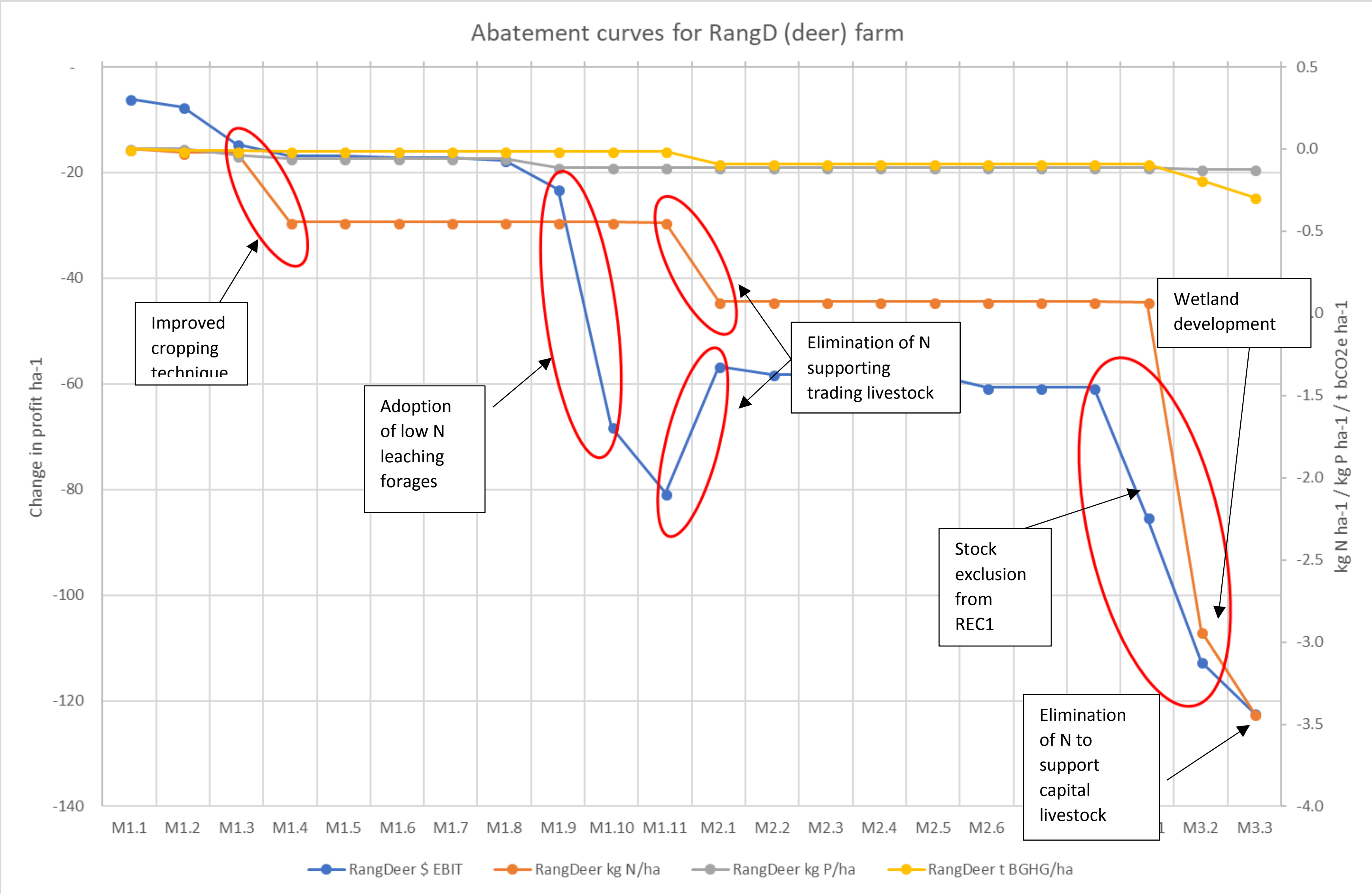

Figure 19: Sequential abatement curves for $ change in profit (LHS) and change in contaminant output (RHS) for the Rangitāiki deer farm system

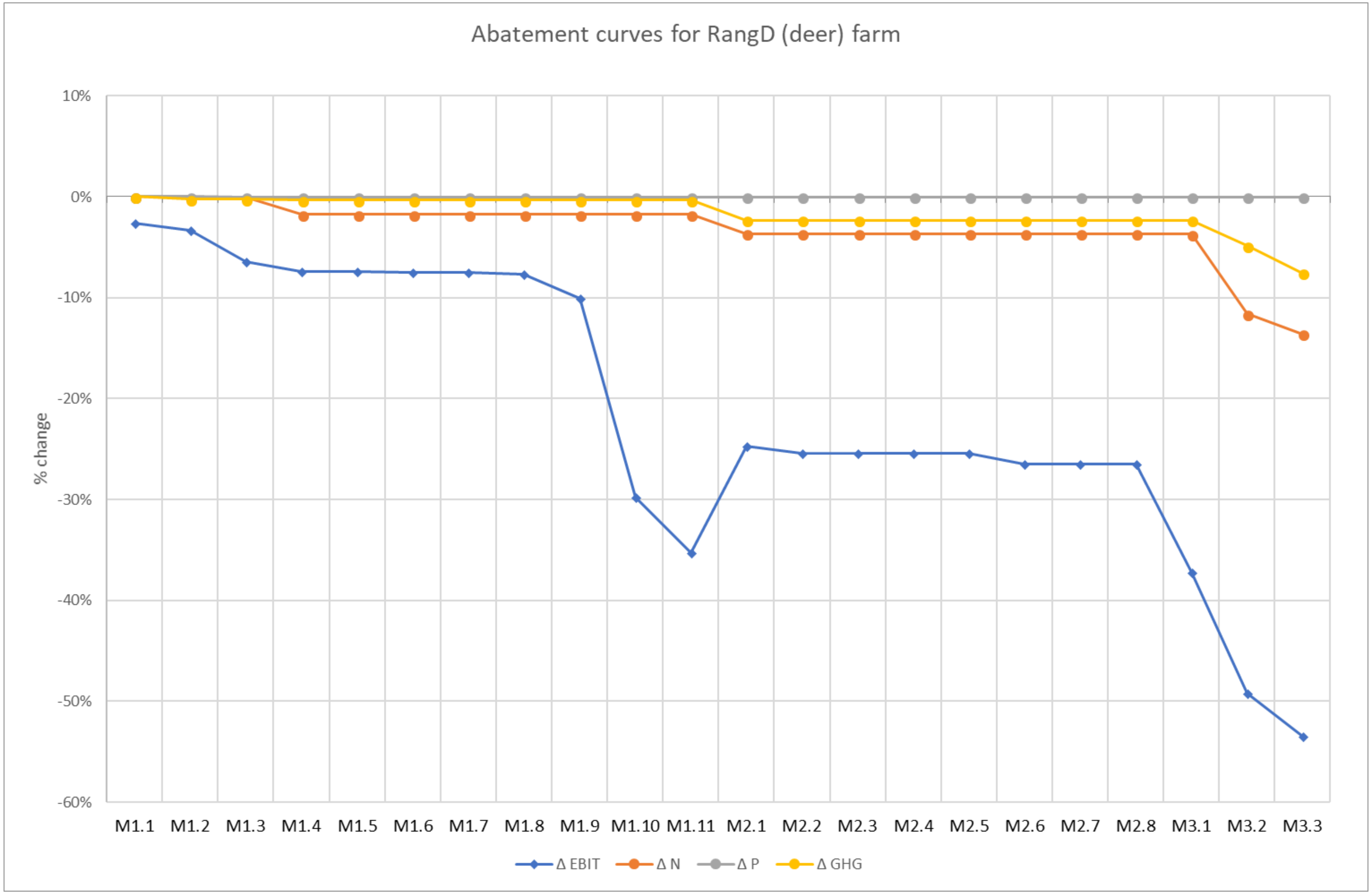

Figure 20: Sequential abatement curves for relative (%) change in profit and in contaminant output for the Rangitāiki deer farm system

7.3 Arable farm systems

7.3.1 Summary of bundles

The implementation of M1 lowered the profitability of the KPW Arable farm system by $153/ha, M2 by $809/ha and M3 by a further $85/ha. The significant impact that reducing N fertiliser [by 15%] had on profitability and the fact that, as modelled, OVERSEER suggested N leaching would go up, makes the re-evaluation of this mitigation for the bundles highly recommended.

Table 37: Change in annual arable farm gate profitability ($/ha) from the implementation of each mitigation bundle (a) and relative cumulative changes in annual arable farm gate profitability and water and atmospheric contaminants as measured in OVERSEER 6.3.0 from the implementation of mitigations (b)

(a)

Bundle		**KPW Arable**
M1	-	153
M2	-	809
M3	-	85
Total	-	1,048

(b)

KPW arable				
Bundle	Δ EBIT	Δ N	Δ P	Δ GHG
M1	-7%	-9%	-1%	-0.1%
M2	-41%	0%	-1%	-0.1%
M3	-45%	-7%	-4%	-0.2%

As can be seen from Table 37 (b) above, the percentage reductions in farm system profitability significantly outstrips the reduction in the three “contaminants” estimated by OVERSEER, being N, P and biological greenhouse gas emissions (CH_4 and N_20).

7.3.2 General observations

In general:

- Forgoing yield in lieu of reducing N losses accounted for 70% of the cost of the bundle implementation. Removing this from the bundles delivered bundles with similar implementation costs;
- As noted above, the OVERSEER modelling suggested removing N fertiliser from the model will increase N losses. This seems intuitively incorrect and follow-up with the OVERSEER team will be required.
- Compared with the pastoral farming systems and despite high N fertiliser usage, the application of the mitigation bundles had negligible impact on the biological GHG emissions profile of this farm system;
- Ten of the thirteen mitigations for the arable farm system were entirely designed to deal with reducing sediment losses. However, the sediment losses were not analysed in this study, as there is no possibility to estimate reductions in sediment losses with OVERSEER.

The biophysical modelling that is done in parallel with this analysis will be important to assess the impact on sediment losses from the bundles.

- The capital cost of implementing the bundles was low, at only $14,000 ($350/ha).

7.3.3 Sensitivity analysis of bundle cost

The cost of implementing all the bundles was considered against a few main variables that might be expected to have some impact for a number of the farm systems. Bundle cost was sensitised against the cost of a key input (N fertiliser), the prices for a key output (maize silage prices) and the cost of carbon and the extent to which farming might have to account for its biological emissions. The results are presented in Table 38 and Table 39 below.

Table 38: Cumulative cost ($/ha) of implementing M1 - M3 for KPW Arable with changes in N fertiliser and maize silage price

Urea price ($/t)	Maize silage price ($/t DM)					
	200	220	240	260	280	300
500	- 822	- 900	- 978	- 1,056	- 1,134	- 1,212
564	- 814	- 892	- 970	**- 1,048**	- 1,126	- 1,204
600	- 809	- 887	- 965	- 1,043	- 1,121	- 1,199
700	- 795	- 873	- 951	- 1,029	- 1,107	- 1,185
800	- 781	- 859	- 937	- 1,015	- 1,093	- 1,171

Table 39: Cumulative cost ($/ha) of implementing M1 - M3 for KPW Arable with changes in carbon price and ETS accountability

Carbon price ($/t CO^2e)	% CO_2e emissions needing to be paid for					
	0%	10%	20%	30%	40%	50%
10	- 1,048	- 1,047	- 1,047	- 1,047	- 1,047	- 1,046
21	- 1,048	- 1,047	- 1,046	**- 1,046**	- 1,045	- 1,045
30	- 1,048	- 1,047	- 1,046	- 1,045	- 1,045	- 1,044
40	- 1,048	- 1,047	- 1,046	- 1,045	- 1,044	- 1,043
50	- 1,048	- 1,046	- 1,045	- 1,044	- 1,043	- 1,041

The following observations were made:

- As with the dairy and drystock farm systems, as the price of the key product increased and the implementation of the mitigation bundles resulted in a reduction of output, then mitigation costs increased. Likewise, the converse was true for the cost of inputs whose use was reduced as a result of the mitigations;
- Unsurprisingly, with the bundles essentially having no impact on the arable farm models biological GHG profile (as estimated by OVERSEER), the cost of implementation was

essentially unchanged by potential changes to the carbon market or degree of farm system accountability under the ETS.

The individual abatement curves for the arable system is presented below in Figure 21 and Figure 22. On a nominal output basis, the change in profitability is charted on the left vertical axis and the change in environmental outputs charted on the right vertical axis. The relative changes in outputs are graphed on a percentage basis against each other

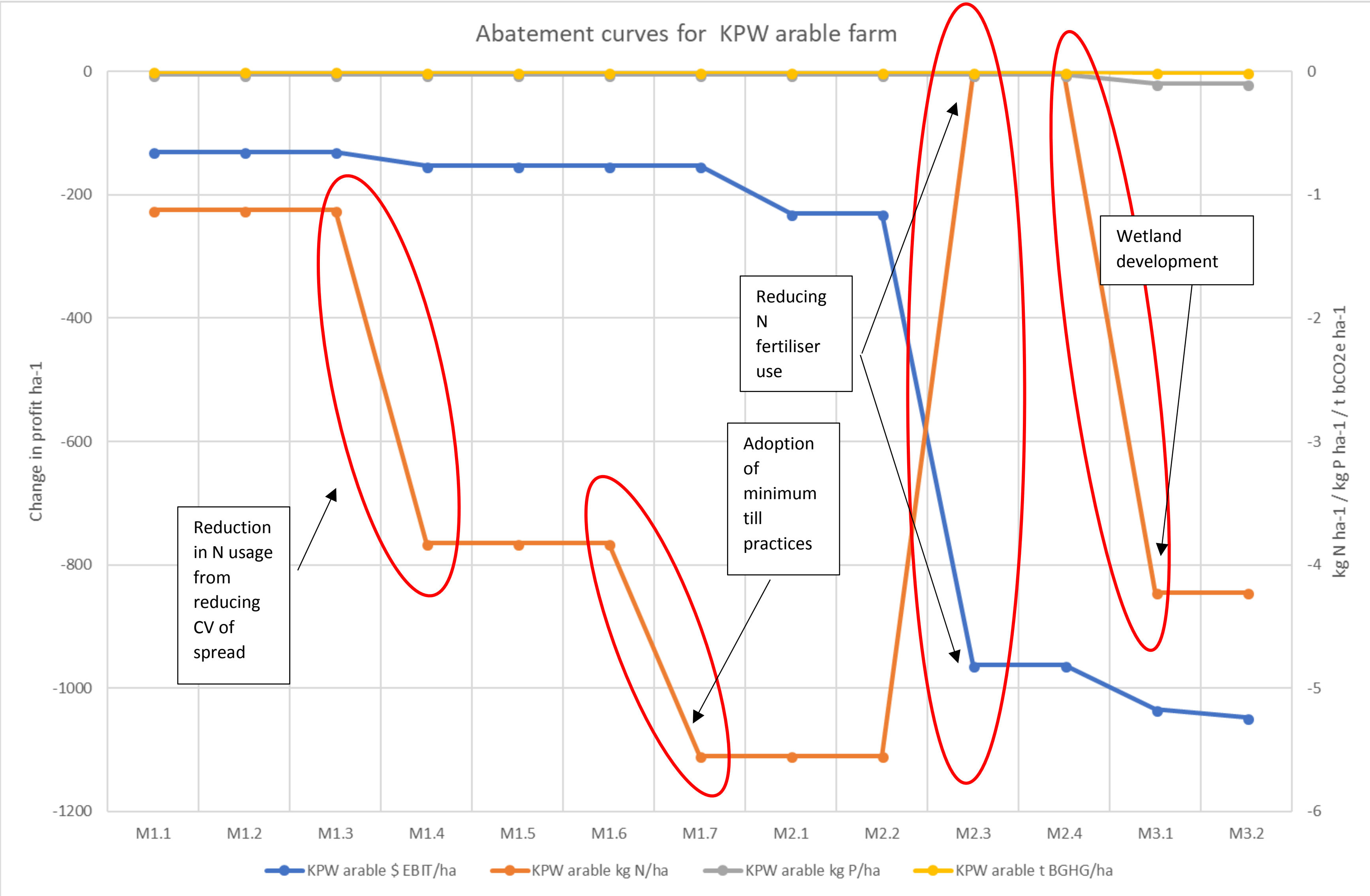

Figure 21: Sequential abatement curves for $ change in profit (LHS) and change in contaminant output (RHS) for the KPW arable farm system

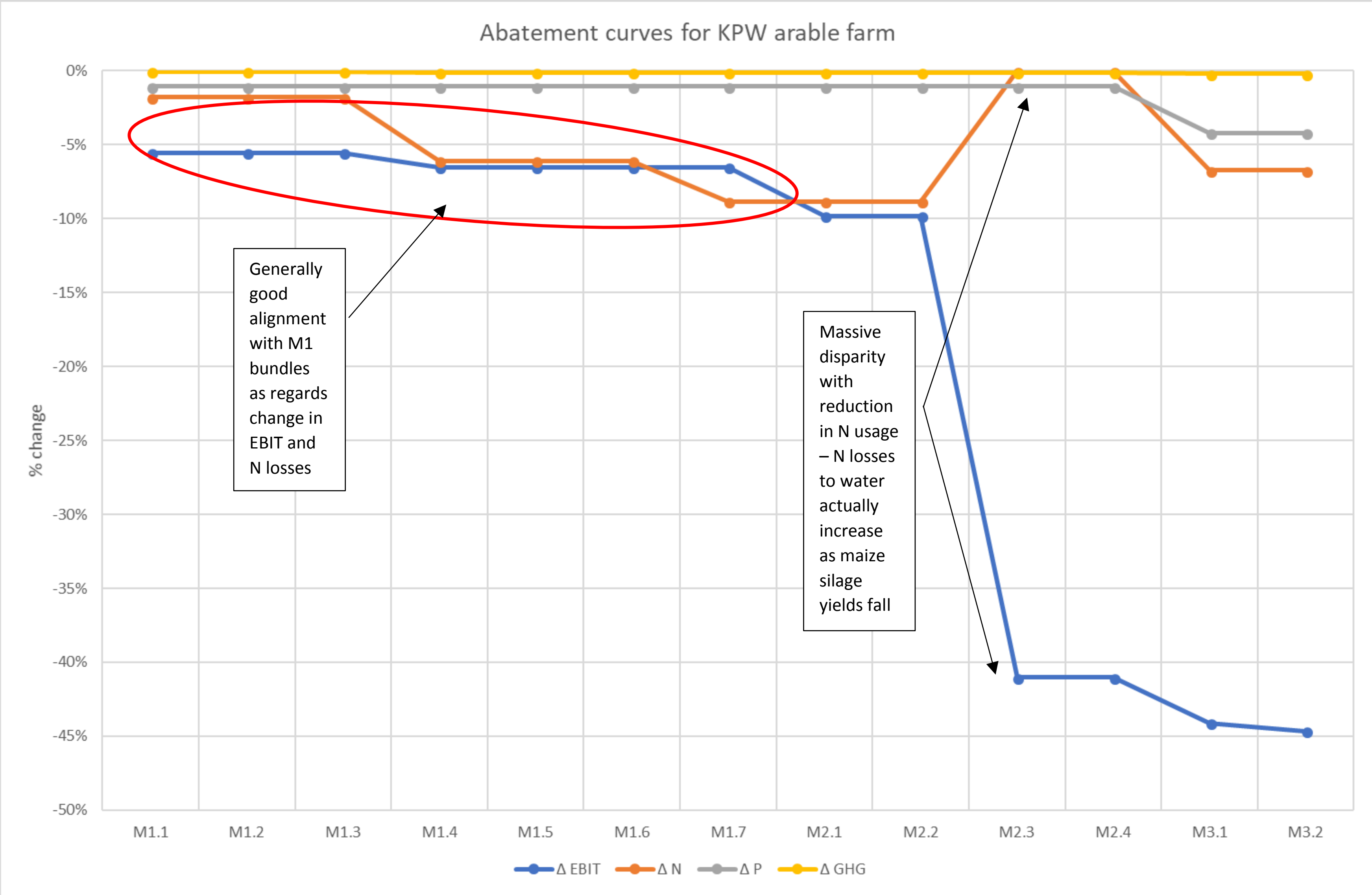

Figure 22: Sequential abatement curves for relative (%) change in profit and in contaminant output for the KPW arable farm system

7.4 Horticultural farm systems

7.4.1 Summary of bundles

Across the two kiwifruit orchard systems analysed, implementation of M1 lowered profitability by $1,892/ha and M2 by $38/ha (Table 40). While nominally high, the per hectare costs are low for the orchard systems as a percentage of total profitability and the overall level of contaminant losses are low.

The largest component of the M1 bundle cost was associated with managing the grass under the canopy, which was assumed to be done with regular mechanical removal. As a % of total returns, this was a more significant cost to green growers than for gold, which simply reflects the higher orchard gate returns currently experienced by gold growers.

Outside of this change, which ostensibly has negligible impact on N losses to water and would essentially have sediment capture benefits, the costs of implementing the mitigation bundles were minimal (Table 41).

Table 40: Change in annual kiwifruit orchard gate profitability ($/ha) from the implementation of each mitigation bundle

	Green	Gold	Average
M1	- 1,892	- 1,867	- 1,879
M2	- 38	- 38	- 38
Total	- 1,929	- 1,904	- 1,917

Table 41: Relative cumulative changes in annual kiwifruit orchard gate profitability and water and atmospheric contaminants as measured in OVERSEER 6.3.0 from the implementation of mitigations

Green				
Bundle	Δ EBIT	Δ N	Δ P	Δ GHG
M1	-10%	-7%	0%	-2%
M2	-10%	-7%	0%	-2%

Gold				
Bundle	Δ EBIT	Δ N	Δ P	Δ GHG
M1	-2%	-8%	0%	-1%
M2	-2%	-8%	0%	-1%

Average				
Bundle	Δ EBIT	Δ N	Δ P	Δ GHG
M1	-6%	-7%	0%	-1%
M2	-6%	-7%	0%	-1%

7.4.2 General observations

In general, notwithstanding the prevailing view that OVERSEER has limitations in modelling nutrient flows in orchard systems as well as those in pastoral farms due to a lack of empirical data:

- The greatest impact on N losses would appear to be associated with irrigated orchards improving water use efficiency, with its subsequent reductions in soil drainage;
- The suggested mitigation of post-harvest N applications is not recommended (Benge, J 2018, pers. comm) and as can be seen in the modelling potentially increases N losses to drainage. Having four split applications over spring would be a better option to improve efficiency of N fertiliser use, but OVERSEER can't currently model this accurately (i.e. it will treat two applications in the same month the same as a single application applying the same quantity of N fertiliser).
- It is important to note that the Psa (*Pseudomonas syringae pv actinidiae*) agrichemical control option called 'Kasumin' requires growers have to "mow" their orchards and be free of flowers before they are allowed to use this. Removing the herbicide option to control pasture would significantly impact on the ability to manage Psa.
- As might be expected, biological greenhouse gas emissions as modelled in OVERSEER were extremely low (<0.5t/ha) and are solely associated with the N fertiliser use in the orchards;
- The flat contour of the orchards assumed in the model (currently the default and only slope option in OVERSEER) reflect the low P risk, despite soil Olsen P levels >50ppm being assumed;
- The higher fruit yields of the gold vines than the green deliver improved N conversion efficiency;
- Capital costs of the full mitigation bundle implementation were estimated at $3,000 per orchard ($750/ha).

7.4.3 Sensitivity analysis of bundle cost

Because the yields and input quantities are essentially unchanged by the mitigation bundles applied to both kiwifruit models and the BGHG profile of orchards are so low, no sensitivity analysis has been deemed necessary to undertake.

The individual abatement curves for the two kiwifruit orchard systems are presented below in Figure 23 through Figure 26 below. On a nominal output basis, the change in profitability is charted on the left vertical axis and the change in environmental outputs charted on the right vertical axis. The relative changes in outputs are graphed on a percentage basis against each other.

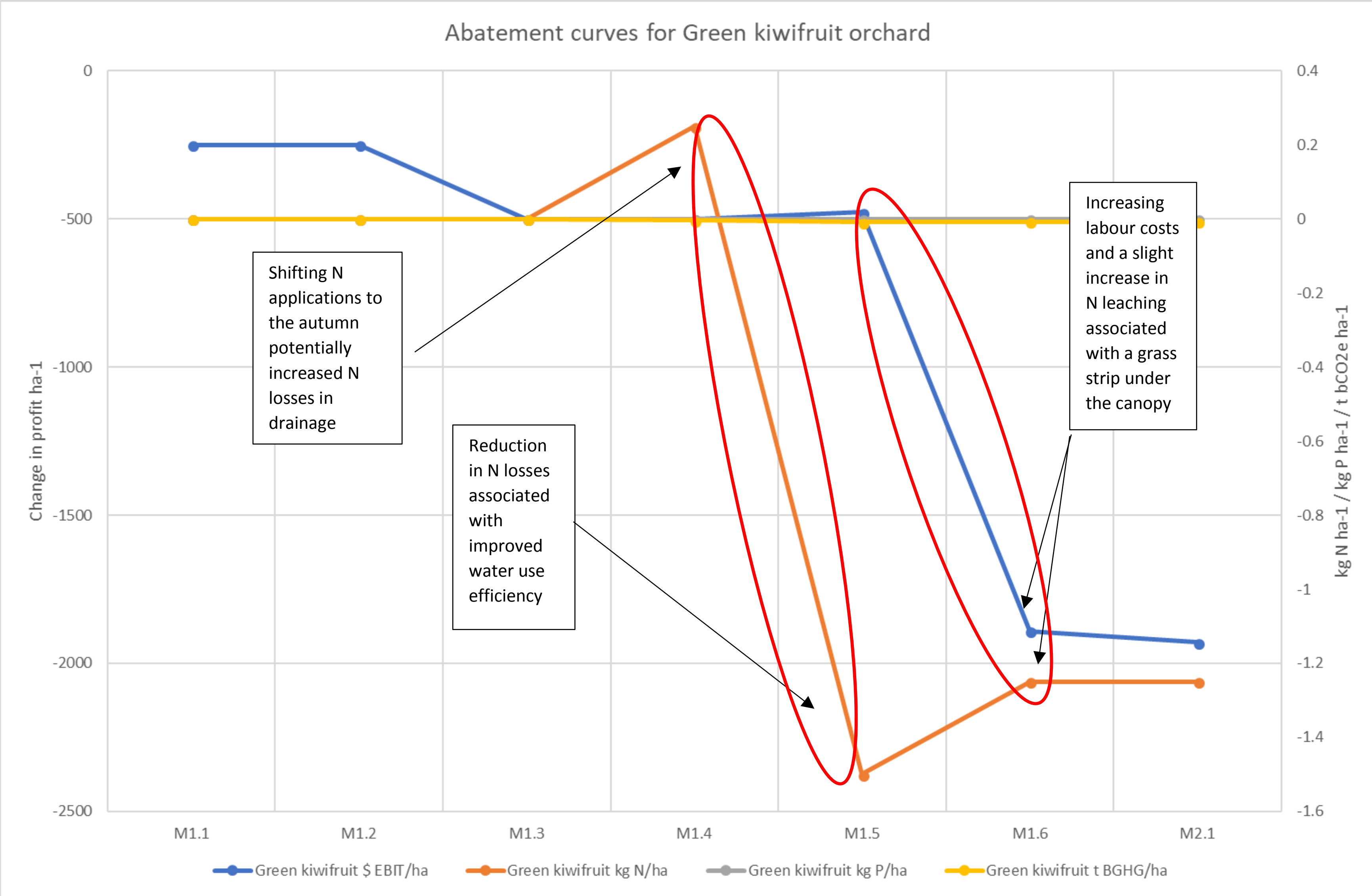

Figure 23: Sequential abatement curves for $ change in profit (LHS) and change in contaminant output (RHS) for the Green kiwifruit orchard system

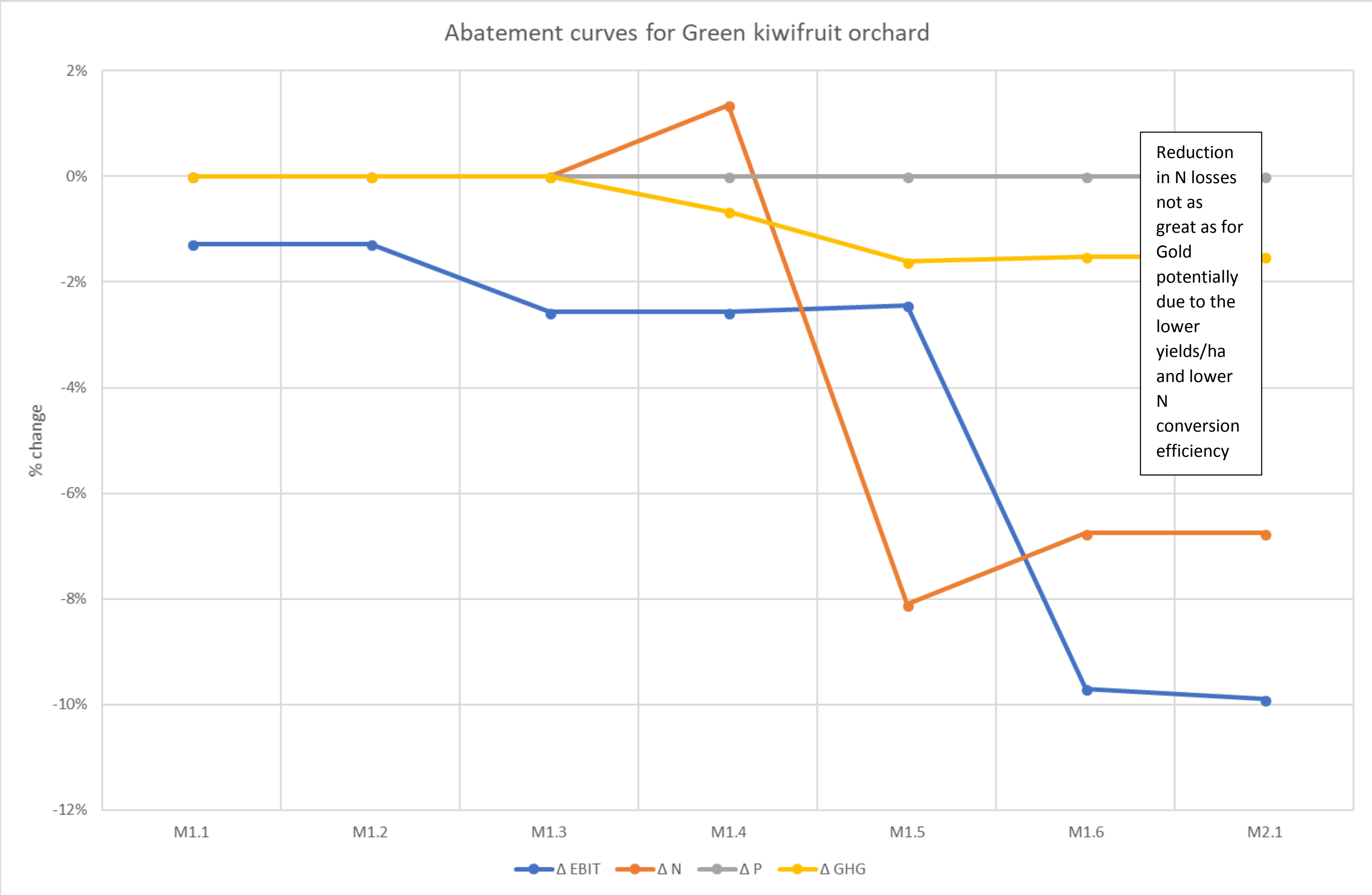

Figure 24: Sequential abatement curves for relative (%) change in profit and in contaminant output for the Green kiwifruit orchard system

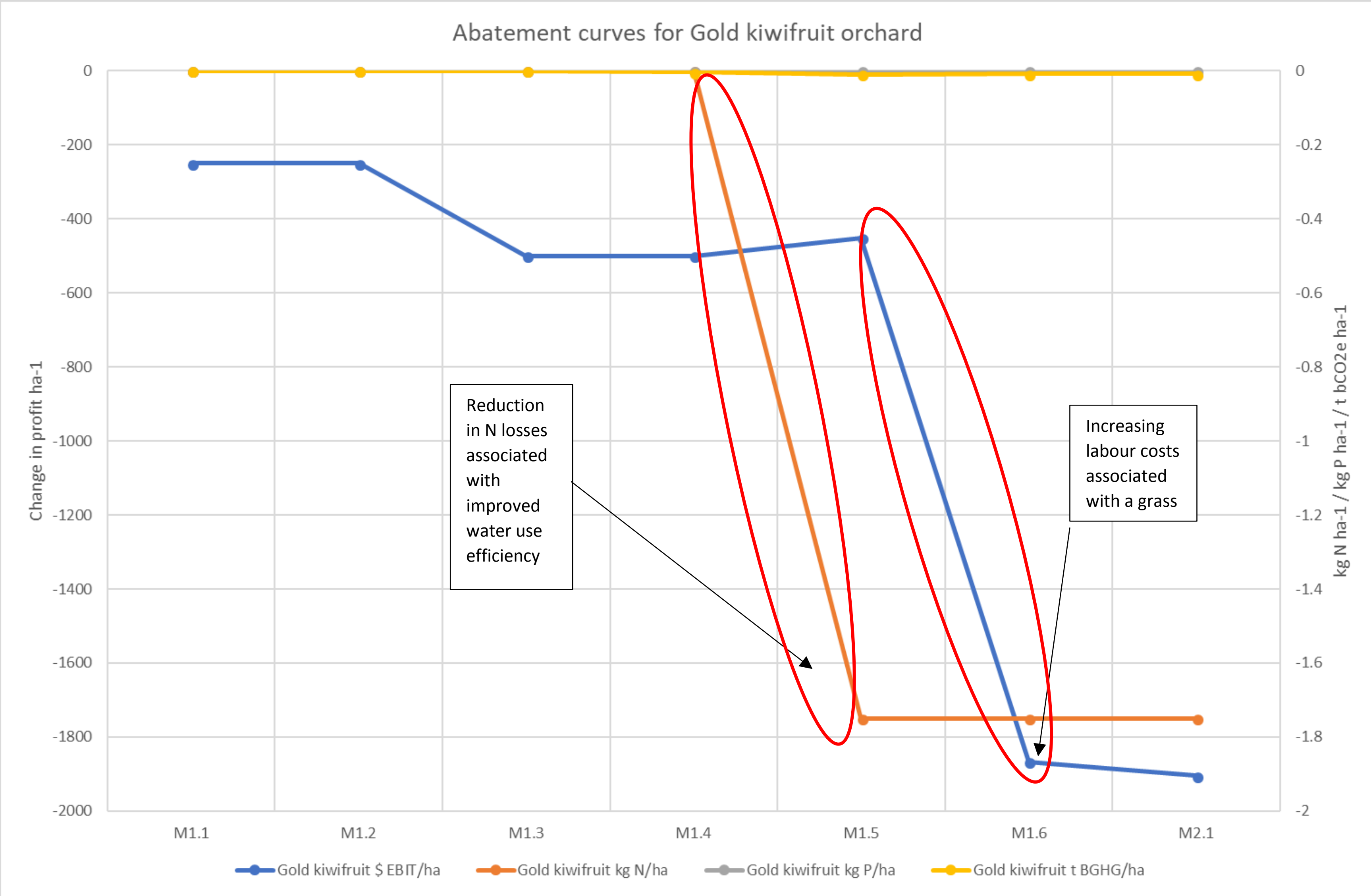

Figure 25: Sequential abatement curves for change in profit (LHS) and change in contaminant output (RHS) for the Gold kiwifruit orchard system

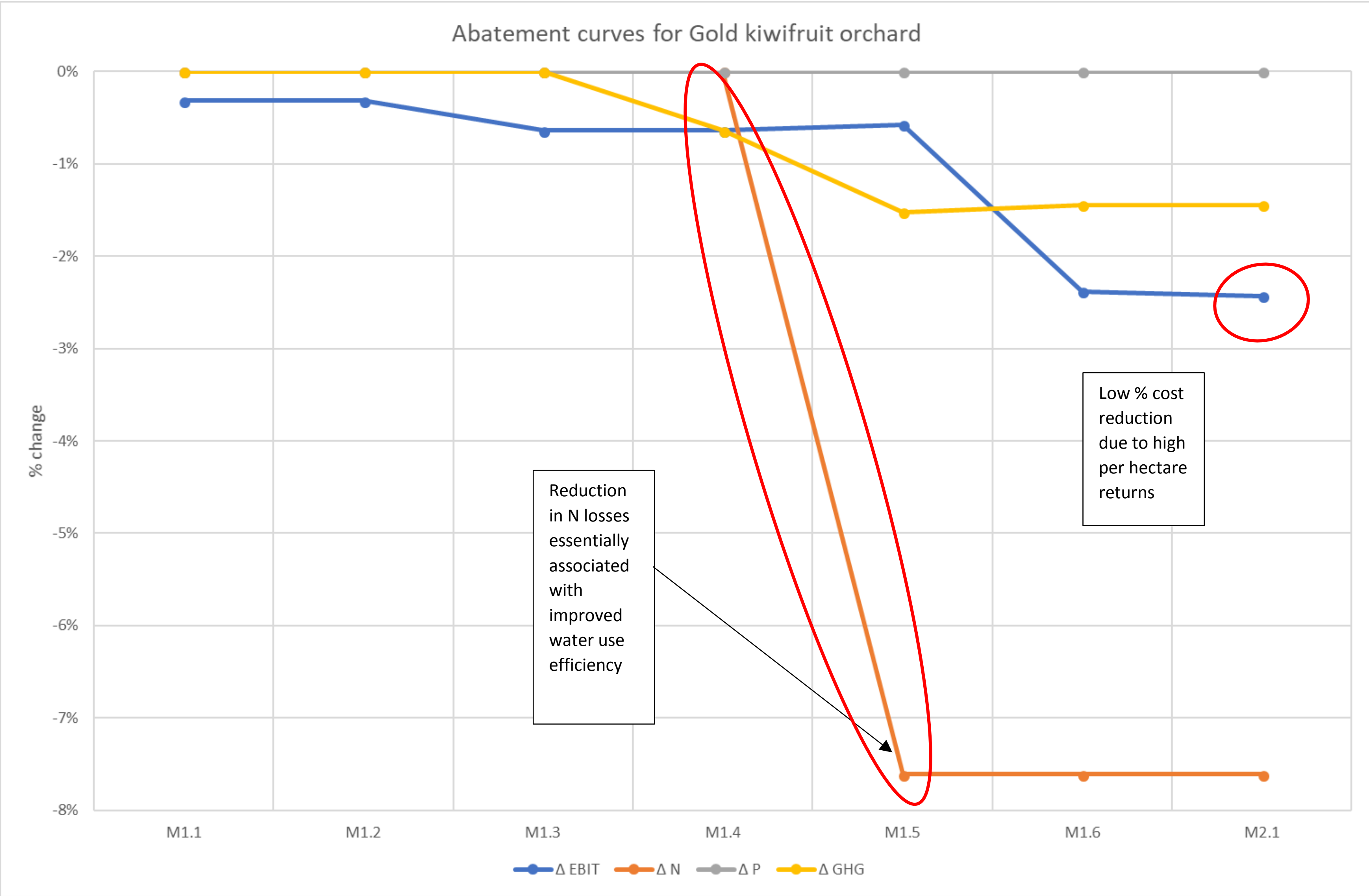

Figure 26: Sequential abatement curves for relative (%) change in profit and in contaminant output for the Gold kiwifruit orchard system

8 Conclusions

As modelled, most of the proposed individual mitigations had relatively modest impacts on annual farm system profitability, with significant impacts generated by key mitigation practices, which flowed through into the overall bundle cost. This was similarly observed for N, P and BGHG losses (as estimated by OVERSEER) albeit often for different practices.

For the dairy farm systems, the most-costly mitigations were:

- Development of stand-off pad infrastructure;
- Wetland developments;
- Creation of lined effluent storage;
- Substitution of autumn N fertiliser with supplementary feeds; and
- Reducing feed imported in the autumn.

On average, full adoption of the mitigation bundles on the dairy farm systems modelled reduced N losses by 44%, P losses by 21%, BGHG emissions by 17% and reduced profitability by 35% of current profit levels.

For the drystock farm systems, the most-costly mitigations were:

- Conversion of steep land to forestry;
- Wetland development;
- Elimination of N fertiliser that supported capital (breeding) livestock;
- Incorporation of low N forages into the farm system; and
- Gorse management.

Full adoption of the mitigation bundles on the dairy farm systems modelled reduced N losses by 14%-35%, P losses by 0%-38% and BGHG emissions by 8%-34%% - with a reduction in profitability ranging between 53% and 183% of existing profits. Compared to dairy farm systems, the sheep, beef and deer farms tended to be substantially affected by bundle implementation, particularly in the Kaituna-Pongakawa-Waitahanui WMA.

For the arable farm system, the costliest mitigation was reducing N fertiliser inputs (which resulted in significant yield loss) and for the orchards moving to having pasture under the vine canopies was judged to add significant per hectare cost associated with mowing the grass.

Apart from the profitability impacts of these mitigations, the net capital cost to fully implement M3 was in the vicinity of $369,000 ($3,000/ha) for non-irrigated dairy farms, $636,000 ($5,400/ha) for irrigated dairy farms and $394,000 for the sheep, beef and deer farms (c. $1,000/ha). In contrast, the capital costs of implantation we judged to be low for the arable and kiwifruit models at $14,000 ($350/ha) and $3,000 ($750/ha) respectively.

Some amendments to the mitigations in the bundles are probably warranted on the basis of the analysis, as is more work on addressing the contrast and tensions between the cashflow impacts and the potential longer-term value uplift from using partial land-use change to forestry as a mitigation.

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Appendix 1: Summary of model development

Landuse	APSIM	Refinements from Green et al.	Revised Perrin suggestions	Final models	Model name
Dairy	Dairy	Lower KPW (flat) dairy Mid-Upper KPW (hill) dairy	Lower KPW (flat) dairy Mid-Upper KPW (hill) dairy	Lower KPW (flat) dairy Mid KPW Upper KPW Mid Rangitaki dairy	Lower KPW Mid KPW Upper KPW Mid Rangitaiki
	High intensity dairy	Rangitaiki (flat) dairy	Rangitaiki (flat) dairy Rangitaiki (flat) irrigated dairy	Lower Rangitaiki dairy Mid Rangitaiki irrigated dairy	Lower Rangitaiki Mid Rangitaiki irrigated
Sheep & Beef	Sheep & Beef	Sheep & Beef	Rangitaiki extensive breeding/finishing sheep cattle operation; Mid-Upper KPW dairy support	Rangitaiki extensive breeding/finishing sheep cattle operation; Mid-Upper KPW sheep & beef Mid-Upper KPW dairy support	Rangitaiki S+B KPW S+B KPW DS
Kiwifruit	Kiwifruit	Green Gold Organic	Green Gold Organic	Green Gold	Kiwi green Kiwi gold
Deer	Deer	Deer - venison operation	Rangitaiki breeding/finishing vension operation	Rangitaiki breeding/finishing vension operation	Rangitaiki D
Arable	Maize	Maize silage	Lower KPW maize silage and dairy support (winter cows)	Lower KPW maize silage and dairy support (winter cows)	KPW A
Vegetables	Vegetables	Te Teko vegetable rotation	Lower Rangitaiki vegetable rotation		
Forestry	Forestry	Radiata pine	Radiata pine	Radiata pine Mānuka	Radiata pine Mānuka
Numbe of models	*7*	*10*	*12*	*15*	*15*

Appendix 2: Baseline dairy farm model profitability estimate

	Lower KPW	Mid KPW	Upper KPW	Lower Rangitaiki	Mid-Upper Rangitaiki	Mid-Upper Rangitaiki irrigated
	($)	($)	($)	($)	($)	($)
Income						
Milk sales	777,411	612,730	589,289	726,611	669,760	752,256
Net Livestock Sales	44,346	33,178	33,724	34,647	34,462	37,876
Contract Grazing	-	-	-	-	-	-
Change in Livestock Value	-	-	-	-	-	-
Total Revenue	821,757	645,908	623,013	761,258	704,222	790,132
Expenses						
Labour costs	136,884	106,140	106,140	115,656	110,166	110,166
Wages	86,768	67,280	67,280	73,312	69,832	69,832
Management Wage (assumin	50,116	38,860	38,860	42,344	40,334	40,334
Stock expenses						
Animal Health	33,461	26,048	25,941	28,148	27,051	27,051
Breeding	10,628	8,241	8,241	8,980	8,553	8,553
Farm Dairy	6,009	4,783	4,530	5,300	4,835	4,888
Electricity	16,082	12,470	12,470	13,588	12,943	12,943
Feed expenses						
Pasture Conserved	-	6,720	-	7,840	5,864	10,468
Feed Crop	-	8,400	11,250	-	16,300	16,860
Bought Feed	51,223	44,173	29,728	16,320	22,568	12,278
Calf Feed	2,335	1,829	1,817	1,877	1,871	1,871
Grazing	95,355	47,966	79,123	49,238	90,538	76,888
Other Farm Working						
Fertiliser (Excl. N)	32,940	26,840	25,620	35,451	34,866	34,047
Nitrogen	32,034	24,343	22,891	21,341	20,935	23,539
Irrigation	-	-	-	-	-	43,875
Regrassing	7,200	1,800	5,400	7,200	2,100	2,220
Weed & Pest Control	5,002	5,002	5,002	4,797	4,797	4,797
Vehicle Expenses	13,176	13,176	13,176	12,636	12,636	12,636
Fuel	8,418	8,418	8,418	8,073	8,073	8,073
R&M Land/Buildings	32,086	32,086	32,086	30,771	30,771	30,771
Freight & Cartage	8,228	6,380	6,380	6,952	6,622	6,622
Overheads						
Administration Expenses	18,300	18,300	18,300	17,550	17,550	17,550
Insurance	8,540	8,540	8,540	8,190	8,190	8,190
ACC Levies	4,514	4,514	4,514	4,329	4,329	4,329
Rates	18,178	18,178	18,178	17,433	17,433	17,433
Total Farm Working Expenses	540,593	434,347	447,745	421,670	468,991	496,048
Depreciation	39,284	39,284	39,284	37,674	37,674	45,981
Total Farm Expenses	579,877	473,631	487,029	459,344	506,665	542,029
Earnings before interest and tax	241,880	172,277	135,984	301,914	197,557	248,103
per ha	1,983	1,413	1,115	2,582	1,689	2,121

Appendix 3: Baseline dry stock and arable farm model profitability estimates

Land use	Sheep & beef			Deer	Arable
Model	KPW DS	KPW S+B	Rangitaiki S+B	Rangitaiki D	KPW A
	($)	($)	($)	($)	($)
Income					
Sheep					
Sales - Purchases	-	118,384	131,729	14,443	-
Wool	-	43,956	44,668	-	-
	-			-	-
Beef					
Sales - Purchases	-	20,626	248,483	-	-
Contract Grazing	339,661	150,908	162,422	-	48,000
Deer					
Sales - Purchases	-	-	-	331,549	-
Velvet	-	-	-	6,398	-
Crop & feed sales	-	-	26,928	12,800	230,500
Total Revenue	339,661	333,874	614,230	365,190	278,500
Expenses					
Labour (at arms length)	78,960	69,894	76,200	75,566	13,500
Stock					
Animal Health	-	11,208	11,594	9,169	-
Shearing	-	18,699	20,911	-	-
Velveting	-	-	-	977	-
Feed/Crop/Grazing					
Conservation	30,460	7,684	32,305	16,733	11,100
Forage Crops	-	-	21,600	11,700	144,000
Regrassing	-	-	14,400	7,800	-
Other Farm Working					
Fertiliser (Excl. N & Lime)	24,570	35,640	47,865	23,328	2,040
Nitrogen	5,472	4,284	22,348	14,791	-
Lime	2,160	2,991	5,390	2,991	369
Weed & Pest Control	4,898	6,781	12,223	6,781	837
Vehicle Expenses	7,200	9,969	17,970	9,969	1,231
Fuel	5,644	7,815	14,086	7,815	965
Repairs & Maintenance	29,809	43,072	63,596	33,942	2,677
Freight & Cartage	7,497	10,833	15,995	8,537	673
Electricity	3,869	5,590	8,253	4,405	347
Standing Charges					
Administration Expenses	9,112	12,617	22,741	12,617	1,558
Insurance	4,666	6,461	11,645	6,461	798
ACC Levies	2,015	2,903	5,182	3,141	344
Rates	11,115	15,390	27,740	15,390	1,900
Total Farm Working Expense	227,447	271,831	452,044	272,113	182,339
Depreciation	13,712	18,986	34,222	18,986	2,344
Total Farm Expenses	241,159	290,817	486,266	291,099	184,683
Earnings before interest and tax	98,502	43,057	127,964	74,091	93,817
per ha	421	133	219	229	2,345

Appendix 4: Baseline green and gold kiwifruit orchard model profitability estimates

Operating profit model	**Haywards**	**G3**
Proportion of potential yield	100%	100%
Trays/ha	10,500	14,000
		0
Orchard gate returns	57,750	126,000
less		-
Operating expenses	25,800	27,400
Operating surplus	31,950	98,600
less		-
Harvesting costs	4,200	6,700
Contract management	2,500	2,000
		-
EBITDA	25,250	89,900
less		-
Depreciation (20yrs)	5,750	11,500
		-
EBIT	**19,500**	**78,400**

Appendix 5: Baseline radiata pine forestry profitability (28 year unpruned regime)

AREA to be replanted (ha) 1 ha

	FORESTRY INVESTMENT - FRAMING MANAGEMENT REGIME												
	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10	YEAR 11	YEAR 12 - 27	YEAR 28
Pre-plant release	$ 833												
Supply, plant and release	$ 667												
Releasing													
Survival and Releasing Assessment		$ 8											
Pruning							$ -						
Thinning								$ 874					
Management/Protection/Maintenance													
Mapping & Stand Records	$ 27	$ 2	$ 1	$ 1	$ 49	$ 10	$ 10	$ 10	$ 2	$ 2	$ 2	2	
Fire Levy & Water Points			$ 2	$ 2	$ 2	$ 2	$ 2	$ 2	$ 2	$ 2	$ 2	2	
Forest Health & Dothistroma Control			$ 4	$ 4	$ 22	$ 4	$ 4	$ 24	$ 4	$ 4	$ 4	4	
Pest & Weed Control	$ 18	$ 18	$ 7	$ 7	$ 7	$ 7	$ 7	$ 7	$ 7	$ 7	$ 7	7	
Property Maintenance	$ 5	$ 5	$ 5	$ 5	$ 5	$ 5	$ 5	$ 5	$ 5	$ 5	$ 5	5	
Road & Track Maintenance	$ 5	$ 5	$ 5	$ 5	$ 5	$ 5	$ 5	$ 5	$ 5	$ 5	$ 5	5	
Insurance	$ 5	$ 10	$ 10	$ 10	$ 10	$ 15	$ 15	$ 15	$ 15	$ 15	$ 15	$ 15	
Rates	$ 100	$ 100	$ 100	$ 100	$ 100	$ 100	$ 100	$ 100	$ 100	$ 100	$ 100	$ 100	
Management	$ 7	$ 7	$ 7	$ 7	$ 7	$ 7	$ 7	$ 7	$ 7	$ 7	$ 7	7	
Total cost $ per Hectare	**$ 1,667**	**$ 155**	**$ 141**	**$ 141**	**$ 207**	**$ 156**	**$ 156**	**$ 1,050**	**$ 147**	**$ 147**	**$ 147**	**$ 147**	**$ -**
TOTAL COST	**$ 1,667**	**$ 155**	**$ 141**	**$ 141**	**$ 207**	**$ 156**	**$ 156**	**$ 1,050**	**$ 147**	**$ 147**	**$ 147**	**$ 147**	**$ -**
Estimated stumpage (net log revenue)/ha													**$ 43,494**
TOTAL INCOME	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ 43,494**
CASHFLOW	-$ 1,667	-$ 155	-$ 141	-$ 141	-$ 207	-$ 156	-$ 156	-$ 1,050	-$ 147	-$ 147	-$ 147	-$ 147	$ 43,494
capital/lease for land	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
TOTAL CASHFLOWS	**-$ 1,667**	-$ 155	-$ 141	-$ 141	-$ 207	-$ 156	-$ 156	-$ 1,050	-$ 147	-$ 147	-$ 147	-$ 147	$ 43,494

NPV	$6,827.15
discount rate	5.0%
internal rate of return	**9.71%**

NPV per ha	$6,827.15
Equivalent annuity over 28 years	$530.27

Appendix 6: Baseline radiata pine forestry profitability (28 year unpruned regime) incl. carbon

		FORESTRY INVESTMENT - FRAMING MANAGEMENT REGIME												
AREA to be replanted (ha)	1 ha													
		YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10	YEAR 11	YEAR 12 - 27	YEAR 28
Pre-plant release		$ 833												
Supply, plant and release		$ 667												
Releasing														
Survival and Releasing Assessment			$ 8											
Pruning								$ -						
Thinning									$ 874					
Management/Protection/Maintenance														
Mapping & Stand Records		$ 27	$ 2	$ 1	$ 1	$ 49	$ 10	$ 10	$ 10	$ 2	$ 2	$ 2	2	
Fire Levy & Water Points				$ 2	$ 2	$ 2	$ 2	$ 2	$ 2	$ 2	$ 2	$ 2	2	
Forest Health & Dothistroma Control				$ 4	$ 4	$ 22	$ 4	$ 4	$ 24	$ 4	$ 4	$ 4	4	
Pest & Weed Control		$ 18	$ 18	$ 7	$ 7	$ 7	$ 7	$ 7	$ 7	$ 7	$ 7	$ 7	7	
Property Maintenance		$ 5	$ 5	$ 5	$ 5	$ 5	$ 5	$ 5	$ 5	$ 5	$ 5	$ 5	5	
Road & Track Maintenance		$ 5	$ 5	$ 5	$ 5	$ 5	$ 5	$ 5	$ 5	$ 5	$ 5	$ 5	5	
Insurance		$ 5	$ 10	$ 10	$ 10	$ 10	$ 15	$ 15	$ 15	$ 15	$ 15	$ 15	$ 15	
Rates		$ 100	$ 100	$ 100	$ 100	$ 100	$ 100	$ 100	$ 100	$ 100	$ 100	$ 100	$ 100	
Management		$ 7	$ 7	$ 7	$ 7	$ 7	$ 7	$ 7	$ 7	$ 7	$ 7	$ 7	7	
Total cost $ per Hectare		**$ 1,667**	**$ 155**	**$ 141**	**$ 141**	**$ 207**	**$ 156**	**$ 156**	**$ 1,050**	**$ 147**	**$ 147**	**$ 147**	**$ 147**	**$ -**
TOTAL COST		**$ 1,667**	**$ 155**	**$ 141**	**$ 141**	**$ 207**	**$ 156**	**$ 156**	**$ 1,050**	**$ 147**	**$ 147**	**$ 147**	**$ 147**	**$ -**
Carbon transactions											169			
Carbon revenue	$25 /t	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 4,225**	**$ -**	**$ -**	**$ -**
Estimated stumpage (net log revenue)/ha														**$ 43,494**
TOTAL INCOME		**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 4,225**	**$ -**	**$ -**	**$ 43,494**
CASHFLOW		-$ 1,667	-$ 155	-$ 141	-$ 141	-$ 207	-$ 156	-$ 156	-$ 1,050	-$ 147	$ 4,078	-$ 147	-$ 147	$ 43,494
capital/lease for land		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
TOTAL CASHFLOWS		**-$ 1,667**	-$ 155	-$ 141	-$ 141	-$ 207	-$ 156	-$ 156	-$ 1,050	-$ 147	$ 4,078	-$ 147	-$ 147	$ 43,494

NPV	$9,420.93
discount rate	5.0%
internal rate of return	**12.60%**

NPV per ha	$9,420.93
Equivalent annuity over 28 years	$632.36

Appendix 7: Baseline Mānuka plantation profitability (third-party honey regime)

PLANTED MANUKA REGIME WITH HONEY INCOME STREAM

Area to plant 30.0 **ha**

Assumptions			
Income			**Notes**
Hives per ha	1.5	hives	
Rent paid for hives	$100	per hive	
Total honey profit ($/ha)	$1,500	per ha	Approx every 5 years there is a bad season with no honey yields
Profit share paid to owner	10%		
Carbon Price	$21.0	per t CO_2	Current carbon price
Expenses			
Planting Manuka	$2,000	per ha	
Spray release and stock replacement	$550	per ha	
Insurance	$30	per ha	
Rates	$40	per ha	
Manuka Plant Maintenance	$100	per ha	
Interest Rate	5%		

Income	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**SQ Year 5+**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Year 11**	**Year 12**	**Year 13**	**Year 14**
Rent paid for hives				$4,500	$4,500	$4,500	$4,500	$4,500	$4,500	$4,500	$4,500	$4,500	$4,500	$4,500
Share of profit				$4,500	$4,500	$4,500	$4,500	$4,500	$0	$4,500	$4,500	$4,500	$4,500	$0
Gross income	$0	$0	$0	$9,000	$9,000	$9,000	$9,000	$9,000	$4,500	$9,000	$9,000	$9,000	$9,000	$4,500
Operating Expenses														
Planting Manuka	$60,000													
Spray release and stock replacement		$16,500												
Manuka Plant Maintenance				$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000
Insurance	$900	$900	$900	$900	$900	$900	$900	$900	$900	$900	$900	$900	$900	$900
Rates	$1,200	$1,200	$1,200	$1,200	$1,200	$1,200	$1,200	$1,200	$1,200	$1,200	$1,200	$1,200	$1,200	$1,200
Total Expenses	$62,100	$18,600	$2,100	$5,100	$5,100	$5,100	$5,100	$5,100	$5,100	$5,100	$5,100	$5,100	$5,100	$5,100
Cash Surplus/Deficit	**-$62,100**	**-$18,600**	**-$2,100**	**$3,900**	**$3,900**	**$3,900**	**$3,900**	**$3,900**	**-$600**	**$3,900**	**$3,900**	**$3,900**	**$3,900**	**-$600**
EBIT	**-$62,100**	**-$18,600**	**-$2,100**	**$3,900**	**$3,900**	**$3,900**	**$3,900**	**$3,900**	**-$600**	**$72,570**	**$2,640**	**$6,420**	**$6,420**	**$3,180**
per ha					**$130**									

Appendix 8: Dairy bundle modelling protocols

M1 mitigations

M1.2 Effluent applied in line with soil moisture levels

"Applications are actively managed box" ticked on the Effluent Block effluent tab in OVERSEER.

M1.3 Reduced tillage practices

Where conventional cultivation has been used, select "direct drill" in OVERSEER for forage brassicas or "minimum till" for cereal/vegetable crops instead. No cost savings are generated from this practice, as additional pest control is typically required when prior vegetation is only desiccated and not cultivated into the ground.

M1.4 Improved nutrient budgeting and maintenance of Olsen P

Reduce soil Olsen P levels to average of optimum range if above, to lower end of the range if below and on flat to rolling contour or leave on steeper land, adjust assumed fertiliser inputs to required P inputs as determined by "Maintenance nutrients" tab in Block reports in OVERSEER. Adjust fertiliser expenditure accordingly and add $500 annual cost for nutrient budgeting advice.

M1.5 Laneway run-off diversion

Assume a further $500/annum in Repairs and Maintenance (R&M) Tracks expenditure.

M1.6 Grow maize on effluent block

Ensure maize crop rotates through effluent block if it not already doing so. Potentially savings in N and P fertiliser in doing so.

M1.7 Elimination of summer cropping

Summer cropping eliminated, and feed substituted with no more than 3kg/cow/day of PKE, with associated feeding and capital costs if required. Regrassing of the same area is now assumed to occur as grass-to-grass renovation in the autumn.

NOTE: Excluded from the bundles until OVERSEER 6.3.0 N loss changes have been confirmed or otherwise.

M1.8 Reductions in seasonal stocking rate

Cull 10% of total culls in early Feb (if not already culling in that window) and a further 10% of culls in early March. Intakes of remaining cows increased to maintain total production (kg MS per peak cow milked).

M1.9 Efficient fertiliser use technology

Reduction in N fertiliser use with no loss of DM production due to improvements in the CV of spread on flat and rolling country. Additional $2,000 per annum cost for use of this technology and N fertiliser savings (Perrin Ag 2017). Modelled in Farmax with a reduction in quantity of 12%, but commensurate increase in assumed response rate.

M1.10 Efficient irrigation practices

Use of a simple tensiometer is assumed to deliver a 50% reduction in spring shoulder (November) water use with no production loss, with a commensurate reduction in water (and electricity) usage.

M1.11 Use of plant growth regulators [to replace N]

Assumed gibberellic acid (GA) applied to a single winter N application (on all flat and rolling land), with the additional DM response from the GA (14kg DM/kg N as per Boom et al 2016) utilised to reduce or eliminate the next subsequent N application. The cost of the GA was assumed at $38/ha - $8/ha for the product and $30/ha for contract application.

M1.12 Adoption of low N leaching forages

Assume 4kg plantain seed included in all permanent pasture seed mixes, adding $90.40+GST/ha (Source: PGGW) to the cost of regrassing. Assuming 10% of farm is re-grassed annually and with the plantain able to be considered persistent in the sward for two years, this should be sufficient to ensure 20% of the farm area might be considered to be sown in a "diverse pasture". No farm productivity benefits have been assumed and the N loss impact as not yet modelled in OVERSEER.

M1.13 Relocation of troughs

Assumed relocation of troughs located in ephemeral flow paths at a cost of $360+GST (trough and fittings) and $120+GST per trough installation (Perrin Ag 2018b). Assume 5% of paddocks require one trough to be relocated, with an assumption of 60 paddocks per farm.

M1.14 Slow release RPR fertiliser

It is assumed a one-off capital application of RPR (3x maintenance) will be required to offset the lower availability, with RPR used normally thereafter. The quantity of 20% potash super phosphate assumed to be used has been replaced by a high P RPR, MOP and Sulphurgain Pure special mix to deliver identical nutrients.

M1.15 Reduce autumn N application

One autumn N application is replaced by the use of imported supplementary feed. PKE used for dry cow supplementation, up to 3kg/cow/day for milkers and then maize silage used for milking cows. If no PKE is currently being fed to dry cows, the capital impact of purchasing of trolleys has been accounted for. An increase in annual vehicle expenses (equivalent to 20% of the cost of the additional feed) is also included to account for the true cost of feeding out.

M1.16 3m average vegetated and managed buffer around rivers, streams, lakes and wetlands subject to the Dairy Accord; 1m around drains; 5m average buffer on slopes between 8 and 16 degrees, 10m average buffer on slopes above 16 degrees

GIS analysis provided by the Bay of Plenty Regional Council estimate the total length of fencing required to fence all Dairy Water Accord waterways for each geo-physical area modelled and the loss of pastoral area associated with increasing the buffer width. Fencing costs were modelled on a three-wire electric fence, with all posts and 50% of wire used in existing accord fencing assumed to be able to be re-used, but a higher per metre rate assumed for labour cost associated with the material recycling.

A native sedge vegetation option (see page 36 of the Dairy NZ Waterway Technical Notes, 2016) was assumed for the vegetation program (costed at an average of $20 per lineal metre of waterway planted, assuming both sides of the waterway were planted), with annual weed control costs of $130/ha retired (De Monchy 2018, pers. comm).

A subsidy of 25% from the BOPRC for all fencing and planting works has been assumed.

Unless the loss of area delivered a deviation from the baseline average pasture cover track or resulted in the model becoming unfeasible in Farmax the farm system was left unchanged. Where required, the base farm system was proportionally scaled back to ensure feasibility was maintained.

<u>M2 mitigations</u>

M2.1 Increase effluent application area

Effluent areas were increased in order to reduce the annual N application applied as dairy farm effluent (FDE) to 100kg N/ha. The cost of expanding the effluent area was costed at $705/ha, assuming one hydrant for every 4 hectares of new effluent area (Perrin Ag 2018b[5]). Maintenance P fertiliser applications were adjusted to reflect the change in effluent area, but N applications remained unchanged. It was assumed that the existing effluent pumps were of sufficient size to deliver effluent to the expanded area.

[5] Source: ABC Milking Ltd, FarmSource

M2.2 Develop a detention bund

A detention bund sufficient to detain a catchment of 40ha was assumed (approximately 4,800m^3 of storage), costing approximately $10,000+GST to install (Perrin Ag 2018b).

M2.3 Duration controlled grazing in autumn (assuming an existing stand-off pad)

A proportion of the milking herd will be stood-off for 16 hours per day during the autumn (March and April), subject to an allowance of 15m^2 per lactating cow. It has been assumed that effluent from the stand-off pad will be actively managed, with an associated additional labour cost (1.5 hours per day ($25/hour) for 61 days) and higher annual R&M costs ($1,000 per annum). It is also assumed that some capital upgrade to the stand-off area will be required to capture effluent from the pad and allow it to be actively managed within the effluent system - a $10,000+GST capital cost has been estimated.

M2.5 Reduce autumn supplement fed by 20%

Total imported feed fed from Mar through May is lowered by 20%. This is managed through drying cows off earlier than otherwise scheduled and using any pasture cover left to feed remaining milkers a higher pasture intake. Fuel and vehicle costs are reduced by 20% of the feed cost eliminated.

M2.6 Reducing fertiliser use

Annual N fertiliser usage to pasture is reduced to no more than 100kg N/ha. Autumn N will be eliminated ahead of spring N, with cows dried off to manage any feed deficit.

M2.7 Full stock exclusion from permanently flowing waterbodies less than 1m wide (REC Order 2 and above) and average 2m vegetated and managed buffer; 3m average buffer on slopes between 8 and 16 degrees, 7m average buffer on slopes above 16 degrees

GIS analysis provided by the Bay of Plenty Regional Council estimate the total length of fencing required to fence all permanently flowing waterways smaller than those mandated under the Dairy Water Accord, for each geo-physical area modelled and the loss of pastoral area associated with increasing the buffer width. Fencing costs were modelled on a new three-wire electric fence.

A native sedge vegetation option (see page 36 of the Dairy NZ Waterway Technical Notes, 2016) was assumed for the vegetation program (costed at an average of $20 per lineal metre of waterway planted, assuming both sides of the waterway were planted), with annual weed control costs of $130/ha retired (De Monchy 2018, pers. comm).

Unless the loss of area delivered a deviation from the baseline average pasture cover track or resulted in the model becoming unfeasible in Farmax the farm system was left unchanged. Where required, the base farm system was proportionally scaled back to ensure feasibility was maintained.

M3 mitigations

M3.1 Afforestation of erosion prone land

GIS analysis provided by the Bay of Plenty Regional Council estimate the loss of pastoral area associated with retiring steep land (>26 deg) determined as prone to erosion for each geo-physical area modelled.

Areas less than 2ha in size were assumed to require fencing off with a three-wire electric fence (assume 200m per hectare fenced off) and planted in mānuka or similar non-commercial native plant species ($2,500+GST/ha). Annual maintenance costs of $100/ha planted have been assumed (Perrin Ag, 2018b).

Unless the loss of area delivered a deviation from the baseline average pasture cover track or resulted in the model becoming unfeasible in Farmax the farm system was left unchanged. Where required, the base farm system was proportionally scaled back to ensure feasibility was maintained.

M3.2 Stock excluded from REC Order 1 watercourses less than 1m wide and 1m wide average vegetated buffer

GIS analysis provided by the Bay of Plenty Regional Council estimate the total length of fencing required to fence all ephemeral water courses (those likely to be considered by farmers as "wet all winter") for each geo-physical area modelled and the loss of pastoral area associated with increasing the buffer width. Fencing costs were modelled on a new three-wire electric fence.

A native sedge vegetation option (see page 36 of the Dairy NZ Waterway Technical Notes, 2016) was assumed for the vegetation program (costed at an average of $20 per lineal metre of waterway planted, assuming both sides of the waterway were planted), with annual weed control costs of $130/ha retired (De Monchy 2018, pers. comm).

Unless the loss of area delivered a deviation from the baseline average pasture cover track or resulted in the model becoming unfeasible in Farmax the farm system was left unchanged. Where required, the base farm system was proportionally scaled back to ensure feasibility was maintained.

NOTE: Was previously M3.3

M3.3 Impervious effluent storage with sufficient capacity to comply with soil moisture guidelines and low rate effluent application.

A lined effluent pond suitable to hold 90 days storage was estimated at a capital cost $175+GST per cow due to calve (Perrin Ag 2018b[6]), inclusive of low rate effluent application equipment. Depreciation rates were increased based on a 20-year lifespan for the pond. Once in place, the system allowed the "Low application method" option to be selected in the Block effluent tab in OVERSEER.

NOTE: Was previously M3.2

[6] Source: Seays Earthmovers

M3.4 Installation of roof to pre-existing stand-off area and extension of use for duration-controlled grazing to winter (May/June)

The cost to install a kitset plastic skinned shelter over an existing stand-off area is estimated at \$110+GST per square metre (Perrin Ag 2018b[7]). It has been assumed that extended use of the stand-off pad incurs an additional labour cost (1 hour per day (\$25/hour) for 61 days in May & June). Depreciation rates were increased based on a 20-year lifespan for the pond and the roof's prevention of water entering the effluent system will allow the assumption that the increased effluent storage in M3.2 is sufficient to manage the additional effluent. Once the cows are dry, an allowance of $5m^2$ per cow is deemed sufficient.

M3.5 Installation of stand-off pad and use for 16 hours per day in autumn

The cost to install a compliant stand-off area (carbon based) sufficiently large to stand-off all lactating cows ($15m^2$/cow) for 16 hours per day is estimated at a capital cost of \$720/cow, with an annual maintenance cost of \$60/cow (Perrin Ag 2018b). It has been assumed that effluent management from the stand-off pad will be actively managed, with an associated additional labour cost (1.5 hours per day (\$25/hour) for 61 days)

M3.6 Installation of a centre-pivot with VRI technology to replace K-line spray irrigation

A net \$4,600/ha cost to replace existing K line systems was assumed (Perrin Ag 2018b). Water (and irrigation costs) use reduced by 25% for no production loss and a labour saving of 2 hours per day for 135 days, but increase in depreciation.

M3.7 Creation of new wetlands

The creation of wetlands totalling 3% of farm landscape with a potential 100% reduction in nitrate nitrite nitrogen (NNN) from roughly 1/5th of the total farm area is assumed. The development cost has been estimated at \$3,000/ha (Perrin Ag 2018a).

The base farm system has then been proportionally scaled back to ensure feasibility was maintained in line with the average pasture cover track in the immediately preceding scenario.

Wetlands have been entered in OVERSEER on the basis of the following input parameters:

- Wetland condition: Artificial Type 1 - Flow path length to width ratio >5 (2 or more stage wetland[8], with even elongated channel or serpentine path created using internal bunds), well vegetated with good dispersion and even flow through the majority of wetland and minimal channelisation or dead-zones;
- Wetland type: Type A;
- Catchment area: 20% of total farm area;
- Catchment convergence: High convergence;

[7] Source: Redpath Shelters
[8] Where water "treatment" process of the wetland and separated into different steps

- Aquitard depth: 3-5m.

M3.8 Reduction in per hectare stocking rate

Stocking rate (defined as peak cow milked per hectare) is reduced by 0.3 cows/ha. The management capability horizon is held constant (which includes the assumed wages of management), requiring per cow production to remain static (no more than 10kg MS/cow/year increase) and the lower stocking rate managed by reductions in imported feed and fertiliser N usage. Maintenance P fertiliser inputs were then re-optimised based on any change in feed inputs, with adjustments made to expenses based on the savings in the reduction in feeding out. The capital impact of a reduction in cow numbers is also accounted for.

The per cow production horizon was allowed to increase for those farms with summer (January-February) growth rates in excess of 40kg DM/ha/day as it was considered an easy management decision to allow cow intakes of high quality pasture to increase. In practice this only applied to irrigated pasture and the Lower Rangitāiki dairy farm system.

Appendix 9: Drystock bundle modelling protocols

M1 mitigations

M1.1 Improved nutrient budgeting and maintenance of Olsen P

Reduce soil Olsen P levels to average of optimum range if above, leave if below, adjust assumed fertiliser inputs to required P inputs as determined by “Maintenance nutrients” tab in Block reports in OVERSEER. Adjust fertiliser expenditure accordingly and add $500 annual cost for nutrient budgeting advice.

M1.2 Efficient fertiliser use technology

Reduction in N fertiliser use with no loss of DM production due to improvements in the CV of spread on flat and rolling country. Additional $2,000 per annum cost for use of this technology and N fertiliser savings (Perrin Ag 2011). Modelled in Farmax with a reduction in quantity of 12%, but commensurate increase in assumed response rate.

M1.3 Stock class management within landscape

Ensuring stock classes are grazed on appropriate landscapes is expected to be largely achievable on most properties without significant infrastructure or stock class changes. We have assumed an increase in labour costs equivalent to one hour per day over the winter period to optimally manage livestock in this manner (91 days x 1 hour/day x $25/hour).

For deer operations, this is largely associated with addressing wallows and fence running. We have assumed a one-off capital investment in fencing etc. with a cost of capital equivalent to the labour costs inferred above.

M1.4 Adopt M1 arable cultivation practices for winter cropping

This mitigation incorporated all the applicable M1 mitigations in the arable model. For winter forage brassicas, this included:

- Use of direct drilling in lieu of conventional cultivation;
- Optimising P fertiliser in line with expected yield;
- Use of improved spreading techniques for N fertiliser application;
- Use of a cover crop between winter grazing and re-sowing into new grass;
- Use of a grass buffer strip at the edge of all cultivated areas;
- Improved cultivation techniques on areas of contour;

On average, this was assumed to deliver a net cost of $57/ha to the winter cropping activity for no loss in net DM production. For more information see Appendix 3 below.

M1.5 Laneway run-off diversion

Assume a further $500/annum in R&M Tracks expenditure. For deer farms it is assumed any laneway diversion will be accounted for in the capital works associated with M1.3 above.

M1.6 Relocation of troughs

Assumed relocation of troughs located in ephemeral flow paths at a cost of $360+GST (trough and fittings) and $120+GST per trough installation (Perrin Ag 2018b[9]). Assume 5% of paddocks require one trough to be relocated, with an assumption of an average paddock size of 6ha.

M1.7 Appropriate gate, track and race placement

Assumed relocation of gates and tracks located in ephemeral flow paths at a cost of $1,500+GST per relocation. Assume 5% of paddocks require one gateway to be relocated, with an assumption of an average paddock size of 6ha. For deer farms it is assumed any laneway and gate relocation will be accounted for in the capital works associated with M1.3 above.

M1.8 Targeted space planting of poles

The targeted planting of poles to areas within paddocks that presented the greatest risk of erosion has been assumed. Average density of these plantings has been assumed at 25 stems/ha (a capital cost of 500/ha) over 2% of the farm area. Pasture production on the planted area is assumed to be unaffected, given the loss of pasture from shading is assumed to be offset by the reduction in pasture loss from erosion events that have typically been occurring.

M1.9 Slow release RPR fertiliser

It is assumed a one-off capital application of RPR (3x maintenance) will be required to offset the lower availability, with RPR used normally thereafter. The quantity of Sulphurgain 15S assumed to be used has been replaced by a high P RPR and Sulphurgain Pure special mix to deliver identical nutrients.

M1.10 Adoption of low N leaching forages

Assume 4kg plantain seed included in all permanent pasture seed mixes, adding $90.40+GST/ha (Source: PGGW) to the cost of regrassing. We have assumed 10% of the farm is re-grassed annually (via under sowing or similar) and with the plantain able to be considered persistent in the sward for two years, this should be sufficient to ensure 20% of the farm area might be considered to be sown in a “diverse pasture”. No farm productivity benefits have been assumed and the N loss impact as not yet modelled in OVERSEER.

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[9] Source: PGGW

M1.11 Full stock exclusion from all waterbodies greater than 1m wide at any point adjacent to farm (including drains) and wetlands. 2m average vegetated and managed buffer around rivers, streams, lakes and wetlands; 1m around drains; 3m average buffer on slopes greater than 8 degrees; 5m average buffer on slopes greater than 16 degrees

GIS analysis provided by the Bay of Plenty Regional Council estimate the total length of fencing required to fence all Dairy Accord waterways for each geo-physical area modelled and the loss of pastoral area associated with increasing the buffer width. Fencing costs were modelled on a three-wire electric fence for dairy support ($5/m erected), 7 wire for sheep ($14/m erected) and deer fencing for deer ($26/m erected).

A native sedge vegetation option (see page 36 of the Dairy NZ Waterway Technical Notes, 2016) was assumed for the vegetation program (costed at an average of $20 per lineal metre of waterway planted, assuming both sides of the waterway were planted), with annual weed control costs of $130/ha retired (De Monchy 2018, pers. comm).

A subsidy of 25% from the BOPRC for all fencing and planting works has been assumed.

Unless the loss of area delivered a deviation from the baseline average pasture cover track or resulted in the model becoming unfeasible in Farmax the farm system was left unchanged. Where required, the base farm system was proportionally scaled back to ensure feasibility was maintained.

<u>M2 mitigations</u>

M2.1 Elimination of N fertiliser applied to accelerate liveweight gain

Assuming a "standard" pasture dry matter response to applied fertiliser nitrogen of 10:1, N fertiliser applied at a cost of $699+GST/t urea[10] equates to a cost of $0.15/kg DM produced. Where the gross margins of a livestock enterprise are less than this, then at the margins N fertiliser applied to produce feed for these classes of livestock is unlikely to be profitable. In these instances, is likely to be more profitable to reduce livestock numbers. Where N fertiliser is applied to accelerate liveweight gains in growing (trading) livestock (as is often the case with spring N) it is typically more profitable to adjust down the numbers of capital livestock (with a lower gross margin) to allow targeted weight gains to occur.

M2.2 Develop a detention bund

A detention bund sufficient to detain a catchment of 40ha was assumed (approximately 4,800m^3 of storage), costing approximately $10,000+GST to install. (Perrin Ag 2018b).

M2.3 Complete protection of gully heads

[10] Source: Ballance AgriNutrients

It has been assumed that gully heads erosion potential exists associated with the easy and steep contoured areas of a farm. We have assumed that these areas will need to be retired or have other capital works put in place to manage gully head erosion, with the cost of such works equating to $1,650/ha for 2% of area of the steep and easy contoured proportion of the farm, with half of that area (1%) needing to be retired (modelled as a riparian area in OVERSEER).

M2.4 Management of gorse

An additional $30/ha in annual weed & pest expenditure has been assumed to be used specifically for accelerated gorse control on the easy and steep contoured land. No productivity improvements have been assumed.

M2.5 Whole paddock space planting of poles

This is considered an applicable mitigation for north-facing easy contoured hill slopes in sheep grazing systems susceptible to erosion, given the exclusion of whole paddocks in solely cattle farming or deer farming systems is considered too disruptive during the establishment phase. Planting at 50 stems/ha ($1,000/ha establishment cost, Perrin Ag 2018a) has been assumed. As these paddocks have a northerly aspect, pasture production is typically low over summer anyway, so the shading impact of the trees as they mature is expected to have limited impact on pasture production. Combined with the reduction in soil loss and positive impacts that shading will have on animal welfare, the net production impact on the farm system is considered negligible. We have assumed 25% of a farm's easy contoured land to be suitable for these purposes.

M2.6 Full stock exclusion from permanently flowing waterbodies less than 1m wide (REC Order 2 and above) and 1m average vegetated and managed buffer; 2m average buffer on slopes greater than 8 degrees, 3m average buffer on slopes greater than 16 degrees [with associated stock water reticulation, if any]GIS analysis provided by the Bay of Plenty Regional Council estimate the total length of fencing required to fence all permanently flowing waterways smaller than those mandated under the Dairy Accord, plus all seeps, for each geo-physical area modelled and the loss of pastoral area associated with increasing the buffer width. Fencing costs were modelled on a new three-wire electric fence.

A native sedge vegetation option (see page 36 of the Dairy NZ Waterway Technical Notes, 2016) was assumed for the vegetation program (costed at an average of $20 per lineal metre of waterway planted, assuming both sides of the waterway were planted), with annual weed control costs of $130/ha retired (De Monchy 2018, pers. comm).

Unless the loss of area delivered a deviation from the baseline average pasture cover track or resulted in the model becoming unfeasible in Farmax the farm system was left unchanged. Where required, the base farm system was proportionally scaled back to ensure feasibility was maintained.

M2.7 Afforestation of erosion prone land

GIS analysis provided by the Bay of Plenty Regional Council estimate the loss of pastoral area associated with retiring steep land (>26 deg) determined as prone to erosion for each geo-physical area modelled.

Areas less than 2ha in size were assumed to require fencing off with a suitable stock-exclusion fence (assume 200m per hectare fenced off) and planted in mānuka or similar non-commercial native plant species ($2,500+GST/ha). Annual maintenance costs of $100/ha planted have been assumed. Areas greater than 2ha are considered suitable for commercial production forestry, with an establishment cost of $1,500/ha. The annualised benefit of production forestry on such areas has been added to EBIT on the basis of a forestry right payment of $200/ha planted. We recognise that this is lower than the likely annual return overtime based on a discounted cashflow approach if the trees were owned, but was selected to be conservative. The impact of forestry if a higher annual income equivalency was used is explored in the discussion.

Areas for planting comprised all the steep blocks in the relevant Farmax models, with the balance taken from easy contoured land (not already in space planted poles). Unless the loss of area delivered a deviation from the baseline average pasture cover track or resulted in the model becoming unfeasible in Farmax the farm system was left unchanged. Where required, the base farm system was proportionally scaled back to ensure feasibility was maintained.

M2.8 Changing stock ratios to reflect lower N leaching potential

Increasing the sheep: cattle ratio would be expected to lower N leaching. The sheep:cattle ratio is adjusted by 10%, to a maximum ratio of 60:40 sheep: cattle.

M3 mitigations

M3.1 Full stock exclusion from REC Order 1 watercourses less than 1m wide and 1m wide average vegetated buffer

GIS analysis provided by the Bay of Plenty Regional Council estimate the total length of fencing required to fence all waterways that are less than 1m wide and REC Order 1[11] for each geo-physical area modelled and the loss of pastoral area associated with increasing the buffer width. Fencing costs were modelled on a new three-wire electric fence.

A native sedge vegetation option (see page 36 of the Dairy NZ Waterway Technical Notes, 2016) was assumed for the vegetation program (costed at an average of $20 per lineal metre of waterway planted, assuming both sides of the waterway were planted), with annual weed control costs of $130/ha retired (De Monchy 2018, pers. comm).

Unless the loss of area delivered a deviation from the baseline average pasture cover track or resulted in the model becoming unfeasible in Farmax the farm system was left unchanged. Where required, the base farm system was proportionally scaled back to ensure feasibility was maintained.

[11] all ephemeral water courses (those likely to be considered by farmers as “wet all winter”)

M3.2 Creation of new wetlands

The creation of wetlands totalling 3% of farm landscape with a potential 100% reduction in nitrate nitrite nitrogen (NNN) from roughly 1/5th of the total farm area is assumed. The development cost has been estimated at $3,000/ha (Perrin Ag 2018a).

The base farm system has then been proportionally scaled back to ensure feasibility was maintained in line with the average pasture cover track in the immediately preceding scenario.

Wetlands have been entered in OVERSEER on the basis of the following input parameters:

- Wetland condition: Artificial Type 1 - Flow path length to width ratio >5 (2 or more stage wetland[12], with even elongated channel or serpentine path created using internal bunds), well vegetated with good dispersion and even flow through the majority of wetland and minimal channelisation or dead-zones;
- Wetland type: Type A;
- Catchment area: 20% of total farm area;
- Catchment convergence: High convergence;
- Aquitard depth: 3-5m.

M3.3 Elimination of N applications to support capital livestock

Assuming a “standard” pasture dry matter response to applied fertiliser nitrogen of 10:1, N fertiliser applied at a cost of $699+GST/t urea[13] equates to a cost of $0.15/kg DM produced. Where the gross margins of a livestock enterprise are less than this, then N fertiliser applied to produce feed for these classes of livestock is unlikely to be profitable. In these instances, is likely to be more profitable to reduce livestock numbers. However, the reduced ability to harvest “free” spring and summer pasture with the feed demand derived from lactating ewes and cows can have a great impact on the farm system than might initially be suspected. Autumn N tends to support livestock numbers used to take advantage of spring surplus. Removing this “capital” N application was managed by a reduction in capital (breeding) stock numbers.

[12] Where water “treatment” process of the wetland and separated into different steps
[13] Source: Ballance AgriNutrients

Appendix 10: Arable bundle modelling protocols

M1 Mitigations

M1.1 Grass or planted buffer strips

Leaving an uncultivated 1m wide buffer strip along the edge of all crop areas, including ephemeral water courses is estimated to reduce effective crop area (and therefore yield) by up to 2%. Crop yields in Farmax are reduced by 2% and crop area in OVERSEER reduced by 2%. Animal liveweight gains or stock numbers are adjusted to accommodate lower feed availability.

M1.2 Complete protection of existing wetlands

It was assumed no wetlands existed within the boundaries of the arable farm systems model.

M1.3 Maintain optimal Olsen P and appropriate P fertiliser use

P fertiliser applications were adjusted to ensure the actual needs of any crop were being addressed, rather than the often-typical practice of applying capital levels of fertiliser “just to make sure”.

M1.4 Efficient fertiliser use technology

Reduction in N fertiliser use with no loss of DM production due to improvements in the CV of spread on flat and rolling country. Additional $2,000 per annum cost for use of this technology and N fertiliser savings (Perrin Ag 2017). Modelled in Farmax with a reduction in quantity of N fertiliser of 12%, but commensurate increase in assumed response rate.

M1.5 Cover crops between cultivation cycles

The sowing of a cover crop between crops is estimated to cost $82/ha. While not planted specifically for dry matter production, the use of a cover crop is assumed to offset any yield reductions because of the use of buffer strips (as per M 1.1 above) when following a brassica crop.

M1.6 Manage risk from contouring

The adoption of contour appropriate cultivation practices is assumed to add $50/ha to the total cost of cultivation. The use of alternating strip tillage isn’t applicable for brassica crops.

M1.7 Reduced tillage practices

Where conventional cultivation has been used, select “direct drill” in OVESEER for forage brassicas or “minimum till” for cereal/vegetable crops instead. No cost savings are generated from this practice, as additional pest control is typically required when prior vegetation is only desiccated and not cultivated into the ground.

M2 Mitigations

M2.1 Use of silt fencing

Assuming that 80% of soil losses come from only 20% of farm area, the use of a silt fence to capture run-off from the 20% most susceptible area of the arable block has been assumed. For the 40ha arable model, this assumes silt fencing is required for use on 8ha of land. The cost of silt fencing is estimated at an annual cost of $378/ha "fenced" (Perrin Ag 2018a).

M2.2 Complete protection of gully heads

It has been assumed that gully heads erosion potential exists associated with the easy and steep contoured areas of a farm. We have assumed that these areas will need to be retired or have other capital works put in place to manage gully head erosion, with the cost of such works equating to $1,650/ha for 2% of area of the steep and easy contoured proportion of the farm, with half of that area (1%) needing to be retired (modelled as a riparian area in OVERSEER).

M2.3 Reducing fertiliser N use

Fertiliser N applications for maize silage are typically in the order of 12kg N/ha applied per tonne DM of maize silage yield targeted for harvest. The maize silage crop model has assumed a total N application of 211kg N/ha as part of the maize silage rotation. As this equates to a rate of 10.55kg N/ha per tonne DM of silage harvest, we have assumed any reduction in N fertiliser will have a corresponding reduction in yield. In this analysis, N fertiliser use has been reduced by 15% (with a reduction in crop costs of $48/ha), with a 3 t DM/ha loss in silage yield.

M3 Mitigations

M3.1 Creation of new wetlands

The creation of wetlands totalling 3% of farm landscape with a potential 100% reduction in nitrate nitrite nitrogen (NNN) from roughly 1/5th of the total farm area is assumed. The development cost has been estimated at $3,000/ha (Perrin Ag 2018a).

The base farm system has then been proportionally scaled back to ensure feasibility was maintained in line with the average pasture cover track in the immediately preceding scenario.

Wetlands have been entered in OVERSEER on the basis of the following input parameters:

- Wetland condition: Artificial Type 1 - Flow path length to width ratio >5 (2 or more stage wetland[14], with even elongated channel or serpentine path created using internal bunds), well vegetated with good dispersion and even flow through the majority of wetland and minimal channelisation or dead-zones;
- Wetland type: Type A;
- Catchment area: 20% of total farm area;
- Catchment convergence: High convergence;
- Aquitard depth: 3-5m.

M3.1 Creation of a silt trap

Assuming that 80% of soil losses come from only 20% of farm area, the construction of a silt trap to capture run-off from the 20% most susceptible area of the arable block has been assumed. For the 40ha arable model, this assumes a silt trap is required to capture flow from 8ha of land. The cost of silt fencing is estimated at a one-off capital cost of $1,300 per hectare (Perrin Ag 2018a) - $10,400 of cap-ex for this model arable system.

[14] Where water "treatment" process of the wetland and separated into different steps

Appendix 11: Kiwifruit bundle modelling protocols

M1 Mitigations

M1.1 Complete protection of existing wetlands

A minimal cost of $250/year has been assumed to account for any weed control required to prevent weed incursion of already protected wet areas.

M1.2 Maintain optimal Olsen P

It is assumed that GAP practices that already result in optimal soil P levels are maintained under kiwifruit orchards.

M1.3 Laneway run-off diversion

Assume a further $250/annum in R&M Tracks expenditure.

M1.4 Efficient fertiliser use

Efficient fertiliser use is modelled here by splitting the calcium ammonium nitrate (CAN) applications across four application periods, rather than just two. This sees post-harvest applications in March and April as well as at bud break and flowering.

M1.5 Efficient irrigation practices

Duerer et al. (2011) define efficient irrigation management as an aliquot of 10 mm of irrigation water being applied every time that the water stored in the 0-2 m depth is less than 50% of the plant-available water (PAW; Tab. 1). This essentially results in a reduction in the volume of water applied of 75% (from 300mm per annum to 75mm per annum) for no loss of yield. Irrigation costs are reduced by 75% as well. It was assumed that orchards would have existing tensiometers available to monitor soil moisture levels.

M1.6 Use of grass swards under canopy and minimising bare ground

"Full pasture" selected as sward type on the General block tab in OVERSEER. This assumes herbicide desiccation of the pasture in the rows the vines are located doesn't occur. Without herbicide, in the absence of new/improved mowing technology growers would have to mechanically weed in rows, using a tool like a weed-eater. This would take a significant amount of time (days per orchard each time) and be a problem for a sector where labour shortage is already an issue. A few years ago, there were side-arm mowers to try and deal with this, but they didn't work well and would damage younger plants (Benge, J 2018). An additional $1,500 in labour and fuel costs per hectare is calculated as a result of needing to mechanically weed the inter-row ground at least six times per year, with a reduction of $85/ha in chemical and application costs from the discontinued herbicide applications.

M2.1 Develop a detention bund

A detention bund sufficient to detain a catchment of 4ha was assumed (approximately 480m^3 of storage), costing approximately $3,000+GST to install.

Appendix 12: Riparian areas, afforestation areas and fencing length estimates

BOPRC estimated the total areas to be retired, afforested and/or fenced under the mitigation bundles. These areas were then applied to the individual farm system models pro-rated for modelled farm area and system type. The original data and the proportionality assumed for the pastoral models is presented below.

Farm system type	Total Area	Area retired (hectares)					Fencing required (km)		
		M1 (Riparian)	M2 (Riparian)	M2 (>25 degrees)	M3 (Riparian)	M3 (>25 degrees)	M1	M2	M3
Lower KPW Dairy	11,085	80	8	NA	4	19	*432*	40	34
Mid KPW Dairy	10,212	72	14	NA	20	1,014	*246*	42	234
Upper KPW Dairy	7,061	101	3	NA	6	807	*163*	5	56
Lower Rangitāiki Dairy	3,919	19	2	NA	-	-	*148*	14	-
Mid-Upper Rangitāiki Dairy	19,826	127	10	NA	26	195	*534*	43	282
Sheep & Beef KPW (including Dairy Support)	16,840	103	2	3,488	16	NA	303	10	165
Sheep & Beef Rangitāiki	11,213	30	2	250	13	NA	139	17	134
Deer Rangitāiki	4,462	7	1	-	6	NA	33	7	63

Riparian areas and fencing lengths are based on Booker et al[15] estimates of wetted widths and GIS analysis. Afforestation areas are based on slope characterisation from the New Zealand Land Resources Inventory database.

[15] The dataset including these estimates is available from the Ministry for the Environment's Data Service at https://data.mfe.govt.nz/table/2536-natural-river-flow-statistics-predicted-for-all-river-reaches/data/ and the methodology is described in:
Booker, D.J. (2010) Predicting width in any river at any discharge. Earth Surface Processes and Landforms. 35, 828-841.
Booker, D.J., Hicks, D.M. (2013) Estimating wetted width and fish habitat areas across New Zealand's rivers. Report to Department of Conservation, CHC2013-075, 33pp.
Booker, D.J.; Woods, R.A. (2014) Comparing and combining physically-based and empirically-based approaches for estimating the hydrology of ungauged catchments. Journal of Hydrology DOI: 10.1016/j.jhydrol.2013.11.007.

Farm system type	Total Area	Fencing length required (km)		
		M1	M2	M3
Lower KPW Dairy	122	4.749	0.440	0.374
Mid KPW Dairy	122	2.939	0.502	2.796
Upper KPW Dairy	122	2.808	0.086	0.968
Lower Rangitaiki Dairy	117	4.418	0.418	0.000
Mid-Upper Rangitaiki Dairy	117	3.151	0.254	1.664
Sheep & Beef KPW	324	5.830	0.192	3.165
KPW Dairy Support	234	4.210	0.139	2.286
Sheep & Beef Rangitāiki	584	7.239	0.885	6.979
Deer Rangitāiki	324	2.396	0.472	4.575

Farm system type	Additional area retired (hectares)					
	M1 (Riparian)	M2 (Riparian)	M2 (>25 degrees	Total M2	M3 (Riparian)	M3 (>25 degrees)
Lower KPW Dairy	0.88	0.09		0.09	0.04	0.18
Mid KPW Dairy	0.86	0.17		0.17	0.24	1.64
Upper KPW Dairy	1.75	0.04		0.04	0.10	0.58
Lower Rangitaiki Dairy	0.57	0.06		0.06	-	
Mid-Upper Rangitaiki Dairy	0.75	0.06		0.06	0.15	0.88
Sheep & Beef KPW	1.98	0.04	67.11		0.31	
KPW Dairy Support	1.43	0.03	48.47		0.22	
Sheep & Beef Rangitāiki	1.56	0.10	13.02		0.68	
Deer Rangitāiki	0.51	0.07	0.00		0.44	

Figure 27: BOPRC fencing length data as applied to the pastoral models utilised for this analysis

Appendix 13: Fencing costs[16]

	per km for		3 wire electric		
0	hrs/km Blade fence line		$60.00	$0	
15	Strainers	No2 2.4m @	$37.40	$561	
15	Stays		$13.90	$209	
125	Posts	No2 &No2 1/2rounds @	$7.74	$968	
4.8	coils wire	650m @	$79.99	$388	
375	Insulators	for posts @	$0.45	$169	
45	Insulators	for strainers@	$2.09	$94	
0.24	Staples	25kg box @	$159.00	$38	
1	Gates	Steel @	$240.00	$240	
0	Gates	Elect.Tape @	$35.00	$0	
0.00	Electric fence unit		$2,049.00	$0	
			Materials	$2,666	$2.67
			Labour	$2,500	$2.50
			Total	**$5,166**	**$5.17 per m**

	per km for		3 wire electric using existing materials		
0	hrs/km Blade fence line		$60.00	$0	
0	Strainers	No2 2.4m @	$37.40	$0	
0	Stays		$13.90	$0	
0	Posts	No2 &No2 1/2rounds @	$7.74	$0	
2.4	coils wire	650m @	$79.99	$194	
375	Insulators	for posts @	$0.45	$169	
45	Insulators	for strainers@	$2.09	$94	
0.24	Staples	25kg box @	$159.00	$38	
0	Gates	Steel @	$240.00	$0	
0	Gates	Elect.Tape @	$35.00	$0	
0.00	Electric fence unit		$2,049.00	$0	
			Materials	$495	$0.49
			Labour	$2,750	$2.75
			Total	**$3,245**	**$3.24 per m**

	per km for		8 wire post & batten	1	electric
1.5	hrs/km Blade fence line		$90.00	$135	
25	Strainers	No2 2.4m @	$37.40	$935	
25	Stays		$13.90	$348	
3	Angles		$13.90	$42	
250	Posts	No2 @	$7.74	$1,935	
12.9	coils wire	650m @	$79.99	$1,034	
1000	battens		$1.84	$1,840	
275	Insulators	for posts and strainers @	$0.45	$124	
200	Permanent strainers	for strainers@	$3.59	$718	
0.64	Staples	25kg box @	$159.00	$102	
1	Gates	Steel @	$240.00	$240	
0	Gates x2 wire	Elect.Tape @	$35.00	$0	
0.03	Electric fence unit		$2,049.00	$57	
			Materials	$7,508	$7.50
			Labour	$6,500	$6.50
			Total	**$6,500**	**$14.00 per m**

[16] Source: PGGW

Recommended mitigation bundles for cost analysis of mitigation of sediment and other freshwater contaminants in the Rangitāiki and Kaituna-Pongakawa-Waitahanui Water Management Areas

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1 Executive summary

A list of 43 rural land use management and land use change mitigations were evaluated for their effectiveness and cost to the farm or orchard system in order to develop mitigation bundles for use in evaluating the cost of improving water quality in the Kaituna-Pongakawa-Waitahanui and Rangitāiki Water Management Areas (WMAs).

Similar to Vibart et al. (2015) and Daigneault and Elliot (2017), a cumulative three-layer framework was developed to bundle the mitigations. However, in this case, bundles were primarily determined based on cost at the farmgate, filtered for effectiveness at reducing contaminant losses. These mitigation strategy bundles, designed to be applied cumulatively to farm and orchard systems, are:

(i) M1: low barrier to adoption; primarily defined by being of low cost (equivalent to less than 10% of EBIT) with a minimum least low effectiveness;

(ii) M2: moderate barrier to adoption; primarily defined by direct costs and/or lowered revenue equivalent to more than 10% but less than 25% of EBIT and at least medium effectiveness for the targeted contaminant;

(iii) M3: high barrier to adoption, primarily defined by significant reductions in pre-mitigation profitability (>25% EBIT) and high effectiveness at contaminant reduction;

Total land use change mitigations were considered a separate bundle (M4) and excluded from consideration.

These bundles were then further considered for applicability on each of the five major land use categories used in the APSIM and eWater SOURCE catchment model, which will be the basis for the bio-physical analysis undertaken for these two WMAs.

Testing both the definitions of the bundles and farmer familiarity with the individual mitigations themselves at the planned community group meetings will be critically important.

2 Overview

In this report, we aim to provide guidance on the suggested bundling of different practices to reduce sediment and other freshwater contaminants from rural land use in the Bay of Plenty Region. Such bundling needs to be structured around both the cost to growers/farmers from implementation and the effectiveness of the mitigation(s) in reducing contaminant load.

Studies looking at the effectiveness and cost of both individual and suites/bundles of on-farm and on-orchard mitigations to improve water quality have been regularly undertaken in the last decade. These have tended to look at the four primary contaminants to water – nitrogen (N), phosphorus (P), sediment and bacteria such as *Escherichia coli (E. coli).* As a result, there is reasonable understanding amongst the scientific and farming community about the relative costs and benefits of various systems and land use changes with regard to mitigating contaminants to water from agricultural land use.

Previous publications that summarise mitigation options for farmers include Low et al (2017), McDowell et al (2013), McKergow et al (2007), Ritchie (2008), Waikato Regional Council (2013) and Wilcock et al (2008). A bundled approach to considering mitigations has previously been considered in New Zealand, including by Vibart et al (2015), Daigneault & Elliot (2017) and Monaghan et al (2016). However, research to increase understanding around the applicability of, and expected effect from, the adoption of individual and bundled practice change within individual regions, freshwater management areas and sub-catchments is ongoing.

Accordingly, in this report we have attempted assess the costs of sediment and other freshwater contaminants' reduction from implementing different mitigations, with a long list of suggested practices used by the BOPRC in canvassing community groups in the targeted WMAs as the starting point. This report then presents a short[ened]-list of mitigation options that are grouped together to form different bundles based on cost. While the mitigation options included in each bundle may or may not be implemented, the aim is to define a range of mitigation options that covers the range of costs likely to be experienced when implementing mitigation options and the range of effectiveness covered by possible mitigation options.

To make such assessment, we have completed a high-level review of the current literature related to on farm land use management practices and supplementary (technological) mitigation options, as well as our own experiences in evaluating cost to farmers and growers from implementing practice change, which has often involved analysis using Farmax[1] and OVERSEER[2] software.

We note that the literature reviewed is not consistent in its estimates or reporting of "cost" to farmers/grower in terms. "Cost" has previously been defined as everything from a relative cost assessment, gross (absolute) cost, cost as a percentage reduction in profit through to a cost per unit of contaminant reduced. With the emphasis in this piece of work being on the cost to farmers and growers, expressing the cost of a mitigation as the equivalent % reduction in annual operating profit (defined here as earnings before interest and tax) is probably most helpful.

[1] http://www.farmax.co.nz/
[2] https://www.overseer.org.nz/

Based on the expected cost of mitigation options identified in the review, the potential mitigations will be structured into suggested low, medium and high cost mitigation bundles for subsequent modelling. Using a framework proposed by Macdonald (2018) (see Section 4 below), proposed mitigations will also be cross-referenced against effectiveness. This will ensure that potentially high cost mitigations with low effectiveness at reducing contaminant load will not be recommended.

2.1 Description of contaminants and key pathways to water

2.1.1 Nitrogen loss

Nitrogen typically enters waterways as nitrate (NO_3-) through drainage, with such losses variable throughout the season based on rainfall, underlying pasture growth and soil moisture conditions. OVERSEER modelling can account for some of these drivers of loss rates. While direct losses are possible through fertiliser or effluent application [via overland flow], the uneven redistribution of N via the livestock urine patch is the primary driver of N loss in pastoral systems. Mineralisation of soil organic matter from cultivation or the excessive application of nitrogen (to ensure N is non-limiting to a developing plant) is a more typical driver of loss in arable and horticultural systems.

Most mitigation practices in relation to reducing N loss to water focus on improving the N conversion efficiency of the agricultural system.

2.1.2 Phosphorus loss

While OVERSEER modelling can estimate average P losses from farming activity, the reality is that such losses are neither uniform across the relevant parts of the property, either spatially or temporally. It is recognized that 80% of all P losses from a pastoral farming operation come from 20% of the property (Gburek & Sharpley, 1988), particularly those areas where transport mechanisms (i.e. water flows) and contaminant sources, such as stock camping areas, water trough surrounds, coincide. These have been defined by McDowell & Srinivasan (2009) as critical source areas ("CSAs").

While it is impossible to eliminate the creation of these CSAs within a farming or horticultural environment, strategies to slow the movement of storm water through ephemeral channels (to facilitate sediment deposition) or break the connectivity between ephemerals and these risk areas tend to dominate P loss mitigation.

2.1.3 Sediment loss

Sedimentation happens in wetlands, lakes, slow-flowing parts of rivers and estuaries, when the sediment load received from the freshwater catchment exceeds their capacity to flush out the sediment. Sediment loads can be caused by mass movement, gully, sheet and rill, streambank and human induced ground erosions. Sedimentation might increase when there is land without (native and exotic) forestry[3] on steep slopes, land with heavily grazed vegetation, soils with poor infiltration

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[3] Including after forestry harvest

and saturated soils. The sedimentation damages fish populations, degrades benthic habitat, and smothers river beds.

2.1.4 Bacterial contamination

E. coli is used as an indicator of freshwater bacterial contamination from animal faeces and is one of the attributes of the "Human Health" water quality value. The higher *E. coli* indicate an increasing risk of infection in humans who use fresh water for primary and secondary recreation activities. *E. coli* enters streams through a direct deposition of faecal matter of livestock, discharges of dairy effluent into streams, overland flow from excess irrigation water and drainage. The main source of such freshwater contamination is ultimately grazing livestock.

3 Assessment of mitigations

Descriptions of sediment and freshwater contaminant reduction and costs of mitigation options are given in Table 1 overleaf based on a review of published research. More detailed description of each mitigation option is given in Appendix 1.

In considering the mitigations in Table 1 below, it is important to recognise that the evaluations of effectiveness ("expected reduction [in losses] from baseline" have been developed from a mixture of empirical research and modelled analysis. The reality is that the impact in real situations could be highly variable depending on individual situations. As such, the information presented should be considered useful for the purposes of relative assessment, rather than absolute accuracy.

All of the mitigations considered would have a high level of applicability to other parts of the Bay of Plenty region.

Table 1: Summary of water contaminant mitigation practices to be considered in the Kaituna-Pongakawa-Waitahanui and Rangitāiki water management areas (? = Uncertain)

Mgmt Area	Mitigations	Expected reduction from baseline				Cost (% reduction in EBIT)[4] level	Nominal costs		Additional details	References
		N leaching	P loss	Sediment/ erosion	*E. coli*		Initial capital	Operating (recurring) costs[5]		
Land use	Land use capability (LUC) class 6, 7 and 8 land that is currently in pasture converted into forestry/mānuka and fenced	4%	15%	80%	?	Medium (steep land) to High (easy contoured land)	$1,000-$2,000/ ha	Just ongoing maintenance	Opportunity cost is 100% of profits from the area occupied by trees, but generates income from trees over time.	Daigneault et al (2017); Doole (2015)
	Creation of new wetlands (assumes 1% of farm area)	40%	70%	80%	Up to 50%[6]	High	$8,940/ ha of wetland, including planting and fencing	$300/ wetland	One wetland can cover 400 ha of area	Daigneault & Samarasinghe (2015); Doole (2015); Low et al (2017)
	Management of gorse (e.g. replacing with pasture, mānuka or natives)	80% on areas converted to trees, 50% to dry stock farming	?	?	?	Medium	$1,000-$2,000/ ha (assumes trees)	Just ongoing maintenance dependent on subsequent land use	Opportunity cost is 100% of profits from the area occupied by trees, but generates income from trees over time.	Magesen & Wang (2008)
	[Complete] Land use change to a less intensive use (e.g. sheep, deer, horticulture, forestry)	50% in changing from dairy to dry stock, 80% in converting from grass to trees	?	?	?	High	Variable depending on relative value of stock classes and infrastructure required	$140-$1,000/kg per N loss reduction	The cost levels occur depending on former and current land use practice. Excludes loss of capital value	Perrin Ag (2012)

[4] Will include the annual opportunity cost of capital associated with capital investment
[5] Can include the annual depreciation cost of capital investment
[6] But recent NIWA work indicates more complexity in this issue

Mgmt Area	Mitigations	Expected reduction from baseline				Cost (% reduction in EBIT)[4] level	Nominal costs		Additional details	References
		N leaching	P loss	Sediment/ erosion	*E. coli*		Initial capital	Operating (recurring) costs[5]		
Riparian management	Effective stock exclusion and planted buffer around water bodies	15% for dairy; 5% for drystock	10% for dairy; 5% for drystock	40%	25-35%	Medium to high	$255/ha	Just ongoing maintenance	A minimum of $255/ha, subject to the opportunity cost of buffer, its width and range of waterbodies are excluded.	Doole (2015); Dymond et al (2016), Keenan (2013); Monaghan and Quinn (2010)
	Stock water reticulation away from surface waterbodies	15% for dairy; 5% for drystock	10% for dairy; 5% for drystock	40%	25-35%	Medium	$142-$601/ha	$3.13-$12.56/ha	Results in good medium-term payback, but some benefit may be extracted through higher carrying capacity, which may increase N losses	Doole (2015); Journeaux and Van Reenen (2017)

Erosion control	Swales, soak holes, slag socks, sediment ponds,	None	0-20% from swales	Swales reduce by 40%; Sediment ponds by 50%	None	Medium to high	$255-$1,300/ha	None	Swales cost $255/ha; sediment ponds cost $750-1,300/ha,	Keenan (2013)
	Detainment bunds	None	Variable	Variable	?	Medium	$300-$500/ha of catchment	Elimination of P fertiliser from ponding areas	Detention bunds appear to be effective at catching particulate P in overland flow, but what this actually equates to on a farm or catchment scale is not fully understood. Not modelled in OVERSEER.	Clarke et al. (2013), http://www.rotorualakes.co.nz/vdb/document/796
	Complete protection of gully heads	None	None	70-90%	None	High	$1,000-1,650/ha	Just ongoing maintenance	Considering protection using afforestation	Daigneault et al (2017)

Mgmt Area	Mitigations	Expected reduction from baseline				Cost (% reduction in EBIT)[4] level	Nominal costs		Additional details	References
		N leaching	P loss	Sediment/ erosion	*E. coli*		Initial capital	Operating (recurring) costs[5]		
Erosion control	Manage risk from contouring/ landscaping	?	?	40%	None	Low	None	$82/ha cropped	Implemented on cropped area	Keenan (2013)
Erosion control	Spaced planting of poplars or willows on land use capability class 4-6 (steep erodible) land	None	20%	70%	None	Low to Medium	$34/ha		Costs are annualized	Daigneault and Elliot (2017)
Stock management	Appropriate stock type and stocking rates for land characteristics (e.g. sheep on steeper land)	21%	2%	None	?	Low to Medium	35% reduction in profits per hectare in comparison to baseline practice	None	Reductions in stocking rate of lamb finishing farms with some beef finishing	Doole (2015)
Stock management	Change in sheep to cattle ratio by increasing sheep ratio	19%	4%	None	?	Low	Variable, depending on relative value of stock classes	91% increase in profits per hectare in comparison to baseline practice, but highly dependent on underlying market relativities	Includes hill-country beef farm with no sheep. Mitigation practice is introduction of sheep. Impact on profitability does depend on market.	Doole (2015)
Stock management	Rotation, grazing management (e.g. wintering off away from catchment or in less sensitive area within catchment)	36% for dairy; 16% for S+B	30% for dairy; 20% for S+B	40% for dairy; 10% for S+B	10% for dairy; 10% for S+B	Low	None	$2-$30/head/week, depending on stock class and species	Can be costly, but a regular component of many dairy farm systems due to high rate of return. However, applicability as a mitigation moving forward is uncertain	McDowell et al (2005); McDowell and Houlbrooke (2009)

Mgmt Area	Mitigations	Expected reduction from baseline				Cost (% reduction in EBIT)[4]	Nominal costs		Additional details	References
		N leaching	P loss	Sediment/ erosion	*E. coli*		Initial capital	Operating (recurring) costs[5]		
Stock management	Appropriate location of feeding and stock drinking water through sites away from waterways	None	Variable	Variable	Varia ble	Medium	Variable	Ongoing maintenance	Extent of contaminant reduction depends on the extent of hydraulic connectivity from these CSAs	
	Responsible break-feeding practices	None	Up to 80%	Up to 80%	?	Low	None	2.5% reduction in crop areas	Should be no significant cost associated with this change in management approach.	Orchison et al (2013)
	Low leaching animal varieties	9%	None	None	None	Medium	Variable	Variable		Perrin Ag (2013)
	Dung beetles	?	70-100% via overland flow	70-100%	35%	Low	$6,000 per farm for colony establishme nt (for 150ha)	None	Preliminary trial NZ trial work is encouraging and in line with other global research. Additional NZ work is currently being undertaken.	Brown et al (2010), Dymond et al (2016), Forgie et al (2018), Paynter et al (2018), Slade et al (2016)
	Barns for intensive systems or in sensitive environments	15%- - 17%	15%	None	10%	High	$1,000- $2000/ cow	$171/ha	Less than half case study farms in Journeaux & Newman generated a return that exceeded their cost of capital. Utilising a barn to reduce N losses is unlikely to be profitable	Greenhalgh (2009); McDowell (2014); Perrin Ag (2013); Journeaux & Newman (2015); Daigneault et al. (2017), Perrin Ag (2018)

Mgmt Area	Mitigations	Expected reduction from baseline				Cost (% reduction in EBIT)[4]	Nominal costs		Additional details	References
		N leaching	P loss	Sediment/ erosion	*E. coli*		Initial capital	Operating (recurring) costs[5]		
Feed and crop management	Low nitrogen-leaching pasture/fodder crop/imported feed varieties	33%	6% increase	None	None	Low	None	\$87-\$391/ha reduction in profits depending on reduction of maize	Represents hill-country bee-breeding farm without sheep and the use of maize-silage crop for dairy support	Doole (2015
	No tillage/low impact cultivation (e.g. along contours, appropriate for season, strip tillage, direct drilling)	10%	50%	25%	None	Low	None	\$171/ha	Expected reduction of 10% in EBIT from arable cropping	Daigneault and Elliot (2017)
	Winter forage crop management	25%	Up to 80%	Up to 80%	Mode rate	Variable	None	Possibly reductions in costs	This is a potential combination of grazing practices, crop establishment and cover crop usage.	Carlson et al (2013), Lucci (2013), Orchison et al (2013)
	Grass buffer strips (2-metre) around cropping paddocks	10-20%	15-30%	65%	80-95%	Low	None	\$175/ha to be mitigated	Price is dependent on area, buffer width and vegetation used	Barber (2014); Low et al (2017); Wilcock et al, (2009)
	Cover crops between cultivation cycles	70-80% if planted in March; 25% if planted in June	None	None	None	Low	None	\$80/ha for cropped area		Low et al (2017)
	Earth decanting bunds for intensive cultivation	None	None	87.5%	None	Low	None	\$130/ha	Recommended capacity is 0.5% (50m/ha) for catchments less than 5ha, and 1% (100m/ha for catchments over 5ha	Barber (2014), Low et al (2017), Doole (2015)
	Alum applied to pasture or forage crops	None	30% at grazed cropland; 5-30% at pasture	None	None	High	None	On grazed land \$160-\$260/kg of P conserved; On grazed cropland \$150-\$500/kg of P conserved		McDowell (2010)

Mgmt Area	Mitigations	Expected reduction from baseline				Cost (% reduction in EBIT)[4]	Nominal costs		Additional details	Reference
		N leaching	P loss	Sediment/ erosion	*E. coli*		Initial capital	Operating (recurring) costs[5]		
Access/crossing infrastructure	Access crossings, bridges, culverts over all waterways regularly crossed by stock	None	95%	99%	Variabl e	High	?	?	Can be a significant cost depending on the size of the catchment the waterway drains.	Low et al. (2017)
	Appropriate gate, track and race placement, design and maintenance (e.g. diverting effluent away from waterways, slope access tracks away from drains to reduce sediment loss and avoid water flowing across disturbed area)	None	Variable, but based on the work of McDowell & Srinivasan (2009), could contribute significantly to reductions in losses if these form critical source areas.			Low to medium	?	?	Maintaining water tables and laneway camber is cheap to achieve but shifting gateways out of flow paths can be costly if an existing race network also needs to be altered. At a whole farm level, contaminant reduction can be significant (up to 80% if all managed effectively)	McDowell & Srinivasan, 2009
Fertiliser management	Paddock/block-level fertiliser planning/nutrient budget based on soil tests and crop needs	10%	10%	None	None	Low	None	$500 per year	Gains likely to be in association with other practices highlighted by appropriate nutrient budgeting	
	Maintaining optimal soil phosphate levels	None	18%	None	None	Low	None	Potentially as high as $200/ha/ year savings while mining excessive soil P levels	Extend of gain will depend on level of above optimal soil enrichment	Perrin Ag (2017c)
	Use of low solubility P fertiliser	None	6%	None	None	Low	Some initial capital application might be required to buffer lag of availability	None	The value of P in RPR tends to be lower than in superphosphate, but sulphur will generally also need to be added as well. The availability of the P from RPR will be limited initially, so best used in conjunction with mining of soil Olsen P levels	

Mgmt Area	Mitigations	Expected reduction from baseline				Cost (% reduction in EBIT)[4]	Nominal costs		Additional details	Reference
		N leaching	P loss	Sediment /erosion	*E. coli*		Initial capital	Operating (recurring) costs[5]		
Fertiliser Management	Efficient fertiliser use (e.g. not coinciding with rainfall, temperatures below 7 degrees Celsius, appropriate fertiliser types and timing of application, Geographical Positioning System [GPS]-based application).	Low (3%)	Variable	None	None	Low	None	Proof of placement technology will incur ongoing costs (est. $2,000 per annum), but savings in N fertiliser use expected	Costs based on fertiliser application level	Grafton et al (2011, 2013), Perrin Ag (2017b)
	Reducing fertiliser N use	15%-33%	None	None	None	Medium	May result in reduction in stock numbers if being used to support capital livestock	Net benefit-$350/year/kg N loss reduction	The extent of any profitability change tends to relate to the cost of any feed purchased in to replace the N boosted pasture or the amount of production forgone by the loss of the feed.	AgFirst (2009), Perrin Ag (2012)
	Use of plant growth regulators (Gibberellic acid)	4-29%	None	None	None	Low	None	$38/ha, but will expect some N savings	Application level is 20kg/ha	Ghani et al. (2014), Bryant et al. (2016)

Irrigation	Efficient irrigation application based on soil moisture deficit monitoring, awareness of soil type/infiltration rate and assessment of crop needs and expected rainfall	10%	None	None	None	Low	Cost of mid-range tensiometer could be as little as $1,100	$58/ha of annualized costs		McDowell et al (2013), Strong (2001)

Mgmt Area	Mitigations	Expected reduction from baseline				Cost (% reduction in EBIT)[4]	Nominal costs		Additional details	Reference
		N leaching	P loss	Sediment/ erosion	*E. coli*		Initial capital	Operating (recurring) costs[5]		
Effluent management	Solid separation	Variable	Variable	None	Variable	Medium to high	Costs vary depending on whether passive or mechanical separation is chosen	Ongoing maintenance and cost of spreading solids ($2,000-$3,000 p.a.)	Weeping walls, screw press and fixed screens are all examples of this technology. Cost of investment and ongoing operation can vary hugely.	Longhurst et al 2017
	Closed loop effluent recycling	?	?	?	?	Medium	$397,000 (based on stated payback of 7.5 years and a suggested $53,000 annual gap between annual costs of pond system versus the FORSI system)	$18,000 per annum	Still require solids separation (via a screen) and disposal of solids to land. No trial work available, but concept has long term potential for farms constrained by soil moisture levels for land-based liquid effluent disposal	https://www.forsi.co.nz/wp-content/uploads/forsi-effluent-recycling-system-2017.pdf
	Farm Dairy Effluent ponds: sufficient holding capacity to comply with soil moisture application standards and fully lined	?, but as much as 5%	10-30%	None	Up to 25%	Medium	$30,000-$100,000 depending on size of farm	$30/kg of P conserved	High capital cost	Dymond et al (2016), McDowell (2010), Low et al. (2017), Perrin Ag (2018)

Mgmt Area	Mitigations	Expected reduction from baseline				Cost (% reduction in EBIT)[4]	Nominal costs		Additional details	Reference
		N leaching	P loss	Sediment / erosion	*E. coli*		Initial capital	Operating (recurring) costs[5]		
Effluent Management	Maize on the effluent block	Variable	None	None	None	Low	None	$140/ha benefit assuming half of N fertiliser could come from effluent	Should allow a reduction in base N fertiliser requirements	FAR (2008), Johnstone et al (2010).
	Efficient application that complies with soil moisture standards and crop needs, more than 20 metres away from all waterbodies	Variable	Variable	None	Variable	Low to medium	Limited	None	$500 for basic soil moisture probe, but on high risk soils more investment may be required	Perrin Ag (2018)
	Increase application area to reduce application concentration	Variable	Variable	None	Variable	Medium to high	C. $705/ha	Ongoing maintenance	Depends on spatial layout of the farm and existing effluent areas	Perrin Ag (2018)
Denitrification	Use of nitrification inhibitors	10%	None	None	None	Medium	None	Prev. $97/ha applied	Products currently banned for use in NZ	Di & Cameron (2007)
	Denitrification technology (i.e. Spikey)	10%	None	None	None	Medium	Investment in equipment	Potentially increased pasture production could offset increased costs, but limited field trials	Moderate capital investment, returns potentially good, but field trials still ongoing	Bates & Bishop (2016)
	Denitrification beds	25%	None	None	None	High	High (not costed)	$137/ha of annualised cost	High capital cost plus. Loss of some fertiliser value from dairy effluent	Schipper et al (2010); McDowell (2013)

4 Proposed mitigation bundles

In contrast to Vibart et al. (2015) and Monaghan et al. (2016), in this study the mitigation practices that are summarised in Table 1 have been bundled based on their cost level (expressed as a reduction in pre-mitigation farm profit as measured by EBIT), but first having been filtered based on their effectiveness as proposed by Macdonald (pers. comm, 2018). This framework is presented in Figure 1 below.

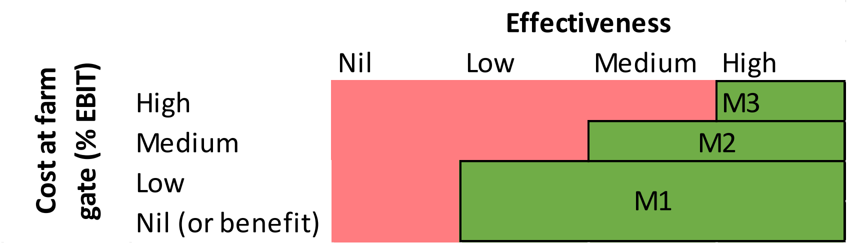

Figure 1: Bundling framework as suggested by Macdonald (pers. comm 2018)

For clarification, the "cost" of mitigation should include the opportunity cost of any capital employed and the loss of value (depreciation) over time, even though the former isn't captured in EBIT. These total mitigations are simply being considered in relation to amount of pre-tax profit that might be consumed as a result of its implementation.

The bundles are therefore broadly defined as:

(iv) M1: low barrier to adoption; primarily defined by being of low cost (equivalent to less than 10% of EBIT) with a minimum least low effectiveness;

(v) M2: moderate barrier to adoption; primarily defined by direct costs and/or lowered revenue equivalent to more than 10% but less than 25% of EBIT and at least medium effectiveness for the targeted contaminant;

(i) M3: high barrier to adoption, primarily defined by significant reductions in pre-mitigation profitability (>25% EBIT) and high effectiveness at contaminant reduction;

The mitigation bundles are designed to be applied cumulatively to farm and orchard systems i.e. M2 mitigations are applied only after applicable M1 mitigations have been implemented on farm.

This framework potentially includes two additional bundles, which have not been listed in the following tables:

(ii) M0: existing [best] management practice already assumed to be largely in place within farm systems (such as stock exclusion of dairy cattle from waterways) with essentially no cost to adoption.

(iii) M4: total land use changes

Based on the above, the proposed mitigation bundles M1 to M3 generated from this analysis are presented in Table **2** through Table **4** overleaf.

In reaching these final bundles, it is important to highlight several practices from the long list of specific mitigations have been excluded from the current bundles due to a current shortage of trial data of their impact on contaminant load to water in the NZ context and low current extent of adoption. However, these mitigations have some promise with regards to cost-effectively lowering the loss of N, P, sediment and/or bacteria to water from our farm and orchard systems. These specifically included:

- the “Spikey’ technology;
- introduction of dung beetles to pastoral systems.

Table 2: Summary of the proposed M1 mitigation bundles to be considered (as applicable) in the Kaituna-Pongakawa-Waitahanui and Rangitāiki WMAs

Mitigation bundle	Land use type				
	Dairy pastoral	Non-dairy pastoral	Arable	Horticulture	Forestry
M1	▪ Placement of feeding equipment ▪ Timing of effluent application in line with soil moisture levels (assumes sufficient storage) ▪ Reduced tillage practices ▪ Improved nutrient budgeting and maintenance of optimal Olsen P ▪ Laneway run-off diversion ▪ Grow maize on effluent blocks (if already growing maize) ▪ Elimination of summer cropping ▪ Reductions in seasonal stocking rate ▪ Efficient fertiliser use technology ▪ Efficient irrigation practices (soil moisture monitoring) ▪ Use of plant growth regulators [to replace N] ▪ Adoption of low N leaching forages ▪ Relocation of troughs ▪ Slow release phosphorus fertiliser RPR ▪ Reduce autumn N application - replace with appropriate low(er) N feed ▪ 3m average vegetated and managed buffer around rivers, streams, lakes and wetlands subject to the Dairy Accord; 1m around drains; 5m average buffer on slopes between 8 and 16 degrees, 10m average buffer on slopes above 16 degrees	▪ Improved nutrient budgeting and maintenance of optimal Olsen P ▪ Efficient fertiliser use technology ▪ Stock class management within landscape ▪ Adopt M1 arable cultivation practices for winter cropping ▪ Laneway run-off diversion ▪ Relocation of troughs ▪ Appropriate gate, track and race placement, design (where possible) ▪ Targeted space planting of poles ▪ Slow release phosphorus fertiliser RPR ▪ Adoption of low N leaching forages ▪ Full stock exclusion from all waterbodies greater than 1m wide at any point adjacent to farm (including drains) and wetlands. 2m average vegetated and managed buffer around rivers, streams, lakes and wetlands; 1m around drains; 3m average buffer on slopes greater than 8 degrees; 5m average buffer on slopes greater than 16 degrees.	▪ Grass or planted buffer strips ▪ Complete protection of existing wetlands ▪ Maintain optimal Olsen P ▪ Efficient fertiliser use and technology ▪ Cover crops between cultivation cycles ▪ Manage risk from contouring ▪ Reduced tillage practices	▪ Complete protection of existing wetlands ▪ Maintain optimal Olsen P ▪ Laneway run-off diversion ▪ Efficient fertiliser use and technology ▪ Efficient irrigation practices (soil moisture monitoring, not following fertiliser application) ▪ Grass swards under canopy, minimise bare ground and vegetated buffers around waterways.	▪ Management of gorse ▪ Complete protection of existing wetlands

Table 3: Summary of the proposed M2 mitigation bundles to be considered in the Kaituna-Pongakawa-Waitahanui and Rangitāiki WMAs

Mitigation bundle	Land use type				
	Dairy pastoral	Non-dairy pastoral	Arable	Horticulture	Forestry
M2	▪ Increase effluent application area ▪ Develop a detention bund ▪ Controlled grazing with stand-off pads (16 hours per day on pad in autumn), if they already have a stand-off pad ▪ Installing variable rate irrigators on existing pivot irrigators ▪ Reduce imported autumn supplement fed by 20% ▪ Reducing fertiliser N use (to 100kg N/ha) ▪ Full stock exclusion from permanently flowing waterbodies less than 1m wide (REC Order 2 and above) and average 2m vegetated and managed buffer; 3m average buffer on slopes between 8 and 16 degrees, 7m average buffer on slopes above 16 degrees	▪ Eliminate N that supports capital livestock ▪ Detention bunds ▪ Complete protection of gully heads ▪ Management of gorse ▪ Whole paddock space planting of poles ▪ Full stock exclusion from permanently flowing waterbodies less than 1m wide (REC Order 2 and above) and 1m average vegetated and managed buffer; 2m average buffer on slopes greater than 8 degrees, 3m average buffer on slopes greater than 16 degrees [with associated stock water reticulation, if any]. ▪ Convert steep land (e.g. LUC class 7-8, >26 degrees) into forestry/mānuka and fenced ▪ Changing stock ratios to reflect lower N leaching potential	▪ Use of silt fencing ▪ Complete protection of gully heads -N/A ▪ Reducing fertiliser N use ▪ Strip tillage	▪ Detention bunds in gullies (where they exist in amongst orchard properties)	

Table 4: Summary of the proposed M3 mitigation bundles to be considered in the Kaituna-Pongakawa-Waitahanui and Rangitāiki WMAs

Mitigation bundle	Land use type				
	Dairy pastoral	Non-dairy pastoral	Arable	Horticulture	Forestry
M3	▪ Afforestation of erosion prone land (e.g. >26 degrees) ▪ Stock excluded from REC Order 1 watercourses less than 1m wide and 1m wide average vegetated buffer ▪ Impervious effluent storage and sufficient capacity to comply with soil moisture guidelines and low rate effluent application ▪ Restricted grazing in covered stand-off pad, with use extended to winter as well ▪ Put in standoff pad if they haven't got one and use for 16 hours per day in autumn ▪ Switching from manual (e.g. K-line) to pivot irrigators with variable rate irrigators – irrigated dairy farms with manual irrigation systems only ▪ Creation of new wetlands ▪ Reducing stocking rates down by 0.3 cows/ha	▪ Full stock exclusion from REC Order 1 watercourses less than 1m wide and 1m wide average vegetated buffer. ▪ Creation of new wetlands ▪ Eliminate N that supports trading livestock ▪ Reducing stocking rates	▪ Creation of new wetlands ▪ Sediment traps		▪ Creation of new wetlands

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6 Appendix 1

6.1 Land use

6.1.1 Land use capability (LUC) class 6, 7 and 8 land that is currently in pasture converted into forestry/mānuka and fenced

In areas where potential pasture production is low (<4t DM/ha), conversion from pastoral farming to forestry is likely to have minimal impact on farm profitability when considered on the basis of long term pricing for timber and animal products. Costs are mainly related to tree plantation establishment and harvesting, and opportunity cost of alternative land use. For instance, Perrin Ag (2013) found that when afforestation of steep hill country was modelled on case study farms in the Upper Waikato, there was limited (if any) reduction of long term enterprise operating profit. However, the precise forestry regime, harvest requirements and location relative to ports and/or mills can have significant impacts on forest profitability. We note also that the recent National Environmental Standards for Plantation Forestry place limits on the afforestation of land deemed to be of very high erosion susceptibility (https://www.teururakau.govt.nz/growing-and-harvesting/forestry/national-environmental-standards-for-plantation-forestry/erosion-susceptibility-classification/).

The economics of plantation mānuka for honey production are questionable given current establishment costs, yields and price and the suitability of targeted lands for the cost-effective harvest of the biomass needed for oil extraction is likely to be low.

6.1.2 Wetland and ephemeral flow path management and protection

Stock exclusion from wetlands is recognised as having positive impacts on downstream water quality. A study of a Waikato hill country seepage wetland by Hughes et al (2013) found that cattle actually spent little time grazing in the shallow wetland and the direct effects of their grazing were minor, fluxes of cattle derived pollutants and damage to wetland margins and vegetation were detected. However, deeper wetlands tend to be avoided by livestock and don't spend sufficient time in them to have a notable effect on contaminant load or sediment disturbance.

On balance, given the loss of productivity from excluding livestock from wetlands is likely to be low and the concern about the long-term effect on water quality from stock access and exclusion is a sensible practice and likely to be achievable with limited cost.

The actual development of new artificial wetlands can be extremely expensive and as a result are often better considered at a whole-of-catchment scale. The review by Low et al (2017) suggested the cost could be between $550 and $7,500/ha, depending on the extent of nutrient and sediment capture desired and the nature of the existing flow in planned wetland area. In contrast, the study by Daigneault and Samarasinghe (2015) estimated that each new wetland can cost $100,000 that covers 400 ha of area. The capacity of new wetlands to take up nutrient losses from the receiving catchment is significant, although this can take a number of years to do so and such features will eventually reach equilibrium. Also, there are high positive impact of wetlands in reducing *E. coli* (50%) and sediment losses (80%) (Low et al., 2013; Daigneault and Samarasinghe, 2015). However, 2014 research by NIWA (https://www.niwa.co.nz/freshwater-and-estuaries/freshwater-and-estuaries-update/freshwater-update-63-november-2014/surprising-net-export-of-e-coli-from) found higher concentrations of *E. coli* in the outflow than in the inflow during monthly monitoring of farm drainage to a wetland during the wetter months of the year. This is a surprising finding given that constructed wetlands treating domestic sewage usually achieved net removal of *E. coli*. It was suspected that this observed increase in *E. coli* was probably due partly to wildlife deposition, but genetic and other evidence suggests that the main source is growth of this bacterium as environmental 'naturalised' populations within the wetland. This potentially raises interesting questions regarding the microbial ecology of *E. coli*, its use as a faecal indicator and interpretation of *E. coli*-based water quality in relation to waterborne disease and the human health risk downstream from wetlands and potentially other nutrient and/or organic-rich vegetative environments.

6.1.3 Management of gorse (e.g. replacing with pasture, mānuka or natives)

From a fundamental point of view, the eradication of gorse and conversion to alternative ground covers is likely to result in a reduction in N loss to water. Magesan & Wang (2008) calculated nitrogen losses to water from mature gorse stands in the Rotorua catchment at 36kg N/ha and 40kg N/ha, which would be equivalent to losses from either intensive dairy support activity or extensive dairy farm systems in the same area. However, there is insufficient information in the literature on the effect of gorse on P losses, sediment and *E. coli*.

6.1.4 Land use change to a less intensive use (e.g. sheep, deer, horticulture, forestry)

Land use change to less intensive activities can substantially change the nutrient leaching, erosion and *E. coli levels*. However, currently, such practice can have limited appeal for land owners. This is typically a result of the following factors:

- Cost of transition can be high i.e. cost of orchard development ($220,000/ha for kiwifruit pergolas and shelter), deer fencing (>$20/m) and handling facilities;
- Barriers to entry to the supply chain of lower intensity alternatives with profitable returns i.e. licences for crop varietals (G3 kiwifruit licence), supplier shares (i.e. Dairy Goat Co-op milk supply rights), limited markets for supply (sheep milk);
- Likely loss of capital value with "permanent" land use change including potentially low salvage value of prior investment (i.e. dairy land being planted in radiata pine);
- Perceived or real loss of profitability and annual cashflow, particularly where existing businesses are moderately or highly geared (pasture land converting to forestry);
- A desire to prevent the "stranding of assets" that have not yet reached the end of their economic life i.e. milking parlours, feed pads etc.
- Inadequate land owner knowledge of the alternative land uses;
- Personal preference.

6.2 Riparian management

6.2.1 Effective stock exclusion and planted buffers around drains, rivers, streams and lakes

Effective stock exclusion and riparian fencing with planted buffer includes vegetation around rivers, streams and lakes. Meta-analysis by Zhang et al (2010) found that buffer width alone accounted for

37%, 44% and 35% of the variance in removal efficacy for sediment, N & P respectively. A summary of the existing literature by Doole (2015) also suggested that the width of the buffer does have an impact on the extent of N loss reduction, but whether this is due to a greater interception area or a reduction in pastoral area (with a commensurate reduction in stocking rate) is unclear. We also note that much of the literature reviewed by Zhang considered N losses in overland flow or run-off, which in NZ pastoral systems is unlikely to be the primary pathway of nonpoint-source N loss to water.

This mitigation option focuses on preventing livestock from direct deposition of manure into these waters or direct stream bank erosion using the planted buffer. This management option will have a substantial reduction in sedimentation and *E. coli*., while to a lesser extent in reduction of N leaching and P losses. There is a concern that nutrient cycling within the riparian areas can act as an indirect source of N and P loss if planted vegetation is not regularly cut and removed (Collier et al, 2013). According to Doole (2015), use of 5-metre pastoral buffer strip can reduce actual N leaching of about 15% and 5% for dairy and dry stock farms respectively, assuming livestock had access to waterways previously.

For P loss reduction the levels are even more modest than for N leaching mitigation and is about 10% and 5% for dairy and dry stock farms (Doole, 2015). In addition, based on estimates of Keenan (2013), Daigneault et al. (2017a) showed that it is possible to reduce 40% of sediment with grass buffer strips. However, Zhang et al (2010) found that buffers composed of trees have higher N and P removal efficacy than buffers composed of grasses or mixtures of grasses and trees. The cost of establishing riparian vegetation strip is around $255/ha for horticulture (Keenan, 2013), but this will vary depending on the choice of any planted vegetation. BOPRC advise that a native sedge vegetation riparian planting strip could be established at an average cost of $20 per lineal metre of waterway planted, assuming both sides of the waterway were planted), with annual weed control costs of $130/ha retired (De Monchy 2018, pers. comm).

To date, most of the regulation and voluntary practice change around riparian management has been centred on high order water bodies and lowland drains. However, McDowell et al (2017) found that 77% of national contaminant load was coming from lower-order streams that are not currently required to be fenced. With P being the primary nutrient entering water ways from overland flow and direct [stock] deposition, the fencing of low-order streams in areas of high P load may be extremely effective in reducing pollution.

As regards to the relative cost and challenge to adoption, Vibart et al (2015) considered excluding dairy cattle from waterways to fall into an M1 bundle, sheep & beef cattle into M2 and utilising a buffer strip (7m) within M3.

6.2.2 Stock water reticulation in lieu of using surface waterbodies

The replacement of natural water sources with reticulated supply for livestock has the potential to improve the profitability of the pastoral operations where it is implemented, although the installation of reticulated supply is likely to require additional co-investment. Journeaux & van Reenan (2017) found in a study of 11 farmers that stock water reticulation can result in the significant internal rate of return of 53% on average. Such mitigation option can reduce *E. coli* and sediment by about 30% and 40% respectively, and with contribution on N leaching and P loss of about 10% depending on livestock type. However, stocking rate tended to increase with the introduction of reticulated stock water in the case study farms, which may in practice, lead to limited (if any) reductions of N loss to water.

6.3 Erosion control

6.3.1 Swales, soak holes, slag socks, sediment ponds, detention bunds/dams

Sedimentation (or erosion) can be controlled using swales, soak holes, slag socks, sediment ponds, detention bunds/dams. Swales are broad grass strips (like riparian grass buffer strips) used to treat sedimentation. Such practice can reduce sedimentation by 40%, in contrast to the baseline land use practice such as horticulture and pasture grazing but is highly slope dependent. The cost of such practice is about $255/ha (Keenan, 2013).

A constructed soak hole can act as a sediment trap, where sediment is collected and left to discharge to a controlled outlet or soak into the ground.

Slag socks are installed sock technologies/materials that intercept and address sedimentation of clay particles. Sediment retention ponds are constructed ponds to trap sediment at bottom of sub-catchment to tackle surface erosion and are suitable for all farm land use types. The sediment ponds can reduce erosion by 50% in comparison to farming practices, and cost of such mitigation option ranges between $750 and $1300/ha of catchment (Keenan, 2013). Detention bunds/dams or debris dams are effective in trapping erosion and associated P from water leaving pastoral farmland during rainfall and runoff events, and their effectiveness depends on influent load in the ephemeral stream . Detainment bunds temporarily pond ephemeral water (via controlled outflow) behind an earth bund (about 1.5 m high) for settling sediment and associated nutrients to onto the pasture and become part of the soil matrix (Clarke et al., 2013). Clarke et al. (2013) observed the largest retention of sediment and P was 2.7 t and 6.8 kg of P respectively in just one ponding event, but what this equated to on a whole far, scale wasn't apparent. Average P retention in Hauraki Stream catchment is 0.2 kg of P per ponding event that could save $28,000 for lake restoration costs over 20 years (Clarke et al., 2013).

6.3.2 Complete protection of gully heads

Once gullies have begun to form they must be treated as soon as possible to reduce negative consequences. To control gullies, building detention dams or bunds and revegetation such as afforestation and space-planting should be undertaken. Afforestation plantations can reduce erosion by 90% from the baseline if trees are not harvested (reduce erosion by 80% if trees are harvested) and can cost farmers $1000/ha (Daigneault et al, 2017). Space planting assumes that areas are planted and all tree plantations are maintained. Such land use practice can reduce sedimentation by 70% and costs $1650/ha (Daigneault et al, 2017). Typically dams are used in combination with tree plantations to control the runoff into gullies to trap sediment within gully systems.

6.3.3 Manage risk from contouring/landscaping

Tillage practices and cultivation on slope ridges can increase erosion. Contour strip cropping can be used and includes strip of pasture or small grain alternation with a strip of row crops. Ridges in contour strip cropping reduce the possibility of erosion. Contour strip cropping can reduce soil erosion by as much as 50% as comparing to farming up and down hills (USDA, 2013).

Cover crops are cultivated often solely to manage erosion. Planting cover crops can lead to the seasonal reduction in surface erosion in contour farming by planting legumes, cereal rye, clover and other crops in horticultural farms. According to Keenan (2013), erosion reduction effectiveness of cover crops is 40% from baseline erosion, which can cost $82/ha in an arable situation.

6.3.4 Spaced planting of poplars or willows on land use capability class 4-6 (steep erodible) land

While the space-planting poles on erosion prone hill country has long been accepted as an effective means of reducing erosion (Hicks 1995), the economic imperative for it is not great. Analysis by Parminter et al (2001) concluded that the productivity gain from soil retention was typically less than the suppression effect from shading on pasture dry matter production and that only on highly erodible soils and where farmers were happy with low returns on the investment from planting was the cost-benefit positive for the landowner. This analysis excluded the potential public good benefit from reducing soil erosion.

6.4 Stock management

6.4.1 Appropriate stock type and stocking rates for land characteristics (e.g. sheep on steeper land)

Treading damage to soils from livestock is recognised to have the potential to increase both the risk of surface run-off and the loss of sediment, phosphorus and nitrogen in any run-off. This risk is heightened in periods of high soil moisture, which in New Zealand typically coincides with the winter period. Nguyen et al (1998) concluded that intensive winter grazing on hill country pasture is potentially a major source of contaminant runoff to receiving waters. This is more likely to occur with [older] cattle than with sheep, but the lower pasture covers potentially achievable under sheep grazing regimes (albeit not desirable from an animal performance perspective) can expose soil to greater erosion risk. Limiting/excluding cattle older than 18 months from steeper hill slopes during winter is a recommended practice.

The risk of soil erosion from deer pacing fence lines on fragile soils can be significant but can be successfully managed by a combination of sensible fencing solutions (including remedial options for existing farms) and stock management practices (New Zealand Deer Farmers' Association 2012). However, the introduction/expansion of deer onto properties with more fragile soils (i.e. pumice) does need to be considered carefully.

The impact of stocking rate and stock type on N loss to water is reasonably well understood, with the urine patch the primary driver of N loss to water in pastoral grazing systems. As a result of urinary dynamics cattle will have a higher N loss signature than deer or sheep, and female stock a greater N loss signature than males. All things being equal, higher stocking rates will generate higher N loss to water as a result of higher quantities of N cycling through the farm system and more N therefore subject to the inefficient return via the urine patch. According to Doole (2015) appropriate stock type and stocking rates have lower P loss (2%) than N leaching (21%) reduction but can lead to profit reduction of 35% per hectare in comparison to the baseline practice. Temporal dynamics are increasingly recognised as being important, with late summer/autumn urine patches to pasture potentially having more impact that those deposited in the late winter, even with higher underlying soil drainage.

6.4.2 Rotation, grazing management (e.g. wintering off away from catchment or in less sensitive area within catchment)

The grazing of stock off-farm as a management practice has typically been limited to dairy farm operations, where either:

(i) a reduction in dry period feed demand is a cost-effective solution to shift feed into the early spring period to support the higher feed demands associated with lactation; or
(ii) the removal of replacement heifer feed demand allows an increase in the stocking rate of cows in-milk, with an increase in the marginal return per kg DM consumed.

The improvement in system N conversion efficiency from both strategies, as well as the reduction in urinary N deposition at a period of high drainage and low pasture growth from these management practices has also typically resulted in a reduction in direct farm N losses to water. In addition, there is high conversion efficiency for P loss, *E. coli* contaminant and erosion reduction, depending on livestock type, from rotation and grazing management. For instance, implementation of such mitigation options at dairy farm can reduce 30%, 40% and 10% of P loss, sediment and *E. coli* with a $9-$30/head/week (McDowell et al., 2005; McDowell and Houlbrooke, 2009).

However, the "exporting" of N and P loss, *E. coli* and sediment from one catchment to another as a mitigation strategy is potentially only a short-term solution, as the importance of water quality in receiving water bodies across New Zealand is of increasing importance.

6.4.3 Appropriate location of feeding and stock drinking water trough sites away from waterways

The importance of reducing the hydraulic connectivity of critical source areas from flow paths and waterways has been highlighted by McDowell & Srinivasan (2009). However, to reduce the cost of installation the location of stock facilities (primarily troughs) have often been placed adjacent to stock access ways, which can commonly be in flow paths. The cost of mitigation will depend on the distance required for relocation and whether the reticulation system has sufficient pressure to deliver water to the new location.

6.4.4 Responsible break-feeding practices

Research conducted by Orchiston et al (2013) demonstrated that break feeding [winter] forage crops with a view to managing overland flow dynamics within the crop paddock (cows entering at top end of the paddock, strip grazed moving in a downhill direction, protection of critical source areas from grazing, back-fencing every 4-5 days) resulted in a considerable reduction in the yields of sediment and nutrients carried in the flow. The cost of achieving such reductions was assessed as low (including a loss of 2.5% of potential crop yield through loss of area cropped).

6.4.5 Low leaching animal varieties

The relative profitability of the sheep, cattle and deer enterprises has a significant impact on the likely profitability of using livestock system change to reduce nutrient losses. While increasing the sheep/deer to cattle ratio tends to lower nitrogen losses, depending on their positions within their respective commodity cycles, implementing such a change might not lead to an increase in profitability if the lamb price is low in comparison to the beef price. Changes in livestock policies, particularly where breeding stock are involved, often have significant lag periods before increases in profitability are achieved and are not easily reversed once implemented. Altering specie ratios may also present challenges for the management of pasture quality and parasite burden.

6.4.6 Dung beetles

Initial NZ research (Forgie et al 2014) suggested that dung beetle activity in New Zealand pastures will result in reduced surface run-off, which is in line with the global research in this area (Brown et al 2010, Doube 2008). Given the strong association of P losses with sediment loss, the observed reduction in sediment loss of between 73-100% where dung beetles were present (Forgie et al 2018) would be expected to result in a similarly high rate of reduction in P losses. Dung beetles would also be expected to significantly reduce the loss of *E. coli* and other pathogens to water, with research in both NZ (Paynter et al 2018) and offshore demonstrating this. At a catchment scale, Dymond et al (2016) estimated *E. coli* contamination to water could be reduced by approximately 35% through the introduction of dung beetles. Other positive ecosystem benefits appear to be generated by dung beetles in pastoral grazing systems, such as reductions in greenhouse gas emissions (Slade et al 2016) and reductions in nematodes (Forgie et al 2014).

6.4.7 Stand-off pads or barns in dairy farm systems

Feed pads have limited impact on reducing contaminant loads to water given:

(i) the short period of time they tend to be in use; and
(ii) that the benefits from potential improvement in feed utilisation is typically captured by increased milk production, not reduced feed use, so the quantum of nutrients cycling through the farm system increases.

The use of stand-off pads in conjunction with duration-controlled[7] grazing throughout the season has, based on empirical trial work, the potential to significantly reduce the loss of N in drainage to water (in the order of 30%-40%). P loss reduction is lower than N leaching and is close to 15% reduction, while *E. coli* mitigation is about 10% lower than the current/baseline dairy farm practice (McDowell, 2014; Perrin Ag, 2013; Journeaux and Newman, 2015; Daigneault et al. 2017). However, this may come at the cost of lowered pasture production due to the changes in both the timing and form of the application of nutrients from animal excreta to the pasture (Christensen et al 2011).

Journeaux & Newman (2015) concluded, based on an analysis of 14 case study dairy farms that, in general, “inclusion of a barn without intensification of the farming system will result in a reduction in nitrogen losses, but at a (potentially significant) cost… [and] that intensifying the farm system to make the barn profitable often results in a rapid erosion of the environmental benefits”. A 2013 analysis of a dairy support operation in the Taupo-Ohakuri catchment, part of the Upper Waikato Drystock Nutrient Study (Perrin Ag 2013), assessed that installing a wintering facility resulted in a

[7] Where cows graze for only 4 hours each morning and evening to consume their desired daily pasture intake and are then removed from the pasture for rumination. This differs from restricted grazing, where cows are totally withheld from the pasture during a given period (say autumn & winter) and pasture is harvested and fed to the cows on a pad or barn facility.

reduction in EBIT of ($113)/ha (23%) for a 17% reduction in N loss. At the same time, in average terms the annual operating costs are about $171/ha (Greenhalgh, 2009; Daigneault et al. 2017). A significant increase in the rate charged for contract winter grazing was required to offset the loss in profitability.

Capital costs to farmers will tend to be less for stand-off pads than that for barns, but the costs can vary widely and can be between $1,000 and 2,000 (Greenhalgh, 2009; Daigneault et al. 2017).

6.5 Pasture/crop management

6.5.1 Low nitrogen-leaching pasture/fodder crop/imported feed varieties

There are a number of alternative forage species that early research indicates have the potential to lower farm N loss to water, albeit such impacts are not well captured in OVERSEER.

Lucci et al (2015) found evidence that suggested chicory planted after a winter brassica crop recovered greater amounts of winter deposited N than a conventional ryegrass white clover sward, but this is yet to be captured in OVERSEER. Analysis by Perrin Ag (2017) indicted replacing summer brassica crops with chicory had a positive impact on farm profit, but the impact on N loss reduction as expressed in OVERSEER was limited to differences in cultivation, not crop variety.

Modelling by Khaembah et al (2014) suggested that diverse pasture mixes (containing at least 50% of alternative species such as plantain and chicory) could result in reductions in urinary N concentration and hence N leaching), but the economic impact was not determined. Subsequently, Edwards et al (2015) observed a 20% reduction in cow urinary N concentration for cows grazing a diverse pasture sward compared to those on conventional ryegrass/white clover. In similar research, Box et al (2016) found cows grazing a monoculture of plantain had reductions in urinary N of up to 56% from that of cows grazing conventional pasture. Again, insufficient data exists to include such impacts within the OVERSEER model, but the impact on productivity through the introduction of high herb content swards is unlikely to be significant, particularly if winter active varieties are selected. Doole (2015) found that substitute of maize-silage crop with low nitrogen imported feed can reduce N leaching 33% than the current feed given to livestock. However, such imported feed increased P loss by 6% and resulted in profit reduction of $87 and $391/ha depending on reduction of maize.

The Forages for Reduced Nitrogen Leaching (FRNL) project (Dairy NZ 2017) has found that leaching from a urine patch was 25-35% lower under Italian ryegrass-based pastures than under other types of pastures due to cool-season N uptake of Italian ryegrass.

6.5.2 No tillage/low impact cultivation (e.g. along contours, appropriate for season, strip tillage, direct drilling)

It is generally accepted that the establishment of crops or forages using conventional “full” cultivation methods result in greater rates of mineralisation of N in soil organic matter than no-till alternatives. However, the impact that this has on actual N loss on soil drainage can be variable. Carran (1990) found that a similar amount of nitrate was present in the sub-soil in mid-winter after establishment of spring sown wheat crops out of established pasture irrespective of tillage method.

However, research to date in the FRNL project found that compared with conventional tillage, direct drilling autumn-sown forage crops reduced the compaction that results from winter grazing, leading to as much as a 20% improvement in the yield of a subsequent cereal [catch] crop, which in turn increases N uptake from the soil. According to Daigneault and Elliot (2017), eliminating crop disturbance from tilling can also reduce P loss and sediment along with N leaching but reduce EBIT of arable crops by 10%.

In practice, there is little difference in the cost of establishment of crops using no-till techniques, with greater weed and pest control often required. However, irrespective of the impact on freshwater and water contaminants reduction, direct drilling or strip tillage will lower the risk of run-off and soil loss and represent a useful practice change on farm.

6.5.3 Winter forage crop management

Lucci et al (2013) assessed that the major risk of N losses associated with winter forage crops was associated with the risk of redistribution of N in the crop via the urine returned to the soil via grazing animals. Their research on crop establishment on pumice soils demonstrated no loss of yields associated with direct drilling compared with conventional cultivation (which would typically be expected to lead to greater mineralisation) and the potential for forage brassicas to remove high levels of mineral N from the soil during growth. Their research also suggested that total DM yields did not increase with fertiliser N applications in excess of 200kg N/ha.

Research by Carlson et al (2013) also indicated the N losses from grazed winter forage brassicas might be reduced through later season (i.e. late July), rather than earlier season grazing (June), further complemented by ensuring the subsequent crop had the potential to uptake significant amounts of mineral N still in the soil.

6.5.4 Grass buffer strips (2-metre) around cropping paddocks

The appropriateness of grass buffer strips of this width is essentially limited in application where there is little risk of surface run-off and they are essentially in place to deliver livestock exclusion from flow paths or stream channels (McKergow et al, 2007). In a cropping context, such width strips are best used for the exclusion of stock from critical source areas whilst grazing forage crops (see Responsible break-feeding practices above). Grassed swales used for controlling overland flow through ephemeral flow paths amongst arable cropping activity should be at a minimum 3m wide shaped into a flat shallow saucer about 0.3m deep (Barber 2014). Grass buffer strips are particularly effective in reducing sediment loss and *E. coli* (Wilcock et al., 2009; Barber 2014; Low et al., 2017).

6.5.5 Cover crops between cultivation cycles

Cover crops are usually grown to be ploughed into the soil, but not harvested or grazed, in order to improve soil quality. Cover crops stabilise soil, accumulate nutrients left from previous land uses, improve drainage and soil structure, and can fix nitrogen (for some cover crops). Such cropping practices are suitable for all farm land use practices (Low et al, 2017). The N leaching reduction from cover ranges depending on crop and season and can be about 70-80% reduction from the baseline for cover crop sown in March, and about 25% reduction for cover crop sown in June. The cost of cover crop cultivation is approximately $80/ha, depending on cover crop. However, this land use has some limitations as it might lead to substantial reduction in N leaching for some crops, e.g. barely, while have meagre effect on the whole farm outcomes (Low et al, 2017).

6.5.6 Earth decanting bunds for intensive cultivation

An earth decanting bund for intensive cultivation is a temporary berm of compacted soil to create a damming area where ponding can occur (Low et al., 2017). Earth decanting is established along the flat contours at the bottom of paddocks. The paddock can hold the runoff to drop out the sediment by moving the headland further up the paddock (Low et al., 2017). According to Doole (2015) the efficacy in sediment reduction of earth decanting bunds in the Lower Waikato region is 87.5% and its cost is $130/ha.

6.5.7 Alum applied to pasture or forage crops

Another option to mitigate P loss is to decrease the source by adding P-sorbing agents such as aluminium sulphate (alum). In cases when alum can bind to the soil before being washed off, it can be effective to decrease P loss. Application of alum to grazed cropland can reduce P loss by 30%, compared to untreated land use and can cost between $160 and $260/kg of P conserved (McDowell, 2010). Alum use on pasture can be effective to reduce P loss by 5 to 30% than under the baseline land use practices, and costs range from $150 to $500 /kg of P conserved (McDowell, 2010). The cost-effectiveness will be influenced by the availability of a ready source of cheap materials. Alum for P loss reduction might be obtained as a by-product from the fertiliser industries.

6.6 Access/crossing infrastructure

6.6.1 Access crossings, bridges, culverts over all waterways regularly crossed by stock

Surface runoff from farming is a great source of P, sediment load and *E. coli* loss to waterways is considered even to have higher pollution than runoff from pasture (Low et al., 2017). Management requires good track design, bunding of culverts and bridges. Implementation of such mitigation options can help to decrease total P loss in runoff by 95% and suspend sediment by 99% (Low et al., 2017).

6.6.2 Appropriate gate, track and race placement, design and maintenance (e.g. diverting effluent away from waterways, slope access tracks away from drains to reduce sediment loss and avoid water flowing across disturbed area)

This essentially comprises the management of critical source areas (with hydraulic connectivity) discussed by McDowell & Srinivasan in 2009.

6.7 Fertiliser management

6.7.1 Paddock/block-level fertiliser planning/nutrient budget based on soil tests and crop needs

The value of whole farm paddock soil testing is questionable. Withnall (2015) suggests that dairy farms utilising this technique are reducing the range in soil fertility status over their farm (i.e. applying less nutrients to areas of high fertility and more nutrients to areas of low fertility), potentially implying that the incidence of [P] fertility above optimal levels is lowered. However, Edmeades (2011) notes the inherent variability in the soil test results for typically tested nutrients and fertility measures, highlighting the reality that a soil Olsen P measure of 20ppm and 30ppm could both be 25ppm. He suggests that taking soil tests (20 cores from a transect) from blocks of similar soil group, slope, land use, and past management history still represents the best process and cost-efficient method for identifying soil nutrient status.

6.7.2 Maintaining optimal soil phosphate levels

Lowering soil Olsen P status provides one of the most powerful mitigations as regards reducing P loss that is quantifiable in OVERSEER. For example, Morton and Roberts (1999) state that near maximum pasture production is achieved at soil Olsen P levels of 38 on pumice soils. However, on rolling contour, soil Olsen P levels of this nature massively increase the risk and extent of P loss. Given both the typical utilization of pasture grazed in situ on dry stock properties and the economic returns from dry stock farming activities, it is questionable as to whether there is an economic return from maintaining soil P reserves at these levels.

Econometric analysis presented by Edmeades in 2008 indicated that the economically optimal soil Olsen P level at a superphosphate price of $400/t can vary between 10 and 24 depending on the level of underlying farm profitability (as expressed in terms of gross margin).

6.7.3 Efficient fertiliser use (e.g. not coinciding with rainfall, temperatures below 7 degrees Celsius, appropriate fertiliser types and timing of application, Geographical Positioning System[GPS]-based application).

Analysis of Grafton et al (2011, 2013) infers that at an application rate of 100kg/ha of urea (46%), lowering the coefficient of variance (CV) of spread from 40% to 20% improves the observed DM response rate in pasture from N fertiliser from 10:1 to 11.2:1. This relationship was the basis for the assumption that N fertiliser application can be reduced to 89.2% of pre-precision technology levels without reducing DM production, cow intakes and milk production. Analysis by Perrin Ag (2017b) indicated that for farms of a suitable scale, use of precision fertiliser spreading technology was likely to increase profitability while reducing N losses.

Grafton et al also comment that reduction in CV of spread for superphosphate would reduce risk of accidental discharge into sensitive (i.e. riparian, drainage) areas etc. However, this is not able to be modelled in OVERSEER, nor is there sufficient research to establish whether phosphate fertiliser applications could be reduced as a result of this technology without compromising existing soil P reserves (as measured by Olsen P).

However, adoption of what is generally considered best practice in relation to the application of fertiliser would be expected to reduce the risk of direct nutrient loss to water. Such practices would include applications being undertaken in accordance with the Spreadmark Code of Practice, P fertiliser not be applied if the three-day weather forecast indicates there is likely to be heavy rainfall, avoiding P applications to ephemeral flow paths and during the months of May through August and considering withholding P fertiliser from all significant stock camping areas. Such practices are already encouraged in the guidance documents for the preparation of nutrient management plans required by farmers in the Rotorua Catchment under BOPRC Plan Change 10 and the Farm Environment Plans under the WRC Plan Change 1

6.7.4 Reducing N fertiliser use

The use of nitrogenous fertiliser, even when applied in line with best management practices has a contributory impact on increasing nitrogen losses from the farm system. This occurs through both increasing the quantity of N cycling through the farm system and typically allowing higher stock intensities to be farmed, normally through the higher risk winter leaching period. The elimination of N in dairy systems might be managed through the importing of additional feed or the use of gibberellin (see 6.7.5 below). However, in dry stock systems where the returns per kg DM eaten are typically lower than the cost per kg DM of imported feed, it is typically more profitable to lower feed demand (i.e. reduce stock numbers) than increase feed supply (i.e. purchase more feed).

Analysis in the Upper Waikato Drystock Nutrient Study (Perrin Ag, 2013) found that the cessation of fertiliser nitrogen usage, typically accompanied by a reduction in stocking rate, generally led to a reduction in system N losses with no reduction in EBIT. This was typically due to the marginal cost of the N fertiliser exceeding the return from the feed reduced.

6.7.5 Use of plant growth regulators (Gibberellic acid)

Gibberellic acid (GA_3) is a plant hormone that when applied to grasses and cereals typically results in the elongation of leaf, sheath and stem (a dry matter response), providing the plant has already experienced sufficient vernalisation (chilling) (Bryant 2014). GA is a growth promoter and won't work in the total absence of plant available N in the soil.

Ghani et al (2014) found that the %N in herbage of pastures treated with GA were significantly lower than those untreated which would reduce urinary-N excretion under grazing. Subsequent modelling suggested whole farm annual N losses could be reduced by 4-29%, although some of these reductions would be associated with the replacement of N fertiliser applications with GA (i.e. same DM production for less N applied). Bryant et al 2016 also concluded that using GA to increase DM yield with reduced herbage protein concentration may have reduced environmental impact through reducing N intake of livestock.

Unpublished PhD research from Woods (2017) indicated that in a lysimeter trial the application of GA had no direct impact on reducing N leaching [through promoting plant uptake of urinary N that would have otherwise leached] which suggests that any whole system N loss reduction from the use of GA is associated with the substitution of N fertiliser and an improvement in whole system N use efficiency. However, Bates & Bishop (2016) propose that this lack of N loss reduction was due to the GA being applied to pasture of insufficient mass to promote a response or that conditions were too cold to get any growth at all (Bates et al 2017).

In conjunction with the urease inhibitor NPBT, GA and (if required) and dissolved organic carbon (marketed as ORUN®) is being promoted as a means to increase the lateral movement of urine patches (the NBPT) and then utilise the N in the urine patch before it leaves the rootzone (via the GA), with Bates & Bishop (2016) suggesting targeted application to the actual urine patch is the preferred method.

6.8 Irrigation management

6.8.1 Efficient irrigation application based on soil moisture deficit monitoring, awareness of soil type/infiltration rate and assessment of crop needs and expected rainfall

Metering the rate and total volume of irrigation water can help to adjust the irrigation application levels and avoid overuse of irrigation water that can increase the leaching of nutrients and bacterial contaminants. Applying water as dictated by soil water needs can have a similar impact. Also, technology can help to avoid poor timing of required irrigation for crops and thus improve crop growth.

6.9 Effluent management

6.9.1 Solid separation

Separation of the solid fraction from effluent is a mechanism to lower application depths for the liquid fraction of farm dairy effluent. This can allow this liquid fraction to be applied in conjunction with conventional irrigation. This is of significant advantage where effluent volumes are likely to be significant (such as from housing, pads) or contain greater volumes of coarse fibrous material.

Separation of solids may also allow more targeted application of the nutrient in dairy effluent, as total %N is highly associated with the dry matter fraction of dairy effluent (Longhurst et al 2017).

The ability to lower the application rate will be beneficial on higher risk soils [that can't sustain higher application rates in achieving appropriate depths] or where targeted application of the nutrients in solids (such as in cropping programmes) may be more manageable than significant land-based slurry application.

6.9.2 Farm Dairy Effluent ponds: sufficient holding capacity to comply with soil moisture application standards and fully lined

If farms have insufficient effluent storage they will be forced to irrigate when soils are actively draining, creating direct losses of nutrients and *E. coli*. While most regional authorities require that effluent is not applied in such conditions, the reality is that many farmers with permitted or consented effluent management facilities are unable to operate with full compliance all of the time.

It is also noted that Houlbrooke et al 2014 identified the losses from old [unlined] two-pond systems that discharge to water as the single largest effluent risk to surface waters, which reinforces the move to eliminate these systems by regional authorities, where they still exist.

Dymond et al (2016) also calculated that where they didn't previously exist, the creation of [lined] storage ponds that allowed irrigation of dairy effluent to land to be time to not coincide with high risk of overland flow would reduce *E. coli* losses to water in the order of 25%.

6.9.3 Maize on the effluent block

The main water quality benefit from growing maize for silage on pastoral areas receiving dairy effluent is a reduction in the quantity of fertiliser nutrient required to be applied in the first and potentially second year's crops, which reduces the risk of direct losses to water and lowers the introduction of mobile nutrients into the farm system. There is an expected improvement in farm profitability from doing so as well (FAR 2008, Johnstone et al 2010).

6.9.4 Efficient effluent application that complies with soil moisture standards and crop needs, more than 20 metres away from all waterbodies

The depth of applied effluent (measured in mm) should always be less than the soil moisture deficit at the time of application. If effluent irrigation occurs on soils that are too wet, then run off to surface water bodies or drainage below the root zone will occur, with valuable nutrients and also bacteria being lost from the farm and contaminating the environment (Dairy NZ 2014).

Deferred irrigation and low application irrigation systems (e.g. irrigation sprinklers) are effective options to reduce contamination related with land uses. The nutrient losses resulting from a single poorly managed irrigation event is estimated in the order of 12 kg N/ha and 2 kg P/ha, approximately one third of the average total whole farm N losses and three times the annual average pastoral P loss (McDowell, 2010). The potential to decrease nutrient losses with better irrigation techniques is great. Such irrigation techniques can be established based on the agro-ecological conditions such as soil types and climate as well irrigation requirement of crops. Deferred irrigation and low application irrigation systems are not only environmentally beneficial, but also can be cost effective.

6.9.5 Increase application area to reduce application concentration

Using N from the fertiliser effluent system to replace N fertiliser is a good mechanism for improving N conversion efficiency on a farm, which will typically result in lower N losses to water. Roach et al (2001) found that nitrate leaching increases significantly when pond FDE is applied at rates above 200 kg N/ha/year and that lowering the application rate to target 100kg FDE N/ha/year (increasing the application area) would deliver maintenance potassium requirements at the same time. The cost-benefit of this will depend on the fertiliser benefit of the additional K and the cost of expansion.

6.10 Nitrate inhibition

6.10.1 Denitrification technology (e.g. Spikey)

The use of dicyandiamide (DCD) as a means to limit N losses from grazed winter forage crops was successfully demonstrated by Shepherd et al (2012), but due to the presence of DCD found in milk products in 2013, this product is not currently available for use in NZ farming systems. When its use (as described by Shepherd et al) was previously modelled by Perrin Ag (2013) for the Waikato Regional Council, it did introduce a cost to the farm system that wasn't able to be recouped through productivity gains.

However, the "Spikey" technology developed by Pastoral Robotics Ltd (Bates & Bishop 2016), with the ability to detect individual urine patches and then apply an alternative treatment to prevent the rapid conversion of urea to nitrate (see 6.7.5 above) may be as equally effective as blanket DCD application, were it still a viable tool.

6.10.2 Denitrification beds

Denitrification beds have application when dealing with point source discharge, like effluent from a farm dairy parlour or a tile drain. Essentially lined containers filled with organic carbon (typically wood chip or coarse sawdust), the wood chips act as an energy source for denitrifying bacteria that convert NO_3^- to N gases. While initial trial work in NZ found a denitrification bed removed the entire N load from dairy effluent (Cameron et al 2010), the applicability of this technology on farm at this juncture is uncertain, given the economic value to the farm system of recycling the N fraction of FDE as a fertiliser and the need to still dispose [to land] of the treated FDE, which will still be high in other nutrients, such as K and P.